Quality and Impact 2018 Kvalitet och Nytta 2018 (KoN2018)

### **Report Template for Review Panels – Overview of Research Field**

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#### Research field/Panel (no. and name): 9 Agricultural and Horticultural Production

#### Strengths

A few strong groups that have good local leadership, both scientifically and in terms of staff management.

The SITES infrastructure and field experiments (including long-term experiments) seem to be adequate.

#### Weaknesses

There appears to be a lack of strategic timely leadership at faculty and department level. Groups, where professors have left (retirement, moving up into higher levels of university management), are mostly in a leadership vacuum. It appears unclear where the responsibility for this lies, i.e. with the department or the faculty. It remains unclear whether this relates to lack of strong visible leadership from SLU central level.

There are overlaps between Crop Production Ecology at Ultuna and the CSE group at Alnarp (they belong to different faculties). These groups are even competing. This appears to result from lacking coordination between the two faculties.

Some researchers are not sufficiently pushed in terms of ambitions. They stay within their comfort zone. This means that the full potentials are not being used.

In some groups, the PhD students and PostDocs are relatively old. This is a potential problem for researchers to develop to high standards, which often requires long-term efforts where PhD studies is part of the early career research education.

Teaching should not be a service, but an integrated part of the science. To make this happen, teaching responsibilities and achievements have to be equally valued to scientific output (papers and impact factors) and the importance of teaching at SLU has to be recognized at all management levels.

International contacts are linked to relatively few researchers. Too many researchers are in a local comfort zone, where this is not needed. There is a lack of international stakeholders.

There was no documented coordination of EU projects. Such efforts, which are rewarding in establishing international contacts, requires strong support from the university for project applications and management.

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Panel/ Research
Agricultural and horticultural production

field
Image: Comparison of the second se

UoA

Crop Science Grass and Forage Science

#### Introduction

#### General assessment of the Unit of Assessment

The UoA has grown within the past two years after retirement of professor and recruitment of new professor consisting of 1 professor, 5 researchers, 3 post-docs and 3 PhD students. Thus, the evaluation period is not fully reflecting the current situation of the UoA. The UoA is part of the Department of Agricultural Research for Northern Sweden in which the other part is livestock science. The two groups form a tightly integrated research environment and large enough critical mass for stimulating research environment not only concentrating in crop science but also covering the livestock science. The clear research strategy and the activity of the UoA in networking and national and international collaboration including other SLU units is shown in the high-quality research and ability to attract international research staff. The clear vision on utilization of their skills in modelling and new technologies combining livestock science and crop science offer them means to develop themselves as one of the world-leading groups with this focus. The UoA has collaborated actively with the stakeholders, especially with the farmers. Even though they have a straightforward vision of the future needs in societal collaboration, further planning with the agricultural societies of the area could be fruitful. Discussions of the needs and requirements in advisory services could strengthen the multiactor approach of the UoA.

### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

Overall, the UoA has published both in high-quality livestock and crop/forage science journals within the period 2009 – 2015. The most used scientific journals represent mainly the top of the discipline. The published work has good internationally visibility, based on the number of citations and citation percentage as well as the affiliations of co-authors. However, the evaluation period is not fully reflecting the current situation of the UoA, due to retirement of the old professor and appointment of a new professor. The publication record does not quite represent the past or future directions because the publications of the previous professor have been omitted and there has also been a shift in the research profile towards a stronger focus combining crop and livestock research. Along with the newly appointed professor, the research profile of the group focus is driven by modelling, sensor technologies and agronomic perspectives of forage production. Decision Support Systems (DSS) could certainly be developed for answering more questions than only 'the optimal harvest date '. Strong co-operation with the animal scientists widens the research profile, not only to the management and quality of the forages, but also to the quality of end-products, such as phytoestrogens and their metabolites in milk demonstrating links to societal demands and concerns. The research profile emphasizes the interdisciplinary character of the UoA and thus, there is a good chance that this UoA could develop to one of the world-leading groups within their focus area.

#### Score for Scientific Quality

#### 5

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

3

With the newly appointed professor, the UoA is reviving the scientific environment. The UoA has already adopted new activities to create an attractive, vigorous and productive scientific environment with an aim not only to attract but also to maintain the highly qualified research staff. These include creation of a stimulating and fostering working environment as well as social activities outside the working environment. Overall, the UoA is international, driven by the enthusiasm of the new professor, perhaps also inspired by his international background. Many of the new employees have an international background, which has likely increased the external influence. The UoA has active international contacts through networks and research collaboration. Genders are equally presented in the UoA and the number of junior faculty has increased markedly within the past year.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA has a clear strategy and methods to support and encourage the development of young faculty, not only in the working environment but also socially. Younger researchers are encouraged to participate in teaching, aided in expanding their professional networks, and guided to acquire research funding. A step towards the development of career pathways are for example posts of associate senior lecturers.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA clearly focuses on Fennoscandia, but they collaborate actively with the other SLU groups trying to broaden their view to cropping systems. Co-supervision of PhD students is beneficial in enhancing the interdisciplinary research and promoting research. Overall, the UoA is well connected internationally through global academic networks and research projects, as indicated in their scientific output and ability to attract international personnel. The group emphasizes the need for improved integration of crop and livestock research and actively contributes to this very important issue.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The UoA integrates different disciplines in an outstanding manner. The UoA works together at the department level with animal scientists, but also with at least 9 other SLU units. The UoA contributes to a cross faculty platform on Cropping Systems. The UoA is also hosting one of SITES (Swedish Infrastructure for Ecosystem Science) facilities. The competence of the UoA in spectral technologies and modelling will increase the attractiveness of the UoA as a collaboration partner, especially with those SLU groups where those competences are missing. These competences also offers possibilities for international collaborations.

#### Score for Scientific Environment

3

#### 1.3 Strategy for Scientific Development

### 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

4

The strategy for scientific quality and renewal has a very clear direction and the pathway is realistic. It is also well aligned with department management, both in terms of strategy and how this is executed. The UoA has for example a clear vision of when and where to apply funding (applying a matrix reflecting research and funding gaps and opportunities). The UoA has utilized different channels for recruitment of new members in an outstanding manner. The UoA makes sure that the research subject areas in focus align with the competence of younger researchers to enhance scientific quality. The UoA describes a clear pathway on how knowledge is maintained and transferred from senior scientists to younger scientists.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The vision of future research directions of the UoA is clear concentrating on the challenges and development of forage production combined with animal production in northern Sweden. The UoA names five central research themes including both production systems and technologies, out of which four are emphasized in future plans. The UoA has a clear strategy for the achievements. They are conscious of the requirements needed for successful implementation of the strategy.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The most important challenges are related to recruitment of new members in the UoA as well as obtaining financing for the research activities.

#### Score for Strategy for Scientific Development

6

#### 1.4 Additional comments

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA presents 5 groups of stakeholders, including students, though the teaching activities have been in a minor role. However, the UoA has had a strong focus on output to farmers, for example in the form of variety testing, fact sheets and educational videos, which can be directly utilized in practice. The UoA participates in regional and national forage conferences and field days for farmers and advisors. The website of the department has a farmers' corner and they are also welcomed to visit the UoA. The UoA has contributed in two books targeted to farmers, students and scientists and even the wider society with an interest towards food production. These activities demonstrate a regular contact with the stakeholders. Overall, the activities of the UoA demonstrates a good contact with stakeholders.

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#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The UoA conducts variety trials and has produced guidelines related to forage management (for example harvesting time related to quality) as outcomes. However, it can be argued that some of the research, such as work with the reed canary grass, might not have yielded high impact outcomes.

#### Score for Outcomes

#### 2.5

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA has strategic goals, which are well integrated in the department, though the future focus of the UoA is dominated by the scientific impact and the social impact is not that clearly described. The incentives and measures are sufficient for implementing the strategy, but more detailed consideration of the role of suggested "samverkanslektor" as a bridge for a multiactor approach to research could be advantageous.

#### Score for Impact Strategy

#### 2.5

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

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The UoA stresses the importance of mutuality and dialogue as a basis of collaboration with society. They emphasize the role of education and direct interaction with stakeholders in farmers groups and committees to establish common approaches and prioritize the research topics.

# 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The new national Food Strategy emphasizes the role of agricultural production in entire Sweden and along to that also the need to increase food production. Furthermore, there is a clear need for advisors specialized in crop and especially forage management in northern Sweden. Thus, it is recommended that the UoA arranges strategic discussions with the agricultural organizations on how to fulfill the societal need. The suggested "samverkanslektor" together with multiactor orientation could provide a solution to these issues. The UoA could also communicate more strongly and visibly with the society in wider aspect of food production, for example related to environmental questions and food security. The UoA has pointed out the importance of Swedish language skills of all staff in an attempt to improve the communication possibilities and thus collaboration with society. Due to the nature of the UoA research, it is likely that their societal impact could have even wider perspective and cover the needs of surrounding areas with similar conditions, such as Norway and Finland.

Panel/ ResearchAgricultural and horticultural productionfield

#### UoA Crop Production Ecology

#### Introduction

#### General assessment of the Unit of Assessment

The research profile gives the chance for high quality research with high societal impact in the area of "Innovative multifunctional crops and cropping systems for food, feed, fuel and fibre. Efficient use of resources in present and future climates". The overall impression of the UoA's research is good to excellent. The research performed is increasingly developed in dialogue with farmers, which is good for a potential societal impact. There is some overlap with the Cropping Systems Ecology group at LTV (interaction of plants with each other, soil, weeds and environment).

The UoA covers a broad area of expertise, understanding plant and cropping systems in arable crops as well as short rotation forestry. This unit is particularly large in number of members, resulting in outstanding research activities and outputs, at the publication level, at the number of PhD degrees awarded, at the funding and research project obtained level, with a high international profile, attracting several researchers to spend at least one month at the UoA. The current and near generation shift can be a big chance to formulate and further develop the research. However, a clear strategy for this is not obvious and seems to be based mostly on continuing current activities. Here lies a huge chance but also a big risk, if the importance of a coherent strategy for future research is underestimated.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

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The UoA is relatively large with 5 professors and overall 27 researchers during the evaluation period. This comprises three research subject areas plus additional and attached units from variety testing to managing field research stations. The three research subject areas are: 1) Plant ecology and weed biology, 2) Agricultural cropping systems, and 3) Short rotation forestry. The research profile is broad and based on a systems approach rather than on specific scientific disciplines. This is very much in line with the overall strategy of SLU of working towards sustainable production systems (a big point resulting from the last KoN assessment in 2009). Mechanistic understanding, multifunctionality and resource use efficiencies are important approaches in the UoA to obtain more insight in agronomic production systems. As a result, the research covers both agronomic and ecological disciplines (e.g., plant ecology and weed biology). Here, particularly the first two research subject areas appear more coherent, whereas the subject area on short rotation forestry is less clearly described and appears somewhat fragmented, covering non-integrated activities on other continents as well as inside of Sweden. Overall, the research is well guided with clear identification of areas, where the group is focusing within the overall systems approach. However, it is also a very broad overall research profile, and a strategic view on future developments would help. The work in such a field is not always easily directed and long term oriented, and the aim is to work towards more sustainable production systems also means that targets are moving. For this it might be necessary to link up more with animal production systems and their interaction/ effects/ possible consequences needs to be considered. There is a clear need to be positioned along the axis of genes, plants, whole fields and landscapes, but clearly, the focus of the UoA is on the plant and field level and less on the interaction or importance of the other aspects. Also, comments on developments within related areas such as digitalization or the interaction with animal production systems are missing.

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For such a more broadly based group the reviewed paper output is good. The UoA analyses its research quality with respect to 2 renowned research groups (Aarhus and Wageningen). Their analysis reveals that if the different number of researchers are taken into account the individual output and citation level is comparable/slightly lower. The 10 major scientific publications are well positioned and the quality of publication in general is very good.

#### Score for Scientific Quality

#### 5

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

This UoA has chosen to be the whole department. This is a very positive and healthy sign. Many measures have been taken within the UoA to foster discussions such as informal meetings, journal clubs, support in application writing etc. Also, a language course in Swedish has been initiated to better integrate foreign researchers. However, the approach appears to be a collection of measures rather than a comprehensive strategy and only the Swedish language course initiative shows activities beyond standard activities within research groups.

The gender balance is very good. A critical situation seems to exist in the area of professors since two are apparently externally funded and retiring now. Two more professors are on the verge of retiring. Half of the researchers will reach retirement age in the coming years. This means a loss of expertise, but also gives possibilities for re-orientation and international recruitment. Some young PhD students have been recruited, but some PhD students are also very old for "a young researcher". In the past 5 years 57% of the recruitment had their PhD degree from a foreign university, hence, there is a clear orientation towards international recruitment. The UoA has a high number of international people visiting. However, the members of the UoA seem to have very little movement to their collaboration partners, and the focus in the interview was more on excuses than on how this could and should be solved.

PhD projects accounted for only 20% of scientific publications from 2009-2016. Compared to the total number of PhD students this appears low, suggesting that more outputs from the PhD projects could be achieved.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

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Specific measures are listed to encourage the development of young researchers, through discussion groups, encouragement to follow specific courses, etc. Also, the encouragement to follow the Swedish language course for foreign researchers within the UoA should be appreciated.

However, there does not seem to be a clear, coherent strategy for supporting young faculty. Also, no overall plan to secure continuous funding for the existing researchers is present. Stimulating outgoing mobility (international) should be a natural part of research education and a necessary part of research career development; however, no outgoing mobility initiatives are mentioned in the report.

# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoAs work does attract visitors and this can only be interpreted in a way, that they do have an impact on other groups work. The network for this is good and extensive.

A number of international contacts are listed and, if used appropriately, can clearly contribute substantially to an overall strategy of internationalisation.

By being partner of the ICRAF, impact in international context is ascertained. However, this appears to be a result of the initiatives of an individual in the UoA and not a strategic decision.

1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The UoA itself works in a very interdisciplinary way. Synergies with other UoAs at SLU do exist with a number of other UoAs and platforms within SLU and within Sweden. Interestingly, the UoA on Cropping Systems Ecology (643\_2\_LTV) evaluated through this panel is not on the list, but was clearly addressed in the interview. Whether this cooperation is developed to its full potential is not possible to judge by us. But possible conflicts of interest due to overlapping research themes are obvious, both on a national and an international level. The statement that the UoA will work from genes to landscapes is not sufficiently specific and a clear strategy is not apparent.

#### Score for Scientific Environment

4.5

#### 1.3 Strategy for Scientific Development

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

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This UoA is going through a huge generation shift and even at the professor level, two out of three professorships need to be renewed. The self-assessment names a number of replacements to be done now or in the near future. The fields of research named appear to be mostly a continuation of the current research approach of the UoA with inclusion of some new technologies. This is a very simple strategy where only new expertise needs to be acquired and no major investments for new domains are needed, and it will also favour promotion of younger researchers within the UoA. However, it may not satisfy the future needs and link well with future technological developments.

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Therefore, the strategy to cover the system from individual plants to cropping systems is very good, but the ambition to cover systems across scales (i.e. from genes to fields and landscapes) seems too much and is not supported by later statements in the self-assessment.

It cannot be judged whether an overall strategy exists. The individual aspects and areas are without doubt good and relevant. Lacking and not named in the strategy is where to go to with the replacements of the professors. Also not touched at all is the question what to do with the third subject area of short rotation forestry, where there does not appear to be a great need in society (at least in Sweden). There appears to be a need to re-evaluate the relevance and scientific directions of the subject areas of short rotation coppice and agroforestry.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The field of work is very important and clearly in line with SLUs strategy towards more sustainable systems. The UoA has shown that it can make internationally well recognized contributions. It might, however, be required to let go of less accepted systems (by farmers) such as short rotation forestry and agroforestry. Sometimes it is difficult to see, what is planned on a more specific level. To 'identify processes and interactions among crops, weeds, pests and soils' is broad and not clear. There also appears to be a lack of consideration of the need to include aspects from new technologies such as digitization.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The most important challenge for the UoA is to achieve a well-organized generation shift. This also includes recruiting young and innovative researchers. A solid and clear career perspective and plan seems to be missing and the age structure shows many mid-qualified persons at a relatively high age. Cutting edge science requires highly motivated researchers, and the UoA is identifying the need for successful recruitment of young staff members, along with the creation of an open and stimulating research environment. However, the UoA seems to underestimate the role and importance of new PI's at professor level.

A big challenge is the diminishing of funding for applied research. This requires more activities with stakeholders and the UoA recalls the importance of the Focus Groups, which are also extensively encouraged by the European Commission (EIP-AGRI), especially Operational Groups.

#### Score for Strategy for Scientific Development

4.5

#### 1.4 Additional comments

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

This UoA (part of NJ) and the LTV one on cropping systems ecology, technology and statistics both want a professor in weed science. Here the absence of an overall strategy and the difficulties of individual departments within separate faculties to deal with this become apparent. This is a limitation in development due to the faculty functioning. It becomes even worse, if you consider cross-faculty departments (which are very good in terms of developing the topic, but very bad when it comes to filling positions).

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### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The activities are such that they can potentially have great societal impact. A range of measures are taken to ensure interaction with farmers. However, one can read between the lines that the farmers are less interested in the more scientific approach and the science base. This points to a possible gap in communication. When looking at the output in terms of popular science (which includes also the grower magazines), the output is low, pointing to a low priority for end-user communication within the UoA. This is hard to understand considering that two communication people and a number of groups working in more applied areas are part of the UoA. There appears to be a big variation in the interaction with society between the more research based subject areas and the different attached groups on the more applied level. The more applied researchers are often presenting results at the regional conferences for advisors in crop production.

#### Score for Activities and Outputs

#### 2.5

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The output in terms of strategies for breeding companies and machinery to be used is very good. There is a mismatch between great areas of research listed in 1.1.a and the actual impact at the practical level. Being able to name and quantify trade-offs should result in significant use by society. But this does not appear to be the case. It is, for example, written that research findings may have influenced fertiliser use etc. (is it yes or no?). Is a key outcome really the successful establishment of agro-forestry in Africa and South-East Asia ? This sounds much broader than what one UoA can ever reach.

The possible development of an insurance system for farmers based on the report of effects of extreme weather on yield in major arable crops is also an important outcome for farmers.

The relevance of the variety testing is reflected in the 7300 downloads in 2017.

However, from an outside perspective it is difficult to understand, that the UoA is heavily involved in the development of machinery, but has no share in the revenue (in form of patents, licences etc). This appears to be a general SLU problem.

#### Score for Outcomes

#### 2.3 Impact strategy

# 2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The focus of the UoA's research is on scientific output rather than on the impact on society. Since also the evaluation scheme provided by SLU to us fosters this priority, the SLU leadership needs to reconsider the importance of this area. A simple question is: Does it help a young researcher in his/ her career if he/ she engages significantly in societal impact?

Nevertheless, the UoA includes two communicator positions. Co-ordination of outreach activities by recently forming a board (VPE kontact) in order to increase impact is also a good step. This board is a good idea and SLU could use this idea, also in other UoA's, to improve the impact. The recent history of the UoA is to be more involved in societal impact. The UoA has set an agenda to strengthen the impact by using the already in place activities when conducting the regular research. Some groups within the UoA already have outreach programmes and they would be used to extend the contribution to societal needs and challenges. Therefore, the UoA is working on bridging the gap between theory based research and application in order to increase the impact.

Bottom-up research where the industry is present at the start to discuss is also an interesting way to impact society. Further improvements are certainly possible but the path is the right one. Industrial PhD's might also be an interesting way to interact with society. An approach that should be encouraged. Societal impact is also envisaged with the agroforestry programme in collaboration with ICRAF, here the focus is on less developed countries and small-hold farmers. But this activity is based on a single person, which seems to be not well connected to any other activity of the department.

#### Score for Impact Strategy

2

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

This UoA is trying, but hasn't found the right way of communicating the more science based approach in their research. The approach to collaboration with society is so far much better as part of the activities during the design and implementation of the projects. So, they are much better in the formulation stage of research activities by integrating different stakeholders. However, the low priority evident in the low number of popular articles and the complaint that Swedish farmers do not accept the more permanent cropping systems show a gap between the UoA and those who should use their results. Overall this UoA has a good understanding of collaboration with society. It is formulated in a logic way and they do understand that there is a gap at the outreach part of project results.

# 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

One of the UoAs topics is determining the trade-off between different farming practices. Since time and personnel is limited, it is a question of the UoAs valuation of the trade-offs of getting involved in explaining this in an easy to understand way to society. The focus of the UoA is clearly more on the development of the research and that appears to be largely in line with SLUs strategy. Interacting with stakeholders is time demanding and must be a win-win relationship to be successful.

643\_2\_LTV Cropping systems ecology, technology and statistics 14

Panel/ ResearchAgricultural and horticultural productionfield

UoA

Cropping systems ecology, technology and statistics

#### Introduction

#### General assessment of the Unit of Assessment

The UoA belongs to two faculties (LTV and VH) which complicated the evaluation. The main group in this UoA is CSE and the other two groups (technology and statistics) seem weak. The applied statistics group primarily performs consultation, not scientific research. The UoA emphasizes participatory multi-actor research approaches involving farmers as the approach to achieve societal impact. Collaboration is mainly with farmers and not so much with the broader society. The scientific output is good (1 scientific paper per year per academic); however, 2 PhD graduations over a 5 year period is too low. The UoA research profile is broad and heterogeneous, and some more focus would be helpful. We suggest the UoA could focus more on horticultural crops and related cropping systems, to strengthen the horticultural research at Alnarp campus and hence also be better support to the Swedish National Food Strategy. Also digitalization in production of field and vegetable crops seems a promising future research field that the UoA could contribute to. There is substantial overlap with Crop Production Ecology (interaction of plants with each other, soil, weeds and environment). The faculty structure seems to be hindering efficient design and implementation of strategies. International exposure should improve (no visits abroad, only the professor acts on international level). The UoA has no convincing strategy for recruiting more PhD students and supporting their career development. Despite the efforts of SLU to stimulate cooperation, the UoA seems to be victims of a more individualistic approach.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA covers a wide range of research themes related to environmental aspects of agriculture, focusing on sustainability issues and mitigation of negative impacts of cropping systems. Main fields of study are relevant and contemporary, such as dealing with GHG, soil fertility enhancement with intercropping, weed pressure, water use efficiency, integrated approaches, multi-functionality of plants (fuel, biomass).

The UoA research profile is broad and some more focus would be helpful. The UoA has 1 professor but consists of 3 groups. One group provides services (consultation in statistics) and is scientifically not productive in terms of papers, even though this offers possibilities for co-authorship of scientific papers, where they were involved in statistical design and analysis. Ambitions to be first author of statistics papers seem unrealistic.

The CSE group works on the ecology of production systems in a systems approach and tackles sustainability of systems including organic production systems. Rather than working on very detailed scientific questions, they have a larger perspective looking more at the system from holistic perspective. The group on animal and plant technology is harder to understand and is further split over two faculties. A professor for this field seems missing and we could not find any objectives or strategies for plant technology.

The publication record in terms of the reviewed paper output is good (1 scientific paper per year per academic) with 37% in Q1 and the most used journals having good impact. The UoA convincingly shows that research with societal involvement (multi-actor participatory approach) can go well together with good impact scientific publications.

Only 2 PhD graduations in 5 years and 3 currently ongoing PhD students is too little. This was justified by the UoA by a lack of qualified candidates and of funds. Both reasons are not convincingly confirmed by the amount of research funds available and by the availability of candidates worldwide.

In general, we find overlaps with the Crop Production Ecology group at Ultuna, and not much cooperation visible. The potential of the animal and plant technology group is difficult to judge and it appears also to be given low research priority since no professorship or senior lecturer is associated with it. Including a statistics group may be an administrative way of handling statistical support, but it is not really supporting the strategic development of the group.

The UoA compares itself with major research units in Europe working on the same themes, emphasizing the major differences related to a greater empirical focus. The UoA does not indicate how they rank themselves among other national and international research groups.

#### Score for Scientific Quality

#### 5

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

Although a number of measures are listed for supporting the scientific leadership and environment, a clear strategy is not obvious. How does "working with strategies and action plans" and "focus on working environment" and "formation and management of statistics centre" lead to an attractive, diverse, intellectually stimulating and creative research environment?

The gender balance seems fine with 65% male, and from new recruitment 67% female.

The external influence seems too limited with 16% of new recruitment being international PhD. Particular critical elements are that the professor will retire during the coming evaluation period, and that 2 out of 3 PhD students and 1 Post Doc are over 40. This shows a skewed age distribution. Also, the number of PhDs and Postdocs is too low to provide an attractive research environment for young scientists.

# 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

There appears to be no strong focus on PhD courses and other training aimed at supporting strong career developments. These activities are apparently of lower priority and the respective answers in the self-assessment form are very short and not detailed. Not very convincing especially when considering the accepted need to attract more PhD students. For young researchers journal clubs have been initiated, which seems a good first step. Young scientists are encouraged to take part in different thematic platforms. Also support with project applications and engagement in project management are mentioned. However, engaging young scientists too early in project management should not be at the expense of building a scientific track record.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

There appears to be in general too limited international exposure. No UoA member had research visits abroad, only 1 out of 13 academics participated in national/international committees; 2 visiting researchers in 5 years is also low. The UoA considers itself as having 'low international visibility'. This might be true for the UoA as a whole, but certainly not for the CSE professor. Internationally the UoA participates in several EU projects. The UoA is involved in academic networks and collaborations with INRA (France), an often mentioned partner, and UoA scientists act as WP leaders (but never project leader) in EU Horizon2020 projects.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The UoA works in an interdisciplinary way and applies a systems approach. The word horticultural is more an add-on than an actual field of work. We find it hard to understand the apparently low level of cooperation with the Crop Production Ecology group at Ultuna. Both groups being in different faculties, plan to appoint a professor in weed science, and coordination appears to be needed at the level of SLU, so that duplication can be avoided and synergies obtained. The UoA is active in program committees of Future Agriculture and SLU platforms. The statistical unit is active in management and organization of statistics@SLU, which coordinates statistical activities at SLU level.

#### Score for Scientific Environment

#### 4.5

#### 1.3 Strategy for Scientific Development

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA has stated 9 points defining goals for the next 5 years. A goal like 'produce knowledge' or 'increase number of statisticians' is not very insightful. The strategy of CSE is to 'distribute responsibilities', which gives little information on the current situation. It is not clear how procedures for internal manuscript audits and Open Access publication will enhance number of international publications. A strategy for attracting more PhD students seems missing.

To us this UoA seems in a difficult situation. An apparently very successful group (CSE), an in size not defined group on animal and plant technology (apparently small) and a statistics group (service provider for SLU) that appears to be connected to this UoA more for an administrative purpose. The CSE professor will retire in the upcoming evaluation period. A forward looking strategy is needed, but not clearly visible. The new professor in weed science needs to be decided upon in coordination with other groups (in particular at Ultuna). With respect to the infrastructure, the UoA wants to further develop the SITES Lönnstorp and their lab facilities. It would have been valuable to know what actual facilities are missing and which investments and new methodologies are needed to achieve substantial advance in their research.

Instead of new recruitments of statisticians in this UoA, the statistics support at SLU should be strategically discussed at university level.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The field of work is very important. The overall main aim of SLUs strategy towards more sustainable systems can be supported greatly through the work of this UoA. We suggest the UoA could focus more on horticultural crops and cropping systems, thus to strengthen the horticultural research at Alnarp campus and hence also be supportive to the Swedish National Food Strategy. Coordination of activities with the Crop Production Ecology group is necessary. The future research directions mentioned, e.g. climate smart agriculture, integration of food, feed, material and energy production, future animal buildings, use of technology like drones and robots, all are indeed relevant directions for agricultural production systems. However, it is not clear how the UoA can/will make significant contributions to these. Focusing on all 10 mentioned broad directions seems to be not feasible.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

Although the UoA is a multidisciplinary group, integration of technology, CSE and statistics is a real challenge. Within the next evaluation period the professor will retire and the position has to be reappointed in a strategic way. There is a strong need for obtaining projects/funds for PhD (and postdoc) positions to strengthen the UoA, increase research capacity and improve the age distribution.

#### Score for Strategy for Scientific Development

#### 4.5

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

We find the apparently low level of cooperation with the Crop Production Ecology group at Ultuna hard to understand. With two groups being in different faculties, both planning to appoint a professor in weed science, coordination at SLU level is needed. A closer link between horticultural production physiology and CSE would seem logic (e.g., form one UaA in the next evaluation). The funding of PhD students is often for 3 years only (e.g. ITN network) while a PhD study takes 4 years. So one year needs to be funded additionally. Despite the efforts of SLU to stimulate cooperation, the system forces scientists towards a more individualistic approach. Paying people only 20% makes that your first priority becomes to earn the additional 80% for yourself.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The activities are such that they do have a societal impact, in particular though application of participatory approaches. The SITES field days could be used more/better for exchange with farmers and extension officers. The self-assessment states that the contact is directly with farmers and other stakeholders. The UoA regards the role of participatory multi-actor research as very high and thus can contribute greatly to an integration of societal needs and the UoA is thus aligned with the future development of the EU research strategies. The relevance of stakeholders is high at the national level and could be expanded at the international level (international organizations, associations, etc.).

#### Score for Activities and Outputs

#### 2.5

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The outcomes of the UoA's research are sound. Although difficult to judge whether it is at its full potential for societal impact, this UoA is at least close to it and clearly values this very high. Studies on grain legumes for food purposes are interesting, but not close to application on a wider scale. The UoA has performed successful participatory research together with farmers.

#### Score for Outcomes

#### 2.5

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

10 broad goals are mentioned (mostly) equal to the scientific goals of the UoA. This does not appear as a 'societal impact' strategy. The UoA has its strength on participatory research, and has considerable experience with stakeholder interactions, in particular with farmers. The UoA has a large production of popular scientific publications, helping the implementation of the strategy. The partnership Alnarp seems a good approach to bring research and society together, and it is an initiative that could be extended to the larger SLU scale.

#### Score for Impact Strategy

2

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA is performing well in terms of collaboration and working on topics directly relevant for society. They show a thoughtful view on how stakeholders can be included in the research. UoA has experience with participatory research projects with farmers and seems to understand the collaborative process. Collaboration is mainly with farmers and not so much with the broader society (end users, consumers, advisors).

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

Collaboration with actors outside academia seems to be well-developed already for this UoA. Improvement is needed for enhancing international collaboration within academia. Since time and personnel is limited, it is a question of the UoAs valuation of the trade-offs of getting involved in such activities. The focus of the UoA is clearly more on the development of the research strategy and that appears to be largely in line with SLUs strategy. The UoA could focus more on digitalization in production of field and vegetable crops. With more expertise in crop modelling and spectral technologies the UoA can clearly significantly contribute to the main questions of adaptation to climate change and nutrient cycling (sustainability). The UoA is also well positioned for topics like food from intercropping and diversity in types of crops and use of crops. Apart from using NDAs when dealing with stakeholders, penalty actions and measures should be included in the written collaboration agreement in case one of the involved parties does not comply to the agreement. Also securing intellectual property (IP) rights should be kept in mind from the beginning.

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Panel/ ResearchAgricultural and horticultural productionfield

UoA

Horticultural microbiology and production physiologi

#### Introduction

#### General assessment of the Unit of Assessment

The UoA belongs to the Department of Biosystems and Technology, and it comprises two rather small groups, namely Microbial Horticulture (MH) and Horticultural Crop Physiology (HCP). The activities of MH are mainly oriented towards strategic research while those of HCP orients towards applied research and extension. These different emphases made the overall scoring difficult and does not give full justice to individual groups. The UoA has a high research profile within microbial horticulture, specialized on food safety issues although covering several aspects of horticulture. The UoA has sound foundations on hard science, an international vision of education and research programs and a strong trust on research based education. The UoA has developed a modus operandi that leads to a high societal impact of the research conducted. Several examples can be highlighted to demonstrate the successful collaboration with the society. The quality of research within this UoA differs considerably between groups with quality (scientific impact, output) much higher for MH than for HCP. The activities are such that this UoA has a great societal impact. The self-assessment clearly states that they reach different stakeholders from policy makers to growers and consumers. The UoA is doing great work in terms of collaboration and working on topics directly relevant for society. They show a thoughtful view on how results need to be communicated (particularly in the area of food safety). During the interview the UoA also stressed the importance of pioneers where results can be implemented.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA comprises two rather small groups, one working in the field of microbiology and food safety and the other one in horticultural production physiology. These fields of research are very important and unique within Sweden and SLU. From the report and also the presentation it is obvious that these two research groups have no other links than the term 'horticulture'. For this reason the scientific quality and impact will be partly considered per group within this UoA. The Microbial Horticulture (MH) group has 10 members according to the interview. This group tackles a difficult but original topic, namely the microbiome of the phyllospere (both epiphytic and potential hazardous microbes linked to food safety) in horticultural crops and in both conventional and organic production systems. Next to the phyllosphere also suppressive substrates are under investigation. Efforts are shown to approach the microbiome in a more holistic way thus contributing to multidisciplinary research. This is a rather unique topic in horticulture. Research on post-harvest issues of vegetables linked to food safety issues are also developed in this group. This group had encountered significant obstacles in terms of equipment and buildings which had an impact during the evaluation period. From the oral presentation it became also clear that the professor has a strong vision on how to develop her research and how to look for niches where she can make the difference. The MH group compares itself with leading international research groups. It has a good research output, though the choice of journals could be reconsidered as Q1 journals have a low percentage of the total number of scientific publications. However, the group is aware of this and showed newer higher ranked publications during the interview. The group has an international profile and is regularly asked as invited speaker showing its prominence in this field of research. The group Horticultural Crop Physiology (HCP) has 8 members according to the interview. It has a high teaching load (34 man months) and this impacts the research activities. This group wants to tackle many different topics in the whole horticultural sector, so is missing focus at this moment. A good extent of classic plant physiological approaches is used for studying several phenomena for plant growth. However, they have an applied approach, responding to short term requirements within industry. As there is no applied research center for horticultural questions and a limited extension service in Sweden, this seems to take also a lot of the potential for research. This work is very valuable, but unfortunately from an academic perspective, it does not result in adequate scientific publications and their activities apparently stay within Sweden. A significant change can be expected to happen with the appointment of a new professor in 2018, who should bring more focus in the research activities. Also, the recent availability of new facilities allows high quality research. Given the importance of the horticultural sector and that it is the only group in this field, attention to support this group at university level must be stressed. Both groups of the UoA participate in a relatively large number of projects and project proposals. The number of PhD degrees seems acceptable although low (4 during 20132017), but efforts to increase the number of PhD are needed.

#### Score for Scientific Quality

#### 4

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

Many activities and actions are mentioned that promote an attractive, intellectually stimulating research environment and encourage the development of younger members of faculty. The UoA is well aware of the important role of PhD training in the unit's research and emphasizes the role of PhD students in advancing research. The UoA undertakes different actions to maintain a creative research environment. Regular seminars and journal clubs favour discussion, exchange of ideas and research knowledge. It is also to be appreciated that efforts for a good research environment are listed and problems in infrastructure and equipment are mentioned, as this influences approaches one can develop in a given research topic. The hosting of visiting researchers/incoming mobility (6 in period) allows the whole research group to benefit from other ideas. Both possibilities of incoming/outgoing mobility are stimulated. In addition, the recruitment of researcher from outside to the research unit is excellent in this UoA with 4/5 recruitments from outside SLU. Also the participation in international projects and COST actions favours a creative research environment. The gender diversity within the unit is skewed towards female representation. In addition, the age balance discriminates young researchers with only 2/20 younger than 30 years. This observation is also present in other UoAs were PhD's and post-doc have a higher age than generally seen in European universities.

# 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA has developed actions to protect time for younger group members not to perish in university administration. They also put efforts in framing the µHort school for a number of years. From the description it is clear that the UoA aims to stimulate group responsibility at research level but also at facility and equipment level. Young post-doc researchers are actively supported at different levels of transferable skills and in their postdoc research careers, and these series of actions actively support younger researchers to develop independent thinking.

# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoAs is very small, but seems active internationally, in particular within the MH group. This is much less developed within the HCP group compared to the national activities. The international collaborations are mainly within EU and within the Nordic network. It is, however, not clear in what way the unit impacts the scientific debate in these networks. On the other hand, being asked as invited speaker shows that the group on MH has impact in its specific research field.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

We cannot judge whether the cooperation is developed to its full potential. By nature in the horticultural field, studies are interdisciplinary and that is also clear in this UoA. One would expect strong co-operation with Crop Systems Ecology (mechanistic understanding of plant and cropping system processes), but this is not clear and could likely be further developed. During the interview, the response to such collaboration was somewhat evasive as greenhouse production is more prominent in their research activities. Interaction with other UoAs seems limited to co-supervision of PhD's, and joint projects are not directly mentioned. UoA members are participating actively in the cross university platforms for cropping systems, food, aquaculture and plant protection and were/are through representation in management committees ambassadors for these activities. Three young UoA members are part of the new task force on horticulture and engage in novel research structures and innovation in horticulture. The UoA has also been represented in the steering committee as well as subject group leaders within the framework of Tillväxt Trädgård (Partnership Horticulture). Plus, the UoA takes part in the strategic work of the Swedish energy surplus network (SSEC).

#### Score for Scientific Environment

#### 1.3 Strategy for Scientific Development

# 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The strategy for scientific quality and in particular for scientific renewal is sound and ambitious. It covers the needs for in-depth science, high positioning of the research and of the outputs, even stronger international collaborations. The coming professor can drive and support this ambitious approach. This strategy would require a greater degree of commitment of all members of the UoA to advance their engagement and international network. Its realisation requires new expertise in different domains and also requires the acceptance that good work can be supported by a more mechanistic analysis, resulting in publications in higher ranking journals without losing the information for and the contact to the practice. Also a challenge for financing new equipment is present and will depend on SLU priorities for investments. Nevertheless, this could enhance collaboration with other departments that have the specific background/technologies.

# 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The overall aim of SLUs strategy towards more sustainable systems can be supported greatly through the work of this UoA. The UoA is well-positioned to continue studying microbial interactions in the horticultural value networks and plant production in highly controlled growing environments. It has unique expertise with respect to food safety and phyllospere communities. Furthermore they also propose cross disciplinary research with the chemical ecology group. For the horticultural oriented group much will be expected from the new professor. At this moment we miss the importance of molecular concepts (genes underlying physiology) which also is more and more important in (international) horticultural research. Overall the UoA can also contribute in our understanding of complex interactions in organic horticultural production systems.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The UoA emphasizes two main aspects to make significant contributions for future research directions, being first stressing SLU toward funding and facilities/equipment (upgrade or replacement), and second stressing human resource management (better dialogue and interactions among members, common goal commitments, a clear career path for young researchers) and recruitment (new expertise and specialized personnel).

#### Score for Strategy for Scientific Development

#### 4

1.4 Additional comments

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The activities are such that they have great societal impact. The self-assessment clearly states that they reach different stakeholders from policy makers to growers and consumers. The UoA provided a list of commissioned research, which illustrates that in Sweden they are recognised for resource management in horticultural systems, different aspects of hydroponics, organic and integrated horticulture. Consultancy with respect to food safety is also illustrated. Also the extension towards farmers is well documented. The full potential for societal impact seems accomplished, especially at the national level. Implementing programmes of Industry PhD students can only increase their impact. The efforts towards societal impact apparently take up a considerable amount of time.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

Although difficult to judge whether the UoA is at its full potential for societal impact, it is at least close to achieving the potential and clearly values this very high. Safe food, reduction of food wastes, integrated/organic production are a core research line of the UoA and societal impact is very clear. In this respect, research output is used in different types of applications to serve society as illustrated in three case studies oriented towards different stakeholders. In addition, information for teachers within the scope of their research is made available.

#### Score for Outcomes

#### 3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA already has a well-established strategy for societal impact, despite their observation that the university system is non-rewarding for intensive societal contacts (financially or as merit). It also analyses strengths and weaknesses of the group to have a societal impact. A dual strategy from acquisition of the question/challenge to translation to society is described and the whole group is co-responsible to identify ways to impact society with obtained results. This is a realistic approach for the unit, as illustrated by the provided impact studies. Several ongoing incentives are mentioned such as "Matologi", which activity is arranged by SLU as a whole and where the UoA is involved. The UoA is active within the extension organization Partnership Alnarp. A more formal organisation at least at department level could potentially further improve the societal impact or give some more time for the researchers to focus on their core business. SLU provides the function of samverkanslektor, and during the interview it was mentioned that this function is part-time present in the UoA. The interview also indicated that in future greater outcome from this function is expected.

#### Score for Impact Strategy

3

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA is doing great work in terms of collaboration and working on topics directly relevant for society. They show a thoughtful view on how results need to be communicated (particularly in the area of food safety). During the interview the UoA also stressed the importance of pioneers where results can be implemented. The UoA has during the years gained good expertise on how to collaborate with society. The IKEA example is a nice illustration of how insights can grow and interaction with society requires a broader approach of a topic than present in the research projects. As such, it stimulates reflection on both sides, academia and society, for a given problem. The pesticide persistence example on the other hand clearly indicates that 'societal interventions', if results do not align with stakeholder expectations, can considerably reduce enthusiasm of research units for projects with societal impacts. As a suggestion for future activities and to avoid drawbacks in this specific case study, a preliminary written agreement between parties outlining all the aspects of the collaboration, including NDA, could reduce negative impacts when things go not as planned.

# 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The outcome of the research of this UoA is clearly targeted towards society. Given the size of the UoA and all the many other tasks, the panel wonders whether there is additional capacity for collaboration with actors outside academia, or whether it is rather a question of focusing these activities.

### Quality and Impact 2018 Kvalitet och Nytta 2018 (KoN2018)

**Report Template for Review Panels – Overview of Research Field** 

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Research field/Panel (no. and name): 10 / Animal Health

#### **Quality of Research**

- In general the quality is good to excellent (score 3-5)
  - Strong fields are found in all UoAs. For example:
    - o Small animal internal medicine, especially cardiology, feline genetics,
    - Equine internal medicine
    - o Infectious diseases and immunology
    - o Animal reproduction
    - o Epidemiology
    - o Pathology
    - Comparative medicine
- Weaknesses are the low number of PhDs and limited international presence (research visits, post docs visits, international meetings etc)
- There was a lack of strategic planning including succession planning in almost all UoAs
- Administration (organization) of SLU seems complex and intrusive as felt by a number of professors and researchers
- There is further potential for expansion and development
  - o Improve already existing scientific collaboration with SVA
  - o The collaboration should be improved with University Animal Hospital
  - o Enhance One health research including low income countries
  - o Translational medicine (between species and from animal to human)
  - Explore increased EU funding and engaging other funding bodies and industry
  - Increase attendance at international meetings and membership of influential of committees and boards

#### Societal Impact

- Societal impact is good to excellent (2-3) in most of the UoAs
- In all, the impact is extensive, extending from pharmaceutical and biotechnological companies, government agencies, veterinary practices, to dog and cat breed clubs, animal owners worldwide and education (close to users and stakeholders)

#### Capacity for collaboration with the Society

- Collaborations exist, but this could be improved and it is necessary to have clear strategic plans to engage with the stakeholders and customers
- Business collaboration could be improved. This could be coordinated at the faculty level.
- Presence in decision making boards would be essential

#### General comments about the review process

- We feel that we have spent more time talking about management issues than research
- We interviewed a lot of positive, talented and motivated individuals
- The research was generally well focused on delivering solutions to real life problems.
- We feel that the organization of the UoAs was an administrative process rather than based on natural collaborations.
- it was difficult to evaluate the UoAs based on the paperwork delivered beforehand, but the presentations were generally excellent and the interviews were very informative

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Panel/ Research field	Animal Health

#### UoA

Surgical Sciences

#### Introduction

#### General assessment of the Unit of Assessment

In general, the research is of good quality. The strong research areas of the UoA are small animal reproduction, especially diagnostics and outcome of canine pyometra, equine orthopedics, especially assessing asymmetry in equine movements/lameness studies, neurology, studies on canine intervertebral disc disease and research on a new surgical implant. The geographical scope of research partners is considered wide and successful.

However, the potential for the UoA is not maximised due to collaboration challenges with the UDS and the research teams' apparent frustration with lack of research leadership that should help them with research strategy planning, recruitment and the improvement of the working environment. This was apparent in the self-assessment and further supported during the panel's interview with the UoA.

The societal impact of the UoA's research will be improved with a clear strategy.

In conclusion, strong leadership with fulltime or tenure track professors and good collaboration with the UDS would be of major help in stimulating research output and quality.

### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA covers research in anesthesia, diagnostic imaging and small and large animal surgery. The research areas are relevant to their fields and versatile varying from species specific research such as canine pyometra or equine anesthesia to topics covering several species, for example diagnostic imaging methods on osteoarthritis and osteochondrosis. Many of the research topics arise from everyday clinical work. The imaging facilities at the University Animal Hospital are world class but their use is limited for research. There seems to be a good collaboration with Pathology and Clinical Pathology. The barrier between the University hospital and academia seems worrying and is a very big obstacle for conducting clinical research.

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The scientific productivity can be considered very good taking into consideration the very low number of professors (one fulltime, one 10%, one 20%), researchers (0), and PhD students (3). The number of senior lectures (9) is fairly high compared to other UoAs but most of their time is spent teaching. It seems that the biggest obstacle for research is lack of senior supervisors who would have time for supervision. Supervision of PhD projects seems impossible with 10% or 20% Professor positions.

The strong research areas of the UoA are reproduction, especially diagnostics and outcome of canine pyometra, equine orthopedics, especially assessing asymmetry in equine movements/lameness studies and neurology, especially studies on canine intervertebral disc disease and research on a new surgical device shown by the top 5 % number of publications, type of journals, external collaboration and number of citations or external funding. Small animal dentistry research has received significant external funding but the there are no research results yet. Objective methods to diagnose equine visual impairment have been developed.

In all, the scientific quality can be considered internationally recognized.

#### Score for Scientific Quality

4

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

There is only one fulltime Professor and no research group leaders, therefore the creation of a vigorous research environment relies on the enthusiasm of some individuals. The efforts have been sincere but are in the development phase.

The gender balance is, as it is in many countries, mainly females. The age range of the senior staff is somewhat worrying in respect of the future since there is only one in the range of 31-40 years. Four staff are in the range of 51-60 years. In addition, there are only three doctoral students and are in the age range from <30 to 50, the recruitment of future senior lecturers might be very difficult. UoA has been successful in international recruitment of two PhD students. However, they returned to their home countries and so are not strengthening the staff in UoA. The exchange of research visits of the UoA members or hosting visitors is minimal.

The working environment at the UoA is suboptimal. The written and oral reports give an impression of frustration which we are certain have a negative impact on research as well as teaching. The recent loss of most of the world leading applied clinical equine biomechanics group, including PhD students and clinical orthopaedic research, has had a huge negative influence on the UoA's research level.

# 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The support of young faculty has some structure in the form of a PhD research school and a Supervisor forum. There is also the Young faculty/researcher group to give support and networking. All these are good forums to support younger faculty.

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# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

Most of the collaboration resulting in publications is national. The collaborators outside SLU are in relevant fields, for example, Uppsala Akademiska Hospital, Karolinska Institute and the private animal hospital chain Anicura. Equine surgery has a good network of collaborators with foreign universities and industry. Small animal surgery has also industrial co-operation. These international networks have resulted in articles with authors from all over the world. The geographical scope can be considered wide and successful. It seems that most of the collaboration has started from the initiative of the UoA and the role of the UoA as the coordinator.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The majority of research of the UoA is done within the Department of Clinical Sciences. This is logical since most of the research is clinical and the nearest co-workers work within the same department. The next most common partners come from Dept of Biomedical Science and Veterinary Public Health and the University Animal Hospital. Similarly, most of the published articles are from SLU. The University of Copenhagen is the most common international partner. The synergies within SLU are not developed to their full potential. Working with the University Animal Hospital is extremely challenging. The hospital would be a logical partner in small animal and equine clinical studies.

The biomechanical group have had collaborations with SLU initiatives, such as SCIMoves, with the Functional Anatomy (AFB) and Epidemiology. International partners have been scientists and developers in Utrecht, London and Zurich as well as private companies. The equine pain surgery group has collaboration with KTH in Stockholm and scientists in San Diego and Davis, CA.

#### Score for Scientific Environment

#### 2

#### **1.3 Strategy for Scientific Development**

# 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA is very aware of the actions which should be performed in order to promote scientific quality. These actions include improving the mechanisms to collaborate with the University Animal Hospital and increasing collaboration internationally and translationally. As well, the number of PhD students and providing specialist training (Diplomate) should be increased.

# 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The general goals are broad but relevant to the fields of UoA. The more detailed forward plans do not propose any new avenues but continue with the same research topics. This is understandable if one takes into consideration the lack of research active people.

30

To merge/re-unite the clinical elements of biomechanics with large animal surgery and create a platform between biomechanics, equine orthopaedics and pain assessment is of utmost relevance to keep Swedish orthopaedic and biomechanical research world leading and to support funding from stakeholders.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

Increasing the amount of research active people and giving more time to the senior lecturers for research would be beneficial. The lack of Professors is a big challenge since currently there is no effective leadership of research. Also, rehabilitation which is now incorporated into the UoA of Sport and Companion Animal Medicine and Veterinary Nursing UoA should be re-united with Surgical sciences. There would be a mutual benefit to facilitate improved coordination of rehabilitation and orthopaedics as well as anaesthesia and perianesthesia research

#### Score for Strategy for Scientific Development

#### 3

#### **1.4 Additional comments**

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

A major priority should be developing mechanisms to make the University hospital available for research. This was a consistent message from the majority of the UoAs we assessed. There would be a mutual benefit for Animal nursing, if they would belong to the UoA of Surgical sciences instead of Sport and Companion Animal Medicine.

The proposed appointment of a Professorship in General surgery sounds outdated and would be against the practice of species related research and specialization which is the current situation elsewhere. If species specific Professorships are not possible, guest Professors or privately funded Professors would be a better option.

The panel recommends that the challenges with the suboptimal working environment be addressed promptly as the potential implications for research output and the furthering of the UoA's knowledge and competence are serious.

There is a considerable risk that within a relatively short space of time, the UoA will have a gap in their surgical research and clinical competence, which will have consequences for the future undergraduate and specialist education.

### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The societal impact of the UoA is wide, extending from insurance, pharmaceutical and biotechnology companies, veterinary practices, to dog and cat breed clubs and animal owners. When the research questions are clinically relevant, as they are in this UoA, the research results can help veterinarians in their daily work when giving recommendations to the owners (Case 3) or detecting pain in horses by Pain Face which helps both veterinarians and owners (Case 2). By increasing the general welfare of the animals, it simultaneously increases the welfare of the owners. By this means, clinical research in small animals and equine has an enormous effect on people. Given the situation the UoA are accomplishing a great deal and the outputs are of great value to society for the sake of animal welfare. This is particularly true for the pyometra project in collaboration with AGRIA and SKK with the aim to limit the high occurrence in high risk breeds by effecting breeding selection and the development of resorbable self-locking implants. Also, the development of objective methods for evaluation of equine movement and pain are of great importance for equine clinical practice and equine welfare.

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#### Score for Activities and Outputs

#### 2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The diagnostic imaging research has shown that radiography is superior to low-field MRI to detect early osteoarthritis in horses. This finding is important for future screening purposes. Studies have also shown there are breed specific differences in the occurrence of some common diseases in dogs such as pyometra, mammary tumors and intervertebral disc disease. These findings can help in the future to limit their occurrence by effective breeding selection.

The equine pain face objective methods and the Visual Evoked Potentials (VEP) have potentially a large impact.

After taking part in the written and oral self-assessment of this UoA it is apparent to the panel that the UoA is highly affected by suboptimal collaboration between the UDS and UoA. This seems to have a negative impact on research and teaching as well as recruitment of Professors.

#### Score for Outcomes

#### 2

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA has formulated strategic goals which are a continuum with current research topics. Although the research topics are clinically relevant and with the potential for societal impact, the overall strategy is lacking. Certain areas of the UoA have more adequate formulated strategies than other areas. However, on the whole there is a lack of clear strategy for how the UoA intend to attain societal impact.

#### Score for Impact Strategy

1

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

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The panel believes that the UoA has great potential with several ongoing projects and research ideas that have and can have great societal impact. However, to make this happen, the collaboration between the university hospital (UDS) and the UoA should be optimized. Thereby, the research knowledge can be disseminated to society and clients/pet owners at the UDS.

3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

Develop a sound strategy for both scientific development and societal impact.

713\_1\_VH Biomedical Sciences and Veterinary Public Health (BVF) 33

Panel/ Research Animal Health field

UoA

Biomedical Sciences and Veterinary Public Health (BVF)

#### Introduction

#### General assessment of the Unit of Assessment

The overall quality of research is good of which some is internationally recognized. The output however in publications could be higher with a higher percentage of publications in the top 10% of citations in the discipline. Despite the shortage of research funds and also the difficulty in obtaining research grants from Swedish sources the panel finds that possibilities to obtain grants from EU sources and or industry could be further explored. The UoA has made some important contributions to enable a supportive environment for research (4th year of PhD support; extra postdocs, extra lecturers). The panel appreciates there are a good number collaborations within as well outside SLU. However, the size of the individual research groups is small and critical mass could be obtained by a much closer collaboration between subunits, other SLU units and with SVA. SVA is focused on risk assessments, diagnostics and applied research, while this UoA is focused on basic and applied research and education. Thus a much closer and formalized collaboration will be of mutual benefit. The panel recommends that this is initiated at the faculty or university management level.

Generally, the impact is excellent because the results of the research have been implemented and have had a direct impact on society in the form of treatment of disease, prevention of disease and in the development of new drugs. Impact could still be increased by strengthening collaboration with stakeholders i.e. by approaching external stakeholders in collaboration with the Production Animal Medicine unit and SVA.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA consists of 9 different research groups headed by professors and the research groups have been merged into three subunits, namely 1) Microbiology (4 professors), 2)Veterinary Public Health (2 professors) and 3) Pathology, Pharmacology and Toxicololy (3 professors). These three subunits represent the whole department of Biomedical Science and Veterinary Public Health. The 9 research groups do all have a small critical mass. Major achievements appear in basic research in Streptococcus equi with advancement in development of a vaccine against strangles (microbiol subunit). Also, osteochondrosis with the identification of a cartilage fraction (patent pending) with possible translational application in human medicine is a major achievement. Pharmacological potency and efficacy where target turnover is taken into account and the in vivo and in vitro bioassays for analysis of drinking water, waste water and sediment (aqua-ecotoxicology) are a major advancement (pathol/pharmacol/toxicol subunit) as also evidenced by the quite high citation to their book. Also, the development of viral metagenomics as a discipline, as evidenced by their publications, is a major achievement. Furthermore, as discussed at interview there is the major international contribution of the UoA in porcine circovirus 2 research.

The UoA strive to obtain external funding for PhD students etc. Most of the grants, however seem to originate from 3 donors, namely FORMAS, Swedish-Norwegian Foundation for Equine Research (SHF), and VR. The publication output is good but there is a potential for improvement especially if funding from alternative bodies like EU and industry could be attracted.

The panel didn't see a common goal or strategy for this department. The department appears as mixture of small research groups with little interaction or common goal. There seemed to be a direct link between the need to provide teaching and maintaining nine research groups which results in an unfocussed research portfolio.

#### Score for Scientific Quality

4

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

We find in the self-evaluation report several items which help the research in the subunits, such as funding the 4th year of a PhD (very positive point) and recruitment of post-docs in parasitology/virology/bacteriology. Moreover, investments in teaching by appointing a lecturer in pathology and offers for residences in vet public health and parasitology & pharmacology helps staff spend more time on research.

We are of the opinion that critical mass is still too small or too dispersed on different topics. Moreover, similar scientific research interest seems to exist with another UoA "Production Animal Science" where there is also a critical mass on pig and ruminant diseases, vaccine development and testing, and epidemiology. As indicated by themselves, there seem to be limitations in career development for docs and postdocs as a maximum of 6 years after PhD is only allowed to get a position at SLU.

One important point for the creation of a good scientific environment or critical mass is the good interdisciplinary contacts and collaboration with other department in SLU (see later 1.2d). We understand from the interview that the department has been formed in 2004 from very diverse domains and moved into the new building in 2014, with separation from SVA and NFA, which resulted in a loss of technical skilled personnel and equipment. The UoA had 4 years to recover from these events, and is now requires a global strategy, including a closer working relationship with SVA and NFA. We understand that SVA and NFA are more focussed on risk assessment and diagnostic testing, which makes collaboration with the UoA more challenging. It would be helpful if the Professors in the UoA have a greater influence on decision making boards of the government or the EU which are responsible for outlining Swedish national or European research strategies.

9 people (prof/lecturer/postdoc) have been recruited in the last 5 year which appears quite normal and good for a group of 50 people (prof/lecturer/postdoc). The age distribution is also balanced with a strong tendency to the young group (47 below 50, 18 above 50) which ensures a continuity in the research domains with smooth successions. Of less importance but interesting to observe is the high representation of woman in this unit like is the case for a lot of UoA's in SLU (40 female versus 25 male).

# 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

We do not see major incentives in the UoA for development of independent researchers. One small contribution from the UoA could be a starting budget for new young researchers or staff appointed at the UoA and a 2 year exemption of teaching so that they could concentrate on writing research proposals for obtaining grants. Another way would be to give them technical lab help from the UoA or to incorporate them into an already existing research group where the young scientist might have done his PhD. All of these measures would require extra support from the university to the UoA.

# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The split of the UoA, of at least some subunits, from the SVA (even sharing some buildings), has had a negative impact on the capacity to carry out strategically important research. They were colleagues before, shared common ideas as it goes between good colleagues, and now have become competitors for the same funds. Therefore, there should be a better high level communication between UoA and the SVA and NFA to discuss priorities in research to avoid competition and promote collaboration. This competition/collaboration paradox is even more exemplified by the fact that 4 senior scientists of SVA are adjunct Professors/lectures at UoA. There seems to be a major effort of the UoA in supporting EFSA, as exemplified by the high number of publications in the EFSA Journal. This activity can establish good networks in specific domains, research ideas and define topics for future research. It is quite striking that members of the UoA make a major contribution to EFSA yet attract very little EU funding.

1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential. There seems to be different initiatives by the UoA and/or the SLU to favour interdisciplinary contacts and collaboration. The SLU platform for Future Animals, Nature and Health is supervised by the Veterinary Faculty and is hosting One Health Sweden initiative. Another one is the SLU's Environmental Monitoring and Assessment (EMA) program which provides funding for environmental health hazards and is important for ecotoxicology, such as the establishment of a National Competence Centre for Chemical Hazards in Drinking Water, activities which fit completely in the targets of research subunit Pathol/Pharma/Toxi.

Moreover, the UoA hosts the Centre of Global Disease Control and the OIE collaboration Centre for Biotechnology-based Diagnosis of Infectious Diseases in Veterinary Medicine which fits completely into the research unit of Microbiology.

The UoA hosts also the Swedish Centre for Aquaculture, a joint platform between SLU and Gothenburg University, coordinating aquaculture research and education, although we do not know where that is exactly fitting in the UoA. All these national and international activities demonstrate the strong endeavor and scientific reputation of the UoA.

With respect to interdiciplinarity within SLU a lot of collaborations have been established with other departments of SLU: joint PhD programs with e.g. Department of Wildlife, Fish and Environmental Studies and the Department of Animal Environment and Health; scientific collaborations with Department of Clinical Sciences, Department of Animal Nutrition and Management, and Department of Animal Environment and Health. Another example is collaboration from clinical pharmacology with dept. of Clinical Sciences, Animal Hospital in Helsingborg as well as National Veterinary Institute and Medical Products Agency regarding antimicrobials and medication for pain relief.

Thus, the UoA scores very good for interdisciplinary contacts and collaboration with other departments.

#### Score for Scientific Environment

4

#### 1.3 Strategy for Scientific Development

# 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

From the self-evaluation report, it is quite difficult to find a common research strategy. The strategy is rather based on the individual strategies of the 9 different units within the UoA, coming together in one health with branches in environment, animal and public. However, we think that it is possible for such a diverse UoA which performs good research and output, to develop a more focussed strategy.

# 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

We were not presented with major plans for future research directions. We were provided with a good idea of the current activities, it appears that every unit is developing their existing plans further. At interview we provided with more clarification on the strategy for future research directions in the different research groups, for example, in aquatic ecotoxicology to screen for drugs and biomarker development by chemical exposure of aquatic organisms.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?
- to have a general strategy for all these different units

- to have more influence or presence in decision making outside the university

- to expand critical mass by very close contact with SVA and NFA

- to attract more outside funding from sources such as EU an industry

- to produce more PhD's and junior research staff and develop a pipeline of talent to support succession planning in the UoA.

### Score for Strategy for Scientific Development

3

### 1.4 Additional comments

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

This is not the only UoA with a lack of general strategy

## Panel - Section 2 Societal Impact of Research

## 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

Overall the UoA has a wide range of activities and outputs providing impact from their research. These include communication activities, industrial collaboration, for example, vaccine development, web-based continued education, publications, book chapters, contributions to EFSA panels and patent-applications.

The different research groups in the UoA have different stakeholders (for example, pharmaceutical industry, farmers associations, national and international authorities) and it seems that the list identified by the UoA covers most relevant stakeholders.

Stakeholders are identified and approached by the Professors within the different research groups. This is important but a more common and strategic approach to stakeholder dialogue, including the EU, (department or faculty level) should be considered.

The panel advises a more strategic approach to communicate activities across the different disciplines of the UoA, to raise awareness of the importance of the work to stakeholders and funders.

### Score for Activities and Outputs

2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The UoA has provided three case studies from different research groups (pathology, microbiology/Food Safety and pharmacology.

The pathogenesis of osteochondrosis has been elucidated impacting both prevention and treatment of the disease in animals and humans. Research at the UoA, in collaboration with SVA, has supported policy development within the national Salmonella control programme in Swedish livestock. The last impact case study is related to in vivo potency "keep the target in sight" which is published as a book chapter and which has an impact upon how pharmacological data in drug and food sciences is designed, interpreted and communicated.

Another important outcome include development of a vaccine against Strangles. Generally, the outcomes are excellent because the results of the research have been implemented and had a direct impact on society in the form of treatment of disease, prevention of disease and in the development of new drugs.

#### Score for Outcomes

3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA's description of its specific goals in terms of social impact is very general and is more or less a repetition of activities. The overall goal of the UoA is to improve health and welfare of both animals and humans and important aims include provision of knowledge and techniques to identify, prevent and eradicate future viral threats. Also combating bacterial diseases is beneficial to society. Development of novel vaccines, diagnostics and antibiotics are important contributions to the global challenge of controlling bacterial diseases including zoonoses and AMR. The UoA would benefit from promoting its social impact to stakeholders, customers and funders.

#### Score for Impact Strategy

1

## Panel - Section 3 Capacity for Collaboration with Society

## 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

From the UoA's self-evaluation it is not easy to find a structured approach or a strategy for collaboration with stakeholders. A lot of stakeholders are identified and relevant but how and when the different research groups approach these are unclear.

During the interview with the UoA it was clear that the UoA understand the importance of dialogue and interaction with stakeholders.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The UoA seems to have a traditional approach to communication its activities i.e. 1) Microbiology, 2) Veterinary public Health and 3) Pathology, Pharmacology and Toxicology. More interaction and collaboration across subunits and research groups and a more strategic dialogue with stakeholders with participation of all research groups should be encouraged in order to change research needs and ideas. Also approaching external stakeholders in collaboration with the Production Animal Medicine unit and SVA should be suggested since the UoA and Production Animal medicine and SVA has many common interests and complementary competencies. For society interaction it would be helpful to produce more articles for livestock keepers and trade journals.

715\_2\_VH Sport & Companion Animal Medicine and Veterinary Nursing 40

Panel/ Research Animal Health field

UoA

Sport & Companion Animal Medicine and Veterinary Nursing

## Introduction

### General assessment of the Unit of Assessment

The scientific output of the UoA can be considered very good taking into consideration the restricted time allocation for research due to time-consuming teaching and clinical work.

Small animal internal medicine, especially cardiology, is the strongest area of the UoA from quality and quantity and societal impact point of view. The two large clinical trials have been ground breaking, resulting in the alteration of the indications for the use of pimobendan. Additionally, doubling the survival time and prolonging the pre-clinical period in this very common heart disease in dogs has high societal impact in addition to the high quality of the research. The research on the feline genome, although not mentioned in detail in the self-assessment of the UoA, shows high quality work with the potential for significant societal impact in affecting breeding practice within many purebred cats. A comprehensive dataset of family lines in pedigree cats has been produced and genome sequencing is being carried out to identify polymorphisms associated with specific disease, for example cardiomyopathy. There is significant potential to identify genetic markers for similar diseases in humans. Therefore, this is a high-quality research programme with potentially wide ranging impacts.

Equine medicine has concentrated its work on clinically important infectious diseases such as strangles (Streptococcus equi) and equine herpes (EHV-2 and 5), resulting in improved clinical diagnosis and the mapping of duration and extent of carrier status respectively. This is shown by publications and funding. These studies are instrumental in implementing robust methods for limiting the spread of disease, and improving the overall health of horses. High societal impact is thereby evident. The panel feels that the UoA carries out good work on equine metabolic diseases but the results of their studies need to be promoted more effectively in the self-assessment as well as in information to veterinarians, horse owners and other stakeholders.

Clinical pathology has achieved results in developing diagnostic biomarkers and improvements in additional clinical pathology methods complementing and improving diagnostic techniques.

Animal nursing has not had as large an output as the other areas, which is as expected considering the resources and juvenile research field. Nonetheless, their areas of focus; rehabilitation, infection control, perianesthesia, lameness assessment in dogs and longevity/increased life-span are highly relevant clinical areas for research that will contribute in enhancing and furthering evidence-based knowledge within the field of veterinary nursing. This, in turn, has high societal impact in improving overall health and pain management in dogs and cats, but also in contributing to evidence-based teaching on the veterinary nursing course and in furthering this competence into animal hospitals and to animal owners.

The UoA shows a thorough grasp of different aspects of society where collaboration is beneficial and show a discerning approach to how they gain this collaboration.

## Panel - Section 1 Quality of Research

## 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA covers research of small and equine internal medicine, clinical pathology and veterinary nursing which includes veterinary rehabilitation, infection control, peri-anesthesia and longevity. The three first topics are logically included in the same UoA. However, for this UoA, the research within animal nursing would benefit from being placed with surgical sciences as the research areas to date correlate better with surgery (rehabilitation, anaesthesia) and this would be mutually beneficial. Also, it is clear the veterinary nursing team collaborate very well with many groups, for example the canine biomechanics group.

In all, the research topics in the UoA are very relevant to the advancement of clinical veterinary medicine. The spectrum of clinical activities are broad in the UoA but they have been successful in focusing their research in some fields.

The strongest area of small animal internal medicine and indeed of the whole UoA, is cardiology shown by the top 5 % number of publications, type of journals, number of citations, scientific impact, external funding and international collaboration. Research in dermatology as well as cooperation between small animal internal medicine and genetics have been successful in regards to publications and external funding.

Equine medicine has mainly focused on equine respiratory diseases with emphasis on strangles shown by publications and external funding. The topic is highly clinically relevant.

Clinical pathology has clinically important research areas, including identification of biomarkers for certain diseases.

Animal nursing is a relatively new field for research and has the additional challenge of educating bachelor degree graduates who are not trained in research. Therefore, the recruitment into research must be external and for the time being from the veterinary profession primarily. Nonetheless, there is a production of highly relevant research despite limited resources and the animal nursing research team is to be commended. Canine biometrics also of good quality research. The level of innovation within their fields of research are varied. The research in rehabilitation and canine lameness is innovative in methods as is the research on longevity.

In all, the scientific quality of the UoA can be considered to be of high international standard.

## Score for Scientific Quality

#### 5

## 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

In all, the UoA has been successful in creating a research active atmosphere despite time consuming duties in teaching and clinical work. However, it seems that time allocation between different duties has been fairly successful. In clinical fields, combining PhD and Diplomate (residency) training is essential and should be paid more attention to. The way the UoA has created a productive research environment has been fairly simple but effective; PhD students have been effectively mentored through their education. Co-operation with other researchers in other fields is also exemplary. The gender balance is predominantly female, as it is in the veterinary field in many countries. Most of the staff is middle-aged or older. What is striking is the lack of tenured staff under the age of 40. Most of the doctoral students are in the age range of 31-40, i.e. none are under 30 years. Hopefully, some of the doctoral students will qualify for senior lecturer positions. It is a concern that no postdoctoral students were recruited under 2013-2017.

Academic mobility has been since supported, the UoA has hosted several research visitors and UoA members have had research visits abroad due to the strong international contacts.

One of the strengths of this UoA is the ability of the researchers to actively seek collaboration and to create a positive research environment despite of challenges in organisational leadership both within the faculty and with the university animal hospital.

A succession plan for upcoming professor positions and having a leader of the research is essential in creating a productive research atmosphere and to ensure the maintenance of said research environment.

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

International contacts have enabled research visits to other countries and research groups which in turn makes it easier for the younger staff to network with other researchers. Active participation at meetings and conferences broaden their perspectives. A very important way to support young faculty in clinical fields is to combine clinical further education (residency programmes) with academic education (PhD). The UoA has just started this in small animal internal medicine which is highly commendable in terms of developing staff to secure future academic positions.

However, the lack of apparent recruitment policy at the department level is a major obstacle and challenge to the development of younger researchers. This is applicable to both recruitment, development and longevity in young research staff. The explanation being, in part, funding issues and the need for external funding on a large scale. The unit should reflect on how to maximise on the momentum that Jens Häggström has created in small animal internal medicine to attract staff.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The main network partners are from Sweden, either universities, the National Veterinary Institute (SVA), private animal hospitals or Karolinska University Hospital which is also seen in the numbers of publications. The international network is very wide from all over the world and has resulted in important publications. The geographical scope can be considered wide and successful.

## 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The vast majority of collaborators within SLU are from the Department of Clinical Sciences. The other partners come from the departments in the fields of clinical sciences. This is logical taking into consideration the research profile of the unit. The UoA realizes very well the need for collaboration. Synergies with the University Animal Hospital (UDS) should be increased since the case material for research comes from the hospital. What is very surprising is that the Animal Nursing does not belong to the UoA of Surgical Sciences, since the benefits would be mutual. Having said that, this has not had a negative impact on animal nursing research as they have collaborated with the surgical science group where relevant and needed.

For equine research it is very clear there is a need for improved collaboration with the university animal hospital.

## Score for Scientific Environment

## 5

## 1.3 Strategy for Scientific Development

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The strategy is very realistic. The UoA is very well aware of demands for the future which benefit both research and public outside the university. First there is a need to increase the number of PhD students as well as specialist training (Diplomate). Secondly, there should be a possibility to combine these specialist routes. These steps would be of the utmost importance to ensure future research having an impact in the field and on society. The need for collaboration with the University Hospital is essential and cannot be stressed enough. It is reported that the structure that exists today, especially financially, acts as an obstacle to effective research collaboration and is perceived as a hindrance and added difficulty in clinical research.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The future research plans are very much a continuum of the current research fields which are topics relevant to clinical practice. There is also evidence that the topics and methods are valid. In equine internal medicine and animal nursing there are plans to extend their scope of research. The plans for a new PhD course led by clinical pathology will aid in improving the quality of laboratory work of PhD studies using the methods of clinical pathology.

In the case of animal nursing research, a possible hindrance to their plans of increasing their research output and scope, is the lack of resources devoted to research as the main focus and resource allocation is in undergraduate education.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The biggest challenges are lack of funding for PhD students, especially the fourth year (since research foundations mostly fund only three years). The co-operation between the University Animal Hospital (UDS) and the UoA is difficult. It seems that improving co-operation between the Department and the University Hospital by joint positions or changing job descriptions might improve the situation. Highly qualified staff is leaving academia due to higher salaries in the industry/private sector.

It is vital to the continuing production and development of research that these challenges are addressed on a managerial level - both at Faculty (UoA) and SLU leadership (UDS) level, respectively.

### Score for Strategy for Scientific Development

#### 5

### 1.4 Additional comments

### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The working relationship between the department and the University Animal Hospital should be improved. This would increase the amount of research active people and also help professional education at a European level. For the Diplomate certification, two internationally peer-reviewed articles are needed. From there it would be possible to continue after Diplomate certification to a PhD project. Animal Nursing might benefit by belonging to the UoA of Surgical Sciences since the benefits with surgery and anesthesia would be mutual.

It was reported that the UoA's were formed as organisational structures and not based on research projects or collaboration. These structures should be reconsidered as it was difficult to see the synergy in research and to review this research.

The university animal hospital and the faculty departments should review mutually beneficial agreements for collaboration in research.

## Panel - Section 2 Societal Impact of Research

### 2.1 Activities and Outputs

# 2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The societal impact of the UoA is wide and remarkable extending from pharmaceutical and biotechnological companies, government agencies, veterinary practices, to dog and cat breed clubs, animal owners worldwide and education. When the research questions are clinically relevant, as they are in the UoA, the research results can at its best change current treatment recommendations (Case study 1) or recommendations for diagnosis and control of a disease (Case study 2). By increasing the general welfare of the animals it simultaneously increases the welfare of the owners. By this means, clinical research in small animals and horses has an enormous effect on people and society.

Animal Nursing is a new field of research with great importance for animal health and welfare. The research is developing and there is already a great ambition for collaboration within and outside of the university, nationally and internationally.

#### Score for Activities and Outputs

#### 2

## 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The outcomes of UoA's research can be considered very successful, especially small animal internal medicine has had major input in the treatment guidelines and diagnostics of some diseases. Equine internal medicine has produced research outcomes relevant to society and by doing so increased knowledge and biosecurity measures/quarantine recommendations of some infectious diseases in horses.

Clinical pathology has improved diagnostics of various diseases, which benefits veterinary care outside the university. Animal nursing has brought new information for assessment and treatment methods in veterinary rehabilitation which in turn increases the welfare of the animals

## Score for Outcomes

## 3

## 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

Future research on equine metabolic related diseases (EMS, insulin-resistance, Cushing/PPID and Founders) were noted and would benefit from an increased focus. SAMed has a long and successful tradition in research. They have a realistic strategy where they have found many ways of communicating with stakeholders and society. Of course, they can develop this further. Additionally, the work on the feline genome to identify disease associations could have a major impact on feline and potentially human health.

### Score for Impact Strategy

2

## Panel - Section 3 Capacity for Collaboration with Society

## 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA shows a thorough grasp of different aspects of society where collaboration is beneficial and show a discerning approach of how to foster these collaborations. They collaborate with breeders and owners to recruit pets for the studies, pharmaceutical and other industry (both nationally and especially internationally) in order to gain funding and PhD students to drive the research and manufacturers in order to obtain equipment for use in research within animal nursing. This is a productive approach both having an effect on impact and optimizing conditions for research.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The research on equine metabolic related diseases could have great impact to society and equine welfare, since there is a lack of evidence regarding current dietary recommendations and medical treatments. The outcome could be developed and spread to stakeholders (horse owners, feed producers, pharmaceutical companies etc.)

The UoA illustrate a sound grasp of the varied tiers within non-academic actors varying from owners, through breed organizations, kennel clubs and others. No additional advice needed.

Panel/ Research	Animal Health
field	

UoA

Production Animal Medicine

## Introduction

## General assessment of the Unit of Assessment

Overall, the UoA makes every effort to focus its research to address important problems in livestock production. It is challenging to have a long term strategic vision for the research because applications for external funding are by necessity opportunistic.

The comparative medicine program is closely aligned to medical research groups and the focus of the research is driven by these external groups, this is very valuable contribution. The cooperation with human medical Universities both in Sweden and in other countries are very valuable and appreciated. The studies of respiratory syncytial virus and coronavirus of cattle have improved disease control programmes and a new aetiological agent of neonatal porcine diarrhea has been identified.

Some of the major diseases of livestock are not being addressed in this programme, for example mastitis of cattle. This is a conscious decision because SVA have an extensive programme on the topic. We would highly recommend developing a closer working relationship with SVA to ensure the research is more aligned to the needs of the livestock producers and promote even greater collaboration.

A number of very good examples were provided of stakeholder engagement and provision of advice to improve disease control. The panel felt that international collaborations could be developed further to raise the profile of the unit and attract additional resources. The recent success in securing EU funding was highly commendable.

Some examples were provided of collaboration with society, including increasing awareness of bacterial (VTEC) infection of people from cattle. Increasing public engagement is an area for development.

## Panel - Section 1 Quality of Research

## 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

This UoA has four different subunits: comparative medicine, pig and poultry, ruminant and veterinary epidemiology. The overall quality is high international and very good.

The comparative medicine programme is carrying out an important supporting role to provide access to porcine disease models for diabetes type-1 and kidney transplantation. These surgical studies are linked to studies of the innate immune response to further improve transplant success. This research is of a very high standard.

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The Pig medicine group has clearly identified a new aetiological agent for neonatal porcine diarrhoea, this is a significant advancement of our knowledge. There is no poultry research carried out in the unit, this is conducted in food safety unit. Ruminant medicine: there is and have been informative studies performed to establish criteria to support control of bovine respiratory syncytial virus and bovine coronavirus in Norway and Sweden. The biosecurity aspect is important to understand the infection route and how biosecurity should be applied in detail. A paper has been published describing the use of gene deleted and subunit bRSV vaccines in cattle. Overall, there have been very good achievements from the UoA compared the resources available. There is a good veterinary epidemiology unit carrying out research with a large number of collaborators. The unit has recently secured significant external funding from the EU with actually 6 PhD students in that group. This demonstrates a very good ability to cooperate with internal and external collaborators, which is based on strong competence and knowledge in applied epidemiology.

The scientific output in publications is rather low for 6 professors, but has been slightly increasing over the last 5 years from >20 to <30 per year. 17% of their publications fall within the top 10% pub based on citations which is good but should be increased, although it is difficult to judge this classification with a maximum of 5 years after publishing.

## Score for Scientific Quality

5

## **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

There is a reasonable balance between young and older researchers (16 under 50; 11 above 50). There is very good cooperation with many other institutions and stakeholders, which is a strength of the unit. The research is focussed within a few areas for example, pig neonatal diarrhoea and BRSV/BCoV in cattle, and innate immune responses in pig-model based transplantations in close collaboration with medics of Uppsala University. Therefore, the unit is making very good use of the limited resources. There is a broader diversity within epidemiology, mainly through cooperation with other institutions and stakeholders. There is good external impact due to a diverse cooperation and there have been 11 visiting researchers at the unit. Representation at international meetings is not strong and this could be an area for improvement. The UoA should secure funds to ensure funding for the 4th year of PhD to reward the staff attracting projects with new PhD students.

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

Attracting funding for new research projects is an ongoing challenge which results in an opportunistic approach to the science strategy. Securing external funding is essential to retain more junior staff. There is a strong team of Professors leading this unit. During the interview we were happy with the actual presence of 10 PhD students in the UoA as only 9 PhD's graduated in the last 5 years.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

There is some cooperation within the Nordic countries and some institutes in France. The department has been quite strong in research needed for the development of control programs for BVD and BRSV/BCoV.

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There are strong and successful collaborations with the comparative medicine group and medical research groups.

For the epidemiological unit there is a strong exceptional broad network and collaboration due to the competence present and a good understanding of the need for cooperation. The unit is also strong in building up and keep going the epidemiological environment in the Nordic countries.

1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

There are a large number of visible interdisciplinary research programmes between this unit and other units at SLU as well as SVA and other universities both in veterinary field and human field.

## Score for Scientific Environment

5

## **1.3 Strategy for Scientific Development**

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

It was very difficult to judge the scientific strategy from the self-assessment, specifically the succession plan. However, after the oral presentation there is obviously a strong strategy for creating cooperation with other units and universities. This strategy seems quite insightful especially in relation to stakeholders.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

From the written report the plan for future seemed unfocused, however, the oral presentation gave a slightly better impression. The members of the UoA agreed they have, by necessity, an opportunistic approach to identifying funding sources.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The most important challenges are to find a way to finance more PhD students, although in epidemiology that appears to be successful. The first priority should be to increase the critical mass of researchers. To improve on this there is a strong need to have a more formal cooperation with SVA and reproduction unit. Moreover there is a lot of common topics with the UoA "Biomedical Sciences and Veterinary Health" and streamlining with that group in a structured way could also increase the critical mass of both UoA's.

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The UoA found that the Ambulatory clinic as run by the University Animal Hospital (UDS) was not providing a useful and cost effective resource for the provision of research and teaching.

## Score for Strategy for Scientific Development

4

### **1.4 Additional comments**

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

It is recommended to improve internal collaborations and strengthen the cooperation with SVA to make a larger critical mass, to both improve the research strategy as well as the education strategy. It is also critical for SLU to have research in areas which is important for production animal medicine like antibiotic resistance, sustainability and animal welfare.

## Panel - Section 2 Societal Impact of Research

## 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA have made good input to the stakeholders' knowledge to build up sound control programs on BVD, BRSV and BCoV, as well as the research on piglets' diarrhoea. Disease problems related to three key areas; antibiotic resistance, livestock sustainability as well as animal welfare should be strengthened. The comparative medicine models of transplantation and the innate immune system is excellent, important and scientifically interesting.

#### Score for Activities and Outputs

2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The UoA unit has contributed very much to build up control programs in cattle both in Norway and Sweden. This is a breakthrough unique to these countries. The identification of Enterococcus hirae at causal agent to neonatal pig diarrhoea is a breakthrough for the development of methods to control this disease. The comparative medicine group are making significant improvements to medical research on transplantation and diabetes. In addition, anaesthesia and analgesia of rabbits is being improved, rabbits are now a common household pet.

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### **Score for Outcomes**

3

## 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The impact strategy presented for the overall programme is very general and lacking in specific details. However, it is clear the different research groups are clearly focussed on carrying out research that will have relevance to livestock keepers, pet owners and medical practice. Some more thoughts need to be given to developing a more defined strategy relevant to the short to medium term. This would be a very helpful exercise to increase their international profile and how they respond more closely to the demands of the livestock industry. Importantly, aligning the UoA's impact strategy with SVA's impact strategy would be valuable, especially if co-ordinated with high level management engagement between the two organisations.

### Score for Impact Strategy

1

## Panel - Section 3 Capacity for Collaboration with Society

## 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA approach to collaborate with the society is demonstrated to be very good. They gave a very good impression and understanding of the need for such collaboration and dialogue.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

They have already a good cooperation with actors outside academia. This could be strengthened even more. There is a need for further structural strengthening of the cooperation with SVA and UoA "Biomedical Sciences and Veterinary Public Health"; this seems to be good already between the researchers. The administration should help and facilitate this cooperation.

Panel/ Research Animal Health field

UoA

Animal Reproduction

## Introduction

### General assessment of the Unit of Assessment

This UoA is performing very well. The goal for a holistic approach (One Health / reproduction) appears as well justified – and strong translational focus for improving quality of reproductive research fits well with the overall goal. The unit has a well formed research strategy based on sustainability of animal health and translational medicine that is well in line with that of the faculty and the SLU. The quality of research is at an excellent international level. The leading publication forums used by the UoA are in appropriate international journals in the field of animal reproduction. The case studies chosen provide excellent examples of global impact. Implications of the effects of climate change– and how efficient technologies applied in reproduction can make a difference to quality of life in highly populated and less developed countries presents with a strong case of societal impact. It is also highly appreciated that the UoA has put emphasis on maintaining the research in a diverse range of mammalian species by research activity of further development of conservation of gamete cells in endangered species. The UoA presents an excellent achievement in colloid centrifugation as a novel technology to improve male fertility and reduce bacterial contamination and thus, decreased need of antimicrobial drugs. The CRU is of essential importance in applications of translational reproductive health that may be utilized even more in cross disciplinary collaboration.

The UoA is also engaged in herd health, specifically in mastitis and antimicrobial resistance in developing countries as well as immunology of reproduction and proteomics in connection to uterine infections and immunity. The majority of the mastitis work is done in collaboration with SVA. The herd health research is mainly done with resources from SIDA which is appropriate, but there appears to be some room for improvement with regard to interaction with Swedish stakeholders within the dairy sector. Overall, the members of the unit have many international collaborations, of which some are global (such as FAO) and some at the European level (such as ECAR and ESDAR).

## Panel - Section 1 Quality of Research

## **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The work selected for impact cases reflects well the holistic One Health approach chosen by the UoA to address grand challenge level research questions in the field of animal reproduction. They present several valid approaches taken in developing countries (i.e. Uganda, Thailand) by the UoA to improve the reproductive function of several, mainly food producing species. The ideas are very original and innovative from the perspective of sustainability of food production and animal health from a global perspective. Further focus on issues chosen such as improving efficiency of reproduction and prevention of spread of antimicrobial resistance will have a great impact on the health and welfare of both the diversity of animal populations and that of the constantly growing human population.

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Likewise, the example of finding indicators of the status of reproductive function in free running feline populations is well chosen and demonstrates simple application of scientific findings that can have a valuable impact on the populations of species of interest.

The third case impact study on applying colloid centrifugation of sperm cells is probably the best scientific achievement of the UoA – and raises the overall quality of research. It presents with an excellent example of a novel methodological development to achieve a major step ahead in reproductive biotechnology. In this case, it brings about a breakthrough in species where poor fertility is a major problem in the male (i.e. equine and giant panda).

The work with mastitis in dairy cows showed that genotype differentiation and within-herd epidemic dynamics suggest avenues to improve the prevention and control of mastitis. They have also worked with modern diagnostics like PCR and cell differentiation in automatic milking systems.

The work with mastitis has also been expanded to developing countries. This work will make a large contribution to improve food quality and reduce the use of antibiotics and antibiotic resistance in these countries.

When examining the publication track records of the UoA, there is some room for improvement to publish in higher impact journals and so gain more attention from the broad scientific community. This could be achieved by more strategic discussions, especially with collaborators.

## Score for Scientific Quality

### 5

## 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The UoA presents an excellent case of a coherent unit of researchers working together towards a common goal according to the ambitious strategy they have chosen together. The UoA has managed well in terms of international activities. They have been active in EBVS specialization program in their field (ECAR), and there has been a number of successful candidates at board examinations. The staff members of the UoA have been actively participating in the committee and board activity in the ECAR, which is considered as a valuable networking investment as well as supporting the development of clinical research in the European context. The residents participate in summer school activities, which is important for their future international networking in the field of animal reproduction.

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There is a balanced gender distribution and the balance between junior vs. senior members of the staff seems rather good and should be maintained. There is a very good proportion of international members of staff, residents and PhD students, which should be further encouraged and maintained. International co-supervision and residence mobility is encouraged and thereby the current structure of international specialization maintained.

The research environment is well organized including fundamental elements of infrastructure (CRU, SLU bioinformatics, Lövsta, Bioviss, KV – Lab), and supporting elements (clinics, diagnostic imaging, IVF lab, sperm freezing, tissue lab, cells for life). Overall, it appears that the unit has a coherent leadership, which stems on senior researchers taking and sharing their responsibility to lead the unit together to fulfill the strategy of the unit.

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

Generally speaking the supportive measures described by the UoA are good and supportive of professional development. Resident training and PhD studies are listed separately, however, the residency in animal reproduction and PhD programs are carried out together. Post-doctoral training abroad or in another institute will support career development of the young researchers in this field, and should be considered as essential element for their growth as independent researchers.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA has a strong record of participation in the leading international networks in this field, especially in Europe, Africa and Asia. The UoA could be stronger in networking with national stakeholders.

The international collaboration is well justified and demonstrated through active resident training activities by the UoA and participation in different committee and board work in this field. The UoA has organized resident examinations in Uppsala – and has actively participated in leading congress organizations in the field of animal reproduction (scientific boards, organization boards, keynote speakers, moderators and a high number of congress contributions). This clearly demonstrates a strong commitment to advancing the scientific debate in this field.

1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

Panel 10 - Animal Health

The UoA has a strong background of collaboration with some units within the SLU, especially with production animal medicine and biomedical research groups and units. The synergies are evident and the collaboration seems to functioning well. Research and synchronization around the activities with regard to projects run in Uganda is a good example of ability of collaboration of these units. The UoA is hosting the Center for Reproductive Biology in Uppsala (CRU), which is an excellent unit for support of key functions within the area of reproductive biotechnology.

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The unit has a good track record of ongoing collaboration with the SVA. This should be maintained, and if possible, made even stronger in the future.

## Score for Scientific Environment

## 5

## 1.3 Strategy for Scientific Development

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

Emphasis should be on recruitment of PhD students and residents including into certain areas where competence needs to be maintained, for example udder health. SLU could in the future lack research activity on important disease complexes in ruminants if recruitment action is not taken. This concerns mastitis and metabolic diseases. Collaboration with the University Animal Hospital should be encouraged and potential managing and administrative / structural problems prohibiting further collaboration should be resolved. The UoA has a strong background in reproductive endocrinology and interface between stress physiology and reproduction – both in methodology and other scientific activity. This is an essential area of research and it should be maintained at high level at the SLU.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

High level of international collaboration is strongly supported, including the strong emphasis in developing African and Asian countries. The intended strong areas of research such as reproductive and udder health should be set as a priority. Environmental toxicology including the demonstrated translational focus should be maintained and made stronger. Reproductive technologies for gamete and embryo banking appear as highly important areas for future research.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The SLU should have a strategic plan to support the expected losses due to retirement in the near future. Udder health is here very critical as this is one of the most important and costly disease complex in dairy production, as well as a large quantity of antimicrobial usage, which could be linked to antimicrobial resistance development. However, excellence in science within the field should be considered as main criteria for future recruitments. The UoA should develop strategies to increase research funding from International development funders, EU sources as well as industry (pharmaceutical companies, feeding industry, veterinary services)

## Score for Strategy for Scientific Development

#### 1.4 Additional comments

## 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

Investments on recruitment in udder health and reproductive health are highly important areas of research in the future. Possibilities for contributions by the highly qualified emeritus professors in this area should be seen as an asset for research in the short term. In the long term, the strategically strong areas of research should be prioritized; including reproductive biotechnology and reproductive biology in developing societies as part of the One Health approach in animal health, environmental toxicology of reproductive function. The cooperation with the SVA is instrumental for the future of research in this field.

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## Panel - Section 2 Societal Impact of Research

## 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA has a clear and strong connection with a high number of domestic and international stakeholders that are highly relevant, demonstrating a strong commitment of the UoA to the goals of the stakeholders.

### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

Testing for presence of gonad function is highly applicable and good example of highly relevant research output. Colloid centrifugation has a lot of highly relevant applications in reproductive biotechnology, including frozen thawed use of gamete cells as well as improving fertility in species with low fertility. Examples related to dairy mastitis demonstrate the long-term commitment of the UoA to research in udder health in conjunction with the SVA – this collaboration should be maintained and made stronger.

### Score for Outcomes

#### 3

## 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

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The grand challenges as presented, including feeding of growing humankind and spreading of antimicrobial resistance have a highly relevant impact for the society, underlining One Health as a relevant perspective in reproductive and udder health and efficiency of animal driven food production. Optimization of animal production trough reproductive technologies seems as a highly relevant goal for future research. Dysfunction of reproductive organs is one of the most sensitive biological testing measures that can be applied for detection of adverse environmental pollutants and toxins. Conservation breeding for better genetic diversity and genetic selection for robust reproduction are essential research goals for the future and as such they should be prioritized. Some aspects such as economics of reproductive disease and function should be left for co-operation with organizations that do hold the competence for that. The strong comparative reproduction related profile of the CRU should be maintained and prioritized.

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## Score for Impact Strategy

3

## Panel - Section 3 Capacity for Collaboration with Society

## 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

Having a staff member appointed as responsible for collaboration with society clearly demonstrates the commitment of the UoA to long term dialogue and partnership with stakeholders. The description of mutual trust and recognition of competence are signals that imply that the UoA is intending to develop a strong relationship with the key societal partners. The main focus is currently with domestic animal breeders and veterinary service providers as well as some private businesses. Business collaboration could be further strengthened though. Case study number one demonstrates the commitment of the UoA to long term partnership with key partners such as Växa and DeLaval in the dairy sector.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The great research qualities of the UoA could be further developed with a stronger business model for improving reproductive and udder health. Applications of biological testing for the presence of adverse agents in the environment through the effects on reproductive function, may be of considerable business value and any resulting intellectual property should be protected.

## **Report Template for Review Panels – Overview of Research Field**

## Research field/Panel (no. and name): 11 / Animal Science

## General Overview of the Research Field

Strengths	Weaknesses
<ul> <li>Highly motivated scientists</li> <li>Ethical dimension considered in many fields, facilitating a positive societal impact</li> <li>SLU internationally recognized due to high profile individual scientists</li> <li>Comprehensive coverage of most relevant research topics</li> <li>Excellent infrastructure in some key research areas</li> <li>Integration of research and teaching</li> <li>Established infrastructures (like INTERBULL center) provide ample opportunities for research</li> </ul>	<ul> <li>Many small funding schemes</li> <li>Lack of sufficient support and critical mass for major grant application writing</li> <li>Absence of clear career path for young scientists</li> <li>Scattered localization</li> <li>Lack of clarity in regard to the target of the research (local/regional/EU/world)</li> <li>No clear strategy for efficient use of high cost research infrastructure</li> <li>No core unit for big data management, processing or data sharing and analysis</li> </ul>
Opportunities	Threats
<ul> <li>Contact with undergraduate students provides a pipeline to post graduate students</li> <li>Possibilities for new approaches to livestock production – shift in emphasis from production to health, provenance and reduced environmental impact</li> <li>Possibilities for expanding research further in companion animals and horses</li> <li>Scattered localization provides good access to regional funding and local society impact</li> <li>A coordinating role of UoAs in large (international) projects is an ideal means for networking and career development (i.e., young research can be task leader, to become WP leader later on in their careers, and to become coordinator even later)</li> <li>The somewhat negative perception of animal agriculture (related to welfare, environment etc.) also provides research opportunities. If you have problems, you have to solve them.</li> <li>Exploitation of big data in relation to precision livestock farming and management (e.g., in breeding, precision</li> </ul>	<ul> <li>Increasingly critical perception of animal production and animal experimentation in the society</li> <li>Decreasing critical mass in some areas of research</li> <li>Lack of integrated research programs across faculty borders</li> <li>Lack of clear research focus in some areas</li> <li>Lack of PhD students, especially Swedish students</li> <li>A possible negative public perception of technologies in animal production (agriculture = natural)</li> </ul>

I

The area of artificial intelligence/machine learning in combination with high throughput data will be a key technology of the future and will be required and used in many areas like precision (livestock) farming, but will not be restricted to the animal science sector. SLU might consider establishing a 'big data' core facility, which may be linked to the bioinformatics platform. It will be critical to provide sufficient resources and a clear policy to combine methodological research and development with service functions in such an infrastructure.

The research in the UoAs is often dependent on short-time funding opportunities, and appears to be driven mainly by individual interests and academic freedom. It appears that this combination has resulted in research with high societal impact, and highly motivated and enthusiastic researchers on one side, but also a scattered and somewhat opportunistic research profile. It might be that the benefits outweigh the possible downsides, but it is an issue that could warrant critical assessment within SLU.

Panel/ Research Animal Science field

UoA

Anatomy, physiology and biochemistry

## Introduction

## General assessment of the Unit of Assessment

The panel acknowledges that the department is in the phase of establishment. The number of new recruitments during the assessment period has been substantial, one of the professors is currently only employed part time, and a new professorship is on its way to being filled. This reflects upon the overall strategy and vision for the department. The department is characterized by having extensive teaching obligations resulting in a budget in which 77% of the research revenue per source of funding is governmental allocation with only little external funding. The panel got the impression that there is a tradition for establishing smaller projects, to a large extend with industrial partners (PhD projects), but there are less traditions for applying for larger projects (except for biochemistry witch is presently not fully integrated in the department). In particular within the line of equine research established in the department, there are potentially unexploited possibilities for external funding.

In general the department has the potential to attract additional external funding.

However, it might consider focusing the research more in order to obtain sufficient critical mass.

The department appears to have a high visibility in particular with regard to equine health (biomechanics). The applied output from the unit as well as the stakeholder contacts clearly shows that there is a high awareness of and ability to collaborate with society.

## Panel - Section 1 Quality of Research

## 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

Scientific Quality and prominence in the field of science

- Achievements have been obtained within four different focus areas:
- Health and performance of the athletic horse
- Dog health and interaction with humans
- Applied biochemistry and cell biology
- Crickets for food

The research performed within the area 'health and performance of the athletic horse' is internationally recognized. Yet, only one of the publications within this area is among the top 10% in the percentile profile. However, several solid papers published in 2016 and 2017 are listed in section 4.1a. The scientific productivity is average, but it contributes with research that is original and that clearly provides results of great importance for the improvement of performance and health in horses. This research area seems to be solidly anchored within the UoA and it is internationally competitive.

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The research area 'dog health and interaction with humans' primarily involves senior lecturers. The scientific productivity is documented by representing approximately half of the papers among the top 10% in the percentile profile, however, the impact is somewhat 'diluted' by covering a range of different research topics. There is extensive collaboration with Department of Clinical Science and the University Hospital within these research areas and in many of the areas the main drivers/coordinator is a researcher at the University Hospital. Continued collaboration will ensure that research continue to be international competitive, however the research area would gain if it became more focused.

Two diverse research areas have been covered within 'applied biochemistry and cell biology', i.e., spider silk, and mast cell research. These areas have been introduced into the UoA by researchers that are presently not full time employed at SLU. The originality and scientific impact of these research areas are documented by publications in high ranking international journals. The scientific production from the areas are limited and the areas are also internationally very competitive, thus critical mass and a good collaboration networks are paramount for the future success of the areas.

A new research field has been initiated recently, i.e., 'crickets for food' (Biobase Materials Initiative). It is too early to evaluate potential scientific impact, but production has been implemented through distribution of eggs (implemented in smallholder farmer advisory program in Cambodia).

Overall, the scientific productivity is moderate.

## Originality of ideas and choice of methods

The equine research is, as mentioned above, solidly anchored within the UoA. Relevant and innovative methodologies have been used as documented by the results that have been provided. The research in dog health and interaction with humans is an area in which SLU is internationally well recognized, thus with collaboration across departments the UoA will be able to contribute also in the future. The methodologies used within this area are state of the art.

The areas spider silk and cricket for food are innovative areas. Within the spider silk area original methods have been used to obtain results of scientific and potentially also applied interest.

## Score for Scientific Quality

5

## 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc During the assessment period 4 senior scientists and 6 junior scientists have been recruited. Some of these recruitments have been aimed at strengthening strategic areas. However, Tthere does not appear to be a common strategy at the departmental level for recruitment. Thus, new research areas are brought into the department's research portfolio by both senior and junior scientists.

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To maintain a creative environment seminars are organized every second week together with another department. Furthermore, a moderate level of exchange of researchers (3 visiting researchers and 2 visits abroad) has taken place during the assessment period. A creative research environment is supported by interdisciplinary PhD projects, many of which are funded externally. These projects ensure collaboration across departments and centres at SLU. Also, the fact that several junior researches of the UoA are active in clinical work at the University Hospital provides good opportunities for the establishment of interdisciplinary research projects.

The age distribution within the unit is good. But, and as is the case within most research areas within the Animal Science UoA's, there is an imbalanced F/M ratio in favor of females. This is most likely due to the F/M imbalance within the university topics providing the candidates relevant for recruitment. This might not ideal; however, it is of no consequence for performance at any level.

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The department has a heavy teaching load requiring that junior faculty members are hired primarily as lectures. Although they are allowed part time for research it is difficult to establish a research carrier under such conditions. During the interview it became clear that this is a problem that is acknowledged by senior staff that provides support by including junior faculty as co-supervisors for PhD students and providing support for writing grand applications.

Both PhD students and post doc's are encouraged to get involved in teaching.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA has a well-established network of collaborators at SLU most notably Clinical Science and the University Hospital. One member of the unit has collaboration concerning a major research program with Uppsala University. In terms of international collaboration the unit collaborates on research projects and PhD supervision with Holar University College, Island. The remaining international collaborations that are listed appear to be networks and engagements in planning of conferences. The unit has only documented experience from wider international collaborations regarding footing for horses – an area that has attracted funding form both national and international equestrian federations (underpinned by one of the case studies).

## 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The possibilities for interdisciplinary collaboration within the unit appear not to be fully exploited although one example of looking at both physiology and biomechanics in horses was given during the interview. The collaboration with Department of Clinical Sciences and the University Animal Hospital is clearly well developed resulting in interdisciplinary projects. Regarding dog health all publications are coauthored most often with a researcher from the university hospital as last author. In both areas collaboration with Department of Animal Breeding, Genetics has potential. With regard to the Cricket for food project it is stated that there is collaboration with Animal Nutrition and Management, but it is not clear if the project is mainly focused on nutrition and what role physiology plays.

## Score for Scientific Environment

### 1.3 Strategy for Scientific Development

## **1.3a** Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

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The strategy for scientific development is somewhat contradictory to one of the weak points mentioned in 1.1c, i.e. lack of critical mass. A range of specific goals are mentioned, however it is not immediate obvious how these goals will be retched. The unit could consider converging rather than diverging with respect to the research topics it wants to cover.

The unit plans to expand and it is mentioned that it wants to attract more grants. Activities to strengthen application writing process has been initiated, however, except for biochemistry there are no outline of witch grants the unit is aiming for. Within the equine research area private funding might for instance be a source for funding.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

Within the area Health and Performance of the Athletic Horse the unit clearly has the potential to continue making significant contributions both at the scientific and applied level. The SciMoves Lab is an excellent infrastructure both for internal and external collaboration. It represents an excellent framework for attracting visiting researchers for collaboration and, as mentioned above, there should be good opportunities for attraction of funding for the biomechanics research.

The main drivers of the research related to dogs seem to be researches at the Clinical department. Through continued collaboration the unit will be able to contribute to this area, but it might consider to focus the research with the aim to obtain more impact.

The three areas: Spider Silk, Crickets as Food, Multipurpose Wildlife, are newly established areas in the unit. The first mention research area has not been fully establish at SLU since the senior scientist responsible for this area is only part time employed at SLU (part time at Karolinska Institute where the research area has been established). Significant research contributions have already been provided, most notably through a publication in Nature Chemical Biology. The area has great potentials provided it researches a sufficient critical mass at SLU.

It is too early to evaluate the potential for Cricket as Food and Multipurpose Wildlife.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

One of the great challenges for the unit is the heavy teaching load. This is reflected in the budget for the department, i.e. 77% of the research revenue per source of funding is governmental allocation (the highest among the UoA's assessed by the Animal Health Panel). Since the teaching obligations are moderate for professors (10-20% according to the interview), there ought to be room for developments through attraction of external funding – an area that apparently has not been of high priority previously. Implicit the heavy teaching load also poses challenges with regard to distribution among staff. It is important that young researches are supported so that they can develop a research carrier.

Another challenge is critical mass. This can potentially be resolved internally by focusing the research within the unit. Regardless, increased external funding is imperative for the future.

## Score for Strategy for Scientific Development

3

## 1.4 Additional comments

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

## Panel - Section 2 Societal Impact of Research

### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The unit is engaged in commissioned education (breed club and companies) and has extensive outreach activities through interviews and interaction with politicians and stakeholders. The panel find that the list of outreach activities is impressive. Overall, the UoA appears to have excellent visibility in the society and among the relevant stakeholder. The visibility appears in particular to be high within the equine community where there ought to be a good potential for attraction of grants for research projects.

#### Score for Activities and Outputs

3

## 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The UoA has had a good output in terms of commissioned research: collaboration with Qualisys AB to establish standards for using and interpretation of measurement results from a locomotion measures; validation of an ELISA assays in cooperation with the company Mercodia using well-characterized samples from overweight dogs; evaluation of a new asthma drug from a Swedish company; Vinnova-financed project on developing novel methods for the production of biologics (collaboration); collaboration with Alertix Veterinary Diagnostic AB for development of ELISA test for cancer management; the results of the cricket feeding trials are implemented in the smallholder farmer advisory program in Cambodja. The three impact case studies document that results from the research has been implemented and in particular footing for horses seems to have had an impact also internationally.

The most prominent outcome appears to be the foundation of 'Spider Technologies AB' (voted one of Sweden's hottest technology companies in 2012). These activities appear to be before the current assessment period and probably an achievement that should be ascribed to the Karolinska Institute.

### Score for Outcomes

3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The two areas that appear to have the have highest potential for providing continues societal impact is Health and Performance of the Athletic Horse, and Spider silk. The first mentioned research area appears to have a sufficient critical mass in the unit and it is well recognized for its achievements both nationally and internationally. Clear goals are set for this area, however, there appears to be no strategy for development of, for instance, international collaboration, development of specific project ideas, and grant application. With regard to Spider silk, as mentioned earlier, critical mass at SLU is imperative, but given the grants already submitted (ERC and Wallenberg Foundation) the panel considers this research area very promising. The remaining areas of research (dog health and interaction with humans; cricket for food; multipurpose wildlife) appears to be less well established and thus, it is too early to evaluate if the unit will be able to have societal impact within these areas. A prerequisite is external funding which is not mentioned for any of the areas.

### Score for Impact Strategy

#### 2

## Panel - Section 3 Capacity for Collaboration with Society

## 3.1 Collaboration

# 3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The output from the unit as well as the stakeholder contacts clearly shows that there is a high awareness of and ability to collaborate with society, i.e., industry, breeding organizations, and the general public.

The two case studies provided are, however, not very illustrative in this context since both describes collaboration with researchers (not actors outside academia).

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The panel was impressed by the units comprehensive outreach activities reaching both the general public through interviews and publication in popular scientific journals as well as breeding clubs and other stakeholder. The panel recommends that part of the outreach activities focus on outreach activity that attract funding from private foundations.

Panel/ Research field	Animal Science
UoA	Animal nutrition and management

## Introduction

#### General assessment of the Unit of Assessment

Quality of research: The UoA Animal Nutrition and Management is one of the larger departments of the Faculty of Veterinary Medicine and Animal Sciences with a focus on (the combined aspects of) Feed, Nutrition, and Management. The panel appreciated the well-written self-assessment report and the open discussion we had with representatives of the UofA. The panel had the impression that the UoA is very well managed and that this is done in a collegial way. This is an important asset because it avoids that the group is perceived as the group of one or two leading scientists., and it facilitates the long-term development and "sustainability" of the UoA's research program. Although research results have been communicated in popular science articles, the peer-reviewed publication record of the UoA is somewhat modest. The UoA is aware of this and has taken measures to improve on this.

Societal impact: The UoA has an applied research profile and many of its research projects have been carried out in collaboration with non-academic stakeholders. These stakeholders are very diverse in nature and a good number of results originating from the UoA have been taken up in practice. Given its broad range of activities, the UoA may consider focusing on a smaller number of areas, allowing for a more in-depth approach. The UoA has a very strong record in contributing in capacity building in low-income countries. The panel felt that the UoA may have been a bit too modest in highlighting this.

Capacity for collaboration with Society: The unit has a strong record of collaboration, but it may reflect upon the changing setting in large research program where research partners are not only "knowledge providers", but an element in a multi-actor and multi-disciplinary setting. The panel is convinced that the UoA has the assets to be successful in doing so.

## Panel - Section 1 Quality of Research

## **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The research of the UoA is organized in three thematic areas of feed, nutrition, and management. In many of the research projects, they combine (at least) two of these thematic areas. Studies are carried out in a large number of species including farmed livestock (pigs, poultry, dairy and beef cattle, fish and shrimp), horses, dogs, and reindeer. Because of the different thematic areas, the diversity of species, and the context in which the research is carried out (e.g., commissioned research), the research profile of the UoA can be characterized as being very broad. Many of the research questions are applied but may suffer somewhat from the lack an indepth analysis.

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The UoA is involved in a good number of commissioned research projects, which is both a strength and a weakness. The strength lies in the fact that the (practical) questions are real, for which an answer is sought. The weakness is (or: can be) that the UoA is not completely free in identifying and developing its own research agenda and that the results may have confidential elements that cannot be readily communicated or published.

The UoA puts considerable effort in capacity building for researchers in low-income countries. This includes realizing joint PhD programs in which the research is carried out in the low-income countries. Given the research priorities and the available resources there, the nature of the questions remains applied and limits the possibilities for a more basic and mechanistic approach. This has been, and still is, a well-considered choice of the UoA but it has had an impact on the scientific impact and prominence in the field.

The panel did not have the time to address the research topic of reindeer management, but it seems to be original and supported by the authorities to ensure the sustainability of this system in Sami communities in northern Sweden. One may question why this research is carried out from Uppsala and not in Umeå, but this may be for historical reasons.

As acknowledged by the UoA, the scientific productivity is modest and more (applied) research results could have been published in peer-reviewed publications. Research results of the UoA have been reported in reports (for commissioned research) or in applied magazine articles, indicating that there is a potential to improve UoA's publication record. There is a saying stating that "research that is not published is research not done". This does not completely hold for the UoA because results are reported, but dissemination remains limited to Swedish readers and stakeholders. The unit has undertaken action to improve its publication records (e.g., by using a designated week to write) and the panel strongly encourages the UoA to pursue its efforts to publish research results in peer-reviewed articles. Establishing an explicit publication policy may help the UoA in achieving this (e.g., by identifying ("old"?) results that can be published and by setting publication targets). The unit is very satisfied with the experimental facilities for dairy, pigs, and poultry. These facilities are very important assets for research and the fact that they are managed at the faculty level seems appropriate. Because of the high overhead costs of experimental facilities, it is important that they are used to their maximum capacity, either by the different UoAs or by external parties. The wish of the UoA to have facilities for equine and dog research should be evaluated in this context.

## Score for Scientific Quality

#### 3

## **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

Panel 11 - Animal Science

European networks and research programs.

The UoA has undergone a recent internal reorganisation dealing with both structural and functional aspects of the organization. The panel had the impression that this has been a very successful operation and congratulates the UoA in doing so.

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The organization of weekly interdisciplinary discussions is a very good initiative and will be of benefit to all. The panel encourages the UoA to expand these sessions beyond scientific topics. Developing strategies in a participative manner will further stimulate the "identity" to which people adhere and engage. Despite being the largest unit assessed by the Animal Science panel, the UoA considered that its critical mass is limited in some areas and that they rely on external networks for many project. Not having expertise in an area is not a problem per se (and is inevitable), but this is different from having insufficient critical mass. It is important that researchers in the UoA find sufficient expertise within the UoA to discuss and challenge ideas, and the panel has the impression that this environment exists (i.e., the wording of "critical mass" may not be appropriate here). The UoA indicated that the area of bioinformatics needs to be developed within the UoA. Although the panel shares the observation that research is increasingly accompanied by the creation of very large and diverse data, we are not convinced that having an in-house UoA bioinformatician will be the most appropriate approach to deal with this (neither for the UoA nor for the bioinformatician). In recent years, the UoA has faced retirements of a large number of senior staff and 8 out of 50 permanent scientists are currently over 60 years of age. This will have significant impact on the capacity of scientific leadership, unless appropriate measures are taken in the coming years. It is important that the UoA renews its skills, especially by recruiting young scientists that are willing and capable to enforce the UoA's participation in

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The successful completion of 18 PhD students is a clear indication of a vibrant academic environment, which encourages interactions between senior and junior members of faculty and graduate students. The UoA has created excellent opportunities for young faculty and students to grow, regardless of gender and position through a proactive engagement. This includes additional funding for PhD students to finalize publications, and encouraging them to obtain international experience. Young researchers are involved in the co-supervision of PhD-students.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA has considerable collaborative activities in research and capacity building especially in Sweden, other Scandinavian countries, South East Asia (Laos, Kambodja and Vietnam) and Africa (Tanzania and Rwanda). Faculty members have been serving in various national and international commissions, in editorial boards and as editor for scientific journals. These involvements demonstrate the wide geographic coverage and prominence of the UoA.

However, the UoA has the potential to further develop collaborative activities with international agricultural research institutes such as ILRI and CIAT, who have a large collection of global forage germplasm and have research undertakings in animal nutrition and management including the impact of livestock production and management on the environment. Such collaborative activities would provide an opportunity for the UoA to engage and become more visible in the scientific debate on animal agriculture in developing countries. Although the unit attracted 4 visitors, only one staff member got (or: took) the opportunity to travel abroad for a period of 1 month or more. Exchange programs are vital to motivate staff and for building international networks (especially in Europe with respect to FP9), and create a vibrant academic environment. The UoA should stimulate both young and senior researchers to engage in international exchange visits ("if you would go abroad, where would want to go, and why").

1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential. It is clear that the UoA is one of the most networked units through its extensive collaborative activities with various UoA in SLU. It is impressive to note that the UoA has collaborative research projects with four faculty and 18 departments. The studies range from nutrition to forest ecology and management, and deal with various animal species. Such a wide range of collaborative research requires involvement of various disciplinary inputs, creating a dynamic and vibrant inter-disciplinary team of researchers. The UoA is an excellent example of an inter-disciplinary research program in various aspects of animal nutrition and management involving both domestic and wild animal species. However, despite the breadth of these interdisciplinary collaborations, the depths of these collaboration was difficult to assess.

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## Score for Scientific Environment

5

## **1.3 Strategy for Scientific Development**

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The panel appreciated the fact that the UoA presented its goals and strategy as "measurable elements". Although the UoA's research focus is clearly stated, there is no clear statement on how it will implement the strategy and link the research that reflects the effect of the production system on the animal and on its surroundings. In this respect, it is probably more appropriate to indicate "nutrition and feeding" than the "production system" as levers for the UoA to realize this goal. The UoA also states that it will increase collaboration with research institutions within Nordic and international networks, but it is not specific in what areas of research this will be done and with which institutions.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

UoA has articulated future research directions clearly and has the capacity to do so. However, it is difficult to see the linkage and alignment of goal, sub-goals and measures identified (1.3a) and future research (1.3b). Strategy and future research directions have to be linked in a systematic manner with clear pathways to contributions to higher level goal.

Several of the proposed promising research directions need to be discussed and can be shared with other UoAs. For example, precision feeding is a component of precision livestock farming which is also one of the areas of expertise of the UoAs "Animal Environment and Building Function" and "Animal Environment and Health". Likewise, insects as an alternative protein source is also an area of interest of the UoA "Anatomy, Physiology and Biochemistry".

The microbiota is a "hot topic" (and very competitive) and nutrition is definitely an important lever to modify the composition and functioning of the microbiota. The interactions between the diet, the microbiota (which one?), and the host are very complex and the causality of the relations is not always clear. The ambition of the UoA should be in line with the (human) resources they can allocate to it.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

A good publication record is a major driver to attract new research projects. The UoA may consider setting up an incentive system to encourage publication of scientific articles, which will increase visibility of the UoA in the scientific community. This will enhance funding opportunities, especially in large national and international consortia ensuring medium-term funding (4-5 years). The UoA may also consider exploring non-traditional funders and expand research frontiers to deal with global issues with countries, universities and international agricultural research organizations such as ILRI, AU-IBAR, and CIAT.

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The UoA works with almost 18 departments within SLU and interestingly has identified the paradoxical challenge of "use of synergies by utilizing competence and methodologies within the UoA".

Although there are a good number of young faculty, a considerable number of senior staff have retired or are approaching retirement, which is crucial for the continuity of high quality research. The UoA and SLU should review this and take action through leadership training and promotion of young faculty or recruitment of staff.

## Score for Strategy for Scientific Development

4

### **1.4 Additional comments**

## 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The research strategy and the research agenda that the Unit is addressing need to be aligned to ensure that the overall goal, sub-goals and measures identified are inter-linked in a logical manner. The UoA is well positioned to implement the research agenda it has identified, but the SLU should consider strategic investment in the different paths of leadership renewal. The SLU should also explicitly encourage and support the UoA to develop joint and collaborative research programs and projects and capacity development in developing countries for mutual benefit.

There are some similarities in the activities and ambitions regarding research in nutrition between this UoA and that of other UoAs (e.g., "Forage utilization" and "Animal environment and health"). Although there may be different reasons for this (including historical and geographical reasons), the SLU should keep a close eye to avoid a too strong overlap of activities (between UoAs) and dispersion of human resources with similar competences and interests across UoAs.

## Panel - Section 2 Societal Impact of Research

## 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA has an applied research profile, and research outputs that have a societal impact include commissioned research for national and international industries and governmental authorities. The UoA is also engaged in external consultancy for industry, NGOs, and authorities.

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The activities and outputs are numerous and very diverse and are targeted at different stakeholders ranging from farmers to national authorities. The UoA has also been active in the organization of national and international conferences. The organization of the annual Nordic Feed Science Conference is a good example ensuring that research results are rapidly communicated to stakeholders. Also, the establishment of the Feed Science Network showed that the UoA found a way to that was of mutual benefit to both stakeholders (to ensure activity in applied feed research) and the UoA (job security during harsh economic periods). The fact that the Feed Science Network works according to an original operational model that allows combining cooperation and competition among participating stakeholders. The case study indicated that the development of a feed preservation additive which has been patented (with other patent applications pending) and which is now largely used in Sweden.

All in all,, the UoA has shown that its activities have an impact on different stakeholders.

#### Score for Activities and Outputs

### 2

## 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The UoA rightly indicated that there is a considerable time-span between research activities and outcomes. Outcomes seen now in society may be the result of research activities carried out 10 or 15 years ago. Moreover, the path from research to outcomes involves different actors, including the UoA. The three impact case studies are convincing examples of how past research had an impact on current situations (i.e., production systems for laying hens, development of a feed preservation additive, and the impact on the development of wind energy systems on reindeer husbandry).

The example of the development of furnished cages for hens shows that the achieved impact is the result of a multidisciplinary approach (welfare, husbandry and management, and nutrition) and that it is a continuous and evolving process. Moreover, the importance of communication to actors and the public has been clearly indicated. The front-running role of Sweden in legislation and the expertise of scientists of the UoA have served Europe and other countries in this area.

The impact case study on reindeer husbandry illustrated the complexity of a societal issue that confronted the development of renewal wind energy with the preservation of traditional reindeer husbandry systems in northern Sweden. The expert opinion of the UoA (resulting from research carried out earlier) was solicited in different court cases in Sweden and Norway.

### Score for Outcomes

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

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The UoA indicates that it has a "strong potential to affect sustainability in animal-derived food products and production systems by performing research in close collaboration with societal stakeholders". The focus on applied research is of course an important element contributing to this potential. The UoA provides a number of examples of areas in which the UoA could contribute to societal needs and challenges, essentially by providing data (or potential solutions?) to different stakeholder categories that allow them to make decisions. The UoA's profile and expertise in nutrition are broad and the strength of the unit in terms of involvement of stakeholders in identifying research questions is relevant. Perhaps the UoA could give some thoughts about strengthening this further through a multi-actor approach that goes beyond sharing the research question and financial contributions. Given a societal need, who could/should contribute to solutions that address it? The panel acknowledges that this is an approach to which we, as a scientific community, are not yet accustomed. Research and research questions are our "core business" contributing to societal needs, but can we turn it around in our thinking, approach, and actions?

The panel would also like to acknowledge the UoA strong contribution in capacity building in low-income countries. Perhaps the UoA has been a bit "too modest" by not highlighting this sufficiently in its goals. The scientific impact of this is of course modest, but it is extremely important in the societal context of global animal agriculture and food supply.

### Score for Impact Strategy

2

## Panel - Section 3 Capacity for Collaboration with Society

## 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA has a long-standing tradition to collaborate with societal stakeholders. The UoA described the underlying idea behind its approach as "dissemination" and that it "brings ideas back to the university to be transformed into research questions". Also, the UoA indicates that it is important that end-users be involved in the "initialization of the project". Stated like this, it gives the impression that the UoA acts as a (scientific) knowledge provider. The case study on the Feed Science Network indicates that it can work differently in a more collaborative way. In that respect, the case study does not fully corroborate with the view given in section 3.1. The trend in many national and international calls (H2020 and FP9) requires that successful projects are multi-actor and multidisciplinary projects were different actors play a role throughout the lifespan of the project. This requires a different approach, mindset, and assessment of scientific communities, and also of the stakeholder communities we work with. Because it is a process, it will take time to achieve it and the UoA has underlined this.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.
As indicated before, adopting a multi-actor approach may require a different mindset (or: better awareness) of all involved actors. Within the UoA, it may useful to collectively think about to develop a (written) strategy on how the unit can address this in their role as project initiator. Because this approach differs from our "typical thinking", it may be good that the UoA calls upon an external facilitator to help them in developing this strategy and that will evolve over time. Again, it is process but each step can be one in a right direction. The UoA has a strong basis of stakeholders and the panel encourages the UoA to think within the UoA on the one hand (as indicated above), and use the collaborative platforms they have on the other hand to initiate a discussion what a multi-actor and multi-disciplinary approach really means.

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The UoA (and SLU) may also consider this approach in their teaching curriculum, especially in PhD programs. PhD are typically very motivated by the scientific aspects of the project, but it may be difficult for them to fully grasp the idea of why and how the UoA proposed the research question they are working on in the first place. Of course, this should not (only) be done in a one-to-one student-supervisor context, but the large community of PhD students in the UoA, the faculty (and even beyond) could be a very stimulating setting to address this question. 74

Panel/ Research field	Animal Science
UoA	Animal Environment and Health

#### Introduction

#### General assessment of the Unit of Assessment

The UoA endeavours to develop knowledge on animal environment, health and welfare through research and education. The research focuses on farm animals, sport and companion animals, laboratory and wild animals. It is endowed with human resources (60 staff) spread over four divisions, and claims its unique competences are not found elsewhere at SLU. UoA has one of the highest percentage of women staff (77.5%), with a good age structure and succession plan. The research is highly international, covers too broad areas and is dominated by various welfare issues, animal nutrition, production systems and ranges from food chains to policy. The list of publications indicates diverse topics in excellent quality journals as demonstrated by high citations in Web of Science. The number of PhD students graduated and enrolled, amount of research funding it attracted and the wide research partnership it has, the research is excellent. Research quality and choice of methods are excellent with high level of citations. The UoA has an excellent list of output that have direct relevance to societal needs. It has prominence at Regional and EU levels and participates from technical to policy level engagement. Coordination of the Centre of Excellent in Animal Welfare Science is a clear recognition of the authority and credibility of the UoA. The major stakeholder of the UoA are prominent institutions ranging from technical to policy, positioning the UoA to influence at both levels. It has received a number of national and international recognitions. It already has an established strong collaboration and recognition with diverse segments of society, ranging from farming communities, private companies to policy makers. Since the UoA has a strong focus on welfare issues, where it also has excellent expertise and global recognition, the panel recommends that 'welfare' is included in the title of the unit.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

UoA is organized into four divisions a) Anthrozoology and Applied ethology, b) Environment, care and herd health, c) Ethology and Animal Welfare, d) Production systems, and an administrative unit. The research focuses on farm animals (cattle, sheep, pigs and poultry), sport and companion animals (horses, dogs and cats), laboratory animals (rabbits, rats, dogs), and wild animals (zoo and natural habitat).

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The UoA has 5 Professors, 8 Senior Lecturer, 12 researchers, and one post-doc and 8 doctoral students. UoA is visible globally and claims to be internationally very well renowned and being at similar or higher scientific level compared to other comparative universities in UK, Austria, Scandinavian Universities, Wageningen University, Netherlands, Italy and Spain. Publications are relevant, appearing in globally renowned journals with high record of citations. Multiple authorship is healthy and shows team work. A total of 13 PhD students (84.6% female) completed their studies and there are 8 PhD students. It has successfully attracted competitive grants and contract research funding.

The team also plays an important role in international scientific collaborations (some were completed in 2014) as a partner and coordinator, through limited to European Institutions. The high level of representation on international conferences as keynote speakers and invited speakers is excellent, with balanced gender representation. The UoA is also visible nationally and internationally as shown in the number of important commissions assigned or elected (62.5% female). The 8 awards and prizes received by staff (75% female) is a good indication of the important work being done both nationally and internationally. However, 6/8 (75%) are limited to awards from Sweden.

Although the focus areas of research deal with animal environment and health, this will make it too difficult to focus the research without addressing issues of nutrition, housing and handling facilities and environmental issues. This requires close collaboration with other UoAs such as Nutrition and Management, Forage Utilization and Environment Health and Buildings which also appears to be well established. However, given the broad research portfolio the UoA tries to cover, there is a risk of being spread too thin.

#### Score for Scientific Quality

#### 5

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

UoA has only one male Professor (61-65 years), 3 (2 female) Professors (51-60 years) and 1 (female) Professor (41-50 years) showing good distribution. Interestingly, out of the 20 Senior Lecturers and researchers, 14 (70%) are between 31-50 years of age and 12 of them (85.7%) are female. There are also 8 PhD students (all female) and 7 of them (87.5%) are between 30 to 40 years of age which is a fertile ground to recruit promising faculty members. Balance between senior and junior faculty shows that there is a relatively higher proportion of young and vibrant team. From the age distribution, there is an excellent succession plan to ensure sustainability and quality of research. UoA has a strong team of female scientists. Share of responsibility (page 1) shows that Professors are active and take lead roles in university wide activities such as leading the platform on Future Animal, Nature and Health; EU evaluation team, and Chairmanship of SLU Scientific Council for Animal Welfare.

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UoA has excellent research facilities at its disposal, is recognized as a Centre of Excellence in Animal Welfare Science and has a strong network of partnerships with commercial farms in different parts of the country. This creates a sense of achievement and attracts young faculty to join and also undertake excellent research. It also has access to diverse research facilities within the SLU (page 24) which include laboratory facility for cats, broilers, horses, advanced fish laboratory and remote monitoring equipment, dairy research facility, beef and lamb research centre, and ruminant meat production. UoA has partnerships and extended network of livestock, pig and poultry farmers in South-western Sweden to run on-farm studies. This is especially important to PhD students to get real life experience of animal production and understand the challenges of the existing and future livestock systems.

UoA is active in creating opportunities for international exchange programmes. The number of visitors to the UoA (7) is a good example of the quality of research and facilities which attracts other scientists. It also provided opportunities for faculty (22) to visit abroad and broaden their experience. In general, the UoA is active and has created a conducive environment for creative, intellectually vigorous and productive environment with diverse and dynamic team of researchers with visible succession plan.

# 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

Recruitment (Page 23) shows 2 senior staff, 6 researchers and 1 post doc within SLU, 1 researchers from other Swedish Universities and 3 researchers and 1 post-doc from foreign Universities. Mix of recruitment from Sweden and international universities shows intention for diversity and attracting young faculty. UoA encourages junior researchers to participate in courses and PhD supervision groups. UoA supports young faculty in developing proposals and encourages participation of PhD students and junior researchers to present results in international conferences. Exposure to take up management responsibility (scientific leadership, budget and personnel management) and to network nationally and internationally through the Centre of Excellence in Animal Welfare Science is appreciated and opens up exchange of ideas, innovations and joint project development. UoA also allows PhD students to participate in international projects and in other programs beyond their projects to enhance exchange of ideas. UoA designs co-supervision of PhD students by researchers from other countries to enhance quality of research and global relevance and encourage them to publish scientific and popular articles which creates a great opportunity for carrier development. The strategy and opportunities to encourage young faculty to grow into independent researchers is very clear.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

UoA indicated a number of networks and collaborations (page 19) with various Universities and institutions in Sweden and international network with Norway, UK, Poland, Germany, Italy, Netherlands, Austria, and Ireland. These are based on joint scientific research and teaching using various funding sources. Although there are 8 collaborative activities presented, in most cases UoA is just a partner, and coordinator in two cases. UoA should take a lead role in the future. The eight international participations in scientific conferences presented include Brazil, Norway, France, UK, Vietnam, and Belgium. UoA was invited as keynote speaker in three cases only. The 50% female participation is noted and appreciated. The panel noted that 6 of the conference are on more general topics and care has to be taken to be selective to ensure relevance. UoA received 8 awards and 6 (75%) of them were won by female members of the UoA, and it should endeavour to be recognized more by international bodies. Although UoA's work has global relevance, the collaboration appears to be limited to Europe. UoA should explore opportunities to expand collaborative activities globally, after carefully assessing its comparative and competitive advantages.

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### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

Lead staff profile (Page 1) indicates a multi-disciplinary team addressing various issues on animal environment and health. The focus is on farm animals, sport and companion animals, and laboratory and wild animals. The nature of the research thrust requires multi-disciplinary approach in order to be successful.

The unit describes extensive interdisciplinary collaboration with other departments at SLU as well as with other national and international institutions. Some of these collaborations reflect upon the list of publications.

#### Score for Scientific Environment

5

#### 1.3 Strategy for Scientific Development

# 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The five year strategy focuses on national and international cooperation for attracting funding for high quality research and being attractive to skilled researchers and talented students. The UoA has done a great job of assessing its weaknesses and strengths properly to identify opportunities for growth and expansion. It has focused on its human resource capacity development and has identified critical new areas of expansion, with engagement of highly competitive national and international PhD student groups, post-docs, Senior position in antrozoology, Senior position in animal ethics, new Professor in meat science, Professor or Senior researcher in Ruminant nutrition, Professor or Senior researcher in business economy.

In the area of Ethology and Animal welfare, the strategy is to maintain the leading research team, through a vibrant network of partnerships, with appropriate staff structure (junior/senior ratio), students and guest researchers.

In the area of Animal welfare the formation of the Centre of Excellence in Animal Welfare Science, broaden the units multi-disciplinary network, organize annual Symposia to extend the content, depth and quality of research, train and encourage young faculty for expanded grant application. The UoA also strategizes to further develop the new research area on Green Care and Animal Interventions through multi-disciplinary national, Nordic and International collaborators.

Overall, the strategy is well thought, clear, realistic, appealing and achievable. The thrust is clear, the division level is clear and UoA level is clear, with targeted staff requirements.

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## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

UoA projected and positioned itself to future challenges of society with increased interest in welfare of animals used for food production, companion animals, sports, entertainment, and research purposes. It anticipates existing unique competence within the UoA that will help to deal with new and emerging challenges in animal welfare. It anticipates opportunities in sustainable livestock systems, fish husbandry and welfare, ethics and welfare of animals used for research, improved methods of transport, slaughter, killing and welfare of non-conventional husbandry systems will increase the demand for research.

It anticipates to contributing to beef and lamb production that are economically and environmentally sustainable, with focus shifting to meta-analysis of existing and new data to develop new modes of production that ensure sustainability. It plans to develop a new area in animal welfare epidemiology using BIG data collected by authorities and stakeholder to make informed decisions on European Food Safety Authority and promotion of global discussion on animal welfare standards. It will work on inclusion of animal welfare into UN SDGs and plans to explore the inter-relationships between animal welfare, climate change and biodiversity.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The challenges for the UoA to implement successful scientific development appear to be both internal and external. The internal challenges are core funding from SLU to cover half-time coordinator for the beef and lamb research centre and long-term financing senior scientist positions in ruminant nutrition and business economy. The capacity of the UoA to attract external funding is very high as demonstrated by the relatively reasonable funding over the last five years. According to the UoA, specific support is required to support Ethology and Animal Welfare research activity.

#### Score for Strategy for Scientific Development

#### 4

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The UoA's strategy for scientific quality and renewal is very clearly articulated. The focus on the research still remains relevant and has positioned itself to deepening and expanding activities into areas where new opportunities exist. There is a good number of well qualified and renowned professionals with support from young faculty and a network of partnership who can lead and sustain the research program. The UoA should:

The strong focus on welfare issues should be maintained.

Review scientific environment and leadership

The current age structure which is very positive, with good age distribution. However, the Unit has to be aware of the need to maintain and ensure growth in the future.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

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The research agenda and societal engagement of the UoA is clearly articulated under 2.1a (page 7). The research profile of the UoA is very impressive and well organized with adequate number of qualified staff.

The level of engagement with society is also diverse, pertinent and impressive. They have entered agreements with regions and societies to support the research group on beef and lamb production. There is an excellent relationships with the national board on agriculture, national food agency and country administrative board and have made presentations in various workshops and trainings. This helps the UoA and SLU to influence policy with the scientific evidence at the highest level. Coordinating and contributing to national and internal projects outside academia and providing science-based advice on animal welfare are an excellent achievements and demonstration of authority in their field of specialization. Coordinating the Centre of Excellence in Animal Welfare Science is recognition of the high level of expertise within the UoA. Organizing national conferences, development of farmer led innovation groups, developing and running course for persons working with mink and animal welfare inspectors and engaging with the media in various forms is an outstanding achievement which for sure increase the visibility of the UoA and SLU at large.

The major stakeholders are wide and diverse and range from policy makers to farmers (government authorities, farmers (beef, lamb, poultry and dairy producers), meat industry (slaughter houses), horse racing, cat shelter, riding school associations, dog therapy schools, agricultural societies, nature conservation organizations and the general public). These are carefully selected and relevant stakeholders which serve as sources of research and innovation and major actors for implementation of research results at scale. However, there is room for improvement.

#### Score for Activities and Outputs

#### 2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

Key outcomes presented by the UoA are impressive and clear demonstration of bringing about policy and practice, operational, technical and behavioural changes in society. The work on transport of working dogs which brought about change in the Swedish legislation as a result of collaboration (under conflicting conditions) with the police and customs to change procedures regarding transport of working dogs.

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The work on over-night lairage of cattle and sheep at abattoirs is another good example which resulted in change in operational procedure with significant implication on cost to procedures and quality of meat produced at abattoirs.

Improvement of knowledge and practice by farmers on forage management has significant implication on production systems and also on environmental footprint of ruminant production. This piece of work will have significant contribution to our knowledge of ruminant livestock production globally. The research on behaviour and welfare of farmed mink to reduce abnormal behaviour is another interesting

study which resulted in introduction of new legislation for mink producers not only in Sweden, but also in new welfare program (WelFur) for fur animals in Europe.

The panel is of the opinion that the full potential for societal impact of the UoA is realised with direct influence of the quality research on developmental outcomes. These developmental outcomes not only influenced procedures and behaviours of society in Sweden, but also other European countries.

#### **Score for Outcomes**

#### 3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA is already well placed within the society, both nationally and internationally. The public concern about animal welfare is very high and this provides huge opportunities for the UoA to engage in debates on sustainability of human-animal relationship in a wider context, interact and work with farmers, producer groups, consumer groups, animal welfare groups, retailer companies, environmental groups, societies and associations, government authorities, the media, etc. It has a strong network of partners and an established credible research deliverables based on societal needs. The UoA has also realized its role and contribution to consumer demands that require the industry to response to quality assurance with welfare indicators, welfare assessment systems and increase in extensive and organic production systems. In addition to its well established network among the scientific community, it has an already established continuous and systemic communication with farmers' magazines, visiting seminars with farmers, advisors and industry representatives. The UoA has also well-articulated it strengths and will continue capitalizing on its network of partners to implement its objectives. The weakness arises from being too spread to address a number of issue. The UoA should focus on its strength in welfare and develop a clear strategy in that line.

#### Score for Impact Strategy

2

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

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The UoA has already an excellent track record of national and international collaboration and has demonstrated its impact on society from technical interventions all the way to policy influence. The UoA has an extensive experience and knowledge of collaboration with society. They understand both the internal and external factors that affect such collaborations. The UoA has sharpened its negotiation skills to engage society for mutual benefit

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The UoA has a clear strategy for collaboration with society, and has a lot of knowledge and experience in dealing with society and societal problems. It should continue the excellent work and also develop some new and innovative ways of dealing with the society. The area of engagement of the UoA is so wide, there could be more demands from society for the UoA to contribute. This could strain faculty members in term of time and care should be taken in setting up priorities of engagement. The Unit should focus its programs around animal welfare where collaboration with society and recognition is high.

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Panel/ Research Animal Science field

UoA

Animal breeding, genetics and bioinformatics

#### Introduction

#### General assessment of the Unit of Assessment

The aim of the UoA is 'to do excellent research and education in the field of life sciences, contribute to society with outreach activities and contribute to sustainable development of food production, use of animals for sport and companionship'.

Quality of Research: The UoA has four sections (Quantitative, Applied and Molecular Genetics, and Bioinformatics) and hosts the Animal Genetic Laboratory, the SLU BioBank and the International Interbull Centre which is the only European Union Reference Centre (EURC) for animal breeding. Substantial research funding is raised and research outputs are numerous and generally of high quality. The group is nationally and internationally highly visible and has impact. A unique characteristic of the UoA is the very broad and comprehensive research approach, integrating state of the art technologies with aspects of economic viability, sustainability and ethical responsibility in breeding.

Societal Impact: The UoA has many stakeholders and performs very important tasks with direct effects for them. Locally, key stakeholders are breeding organizations and owners of livestock and companion animals. Development of genetic evaluation systems, with a focus on functional and Health traits and search for important genes, also often related to animal health and welfare, provide visibility and broad acceptance. The UoA is also advising policy makers. The collaboration with ethicists, exploring future options of gene editing, is highly commendable. The UoA has high reputation in developing countries for capacity building, providing postgraduate courses on animal breeding and genetics in many countries.

Capacity for Collaboration with Society: Managing collaborative activities with the wide range of stakeholders is a challenge, and the recent development of an 'interaction with society' strategy is a significant achievement of the UoA. Based on the history of close collaboration, it has high trust of partners. Rapidly evolving novel technological opportunities (e.g. genomics, big data, gene editing) will provide new opportunities, but also will make it necessary to re-define the UoA's position towards a responsible, ethical and societally acceptable use of the various options.

### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA which is basically identical with the Department of Animal Breeding and Genetics, represents in a European context one of the largest groups in the field with nine dedicated professor positions and is organized into four sections – Quantitative genetics, Applied Genetics, Molecular Genetics and Bioinformatics. The unit hosts the Animal Genetic Laboratory for parentage testing, molecular tests of disease and coat colour genes. In addition, it also hosts the SLU Biobank and the International Interbull Centre which provides genetic information services and applied research for improvement of livestock to a worldwide network. It is also the

#### only European Union Reference Centre (EURC) for animal breeding.

The UoA has the highest number of staff in the faculty. The unit has the only Professor in Bioinformatics and hosts the SLU Bioinformatics Infrastructure (SLUBI), which allows to create useful links to other disciplines and can be seen as a core asset. The unit has been successful in completion of 30 PhD students and with 13 on-going PhD studies. The unit has attracted highest research funding in 2016 among all UoAs in this section with 35 M SEK.

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The UoA has a comprehensive research approach in that it pursues and combines all different aspects of animal breeding and genetics. It has a very strong fundament in quantitative genetics and selection theory, has developed a high competence in molecular genetics and genomics, and is well prepared to handle and process massive amounts of breeding data (phenotypes, genotypes, pedigree etc.) both in a statistical and a bioinformatics context. Somewhat unique (in comparison to other major animal breeding groups) is the emphasis on ethical aspects of animal breeding, which is not considered as an 'add on' to the subject, but as an integral aspect in all research projects, which also can be considered as a 'Nordic' approach to deal with the subject. All components in this profile appear to be represented in equally high scientific quality, so that none of the different disciplines dominates the others. Several of the researchers from all levels have received distinctions and/or have had functions in international commissions and/or have been invited speakers at international conferences, underlining the high recognition of the group in the respective peer group.

This somewhat unique and very powerful constellation allows the UoA to develop a strong research portfolio, both in 'stand alone' projects and as a partner in larger collaborative projects. Examples for such prominent achievements, as given in the self-assessment report, are:

• Uncovering the causative gene variants of diseases and malformations by combining genome wide association studies with targeted re-sequencing of associated regions. This also led to the development of several new gene tests for canine and equine genetic diseases and performance traits.

• Development of quantitative genetic methods for analyses of variance heterogeneity, new genomic selection algorithms and analyses that simultaneously model susceptibility and recovery to disease.

• Development of a model that integrates inherited variability and indirect genetic effects, facilitating studies on genetic relationships between these phenomena in natural and domestic populations, used to detect and validate genomic regions for bone strength in laying hens.

• Development of new genetic evaluations of health and behavioural traits for dogs, and performance and conformation of horses.

• In a research topic 'Breeding for alternative production systems' farmers' preferences for breeding goals in different species and production systems were assessed and sustainability of breeding programs was integrated with other sustainability aspects, showing large variation in sustainability of European pig farming systems.

• The field of genetically modified farm animals was reviewed and discussed from an ecological perspective. A synthesis integrating breeding and ethical perspectives was, for the first time, discussing ethics of real cases of genetically modified farm animals.

These exemplarily listed scientific achievements show both depth and breadth of research in genetics and breeding, with a clear demonstration of originality of ideas with a focus. The scientific methods are always sound, often cutting edge, and the impact of the research output is relevant globally. The team has been scientifically highly productivity as shown by the number of scientific and popular publications, with high citations in Web of Science, but with a lack of very high impact publications led by researchers of the group. In addition, a number of faculty members have also participated in national and international workshops/conference as invited speakers, keynote speakers and session chairs. All this demonstrates scientific impact, recognition and prominence in the field of science.

A specific characteristic of the scientific environment in Uppsala is that there are two universities (SLU and UU) with a high profile in animal genomics. While there have been joint research achievements in the past (e.g. mapping of the DMRT3 gene causing gait variability in horses) an even better integration of the two groups certainly would hold the potential of developing a world leading group in that specific area.

To summarize, the overall scientific quality is definitely high compared to international standards. In some fields, like the consideration of ethical standards in breeding research, it is somewhat unique and thus World leading, but the group certainly would have the potential to drive its scientific quality to an even higher level by focusing more on its strengths and unique assets and by teaming up with some of the strong partners in the scientific environment.

#### Score for Scientific Quality

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The unit is organized into four inter-connected sections (quantitative, applied and molecular genetics and bioinformatics, with 64 staff and 13 PhD students. The professional staff is composed of 9 Professors (22.2% female; excellent age distribution), 2 female Senior Lectures, and 14 researchers (71.4% female; excellent age distribution). There are also 3 post-docs (66.7% female) and 13 PhD students (69.2% female) (258). The UoA successfully attracts international guests and encourages interactions among staff at various levels and age groups. The staff composition (junior to senior, male female ratio) and involvement of a number PhD students is an excellent mix to build up a very vibrant research team. Recruitments in the reporting period above the post-doctoral level were dominated by recruitements from foreign universities (7 female, 4 male), other Swedish universities (4 male) and just a single (male) recruitment from SLU. It may be seen as one of the main challenges that it becomes increasingly difficult to keep well trained young professionals in the group, because there is, nationally and internationally, a high request for people with a specific profile, e.g. in bioniformatics. Here, the university also competes with the industry for young talents.

The field of responsibility of the UoA is a dynamic and highly competitive area which is constantly evolving with a rapid turnover of technological innovations and therefore needs an adaptive innovation management. The UoA has an excellent leadership from professors and senior scientists, who appear to collaborate very harmonically in a team, which is critical for the survival and success of the UoA. In addition, involvement of a good number of young and dynamic researchers and post-docs armed with the latest technologies and ideas and PhD students who explore new areas of research is an excellent example for how to stay upfront in the international scientific world and ensures sustainability of the research program. In order to promote exchange of ideas and experiences, the unit had 9 visiting researchers from the international scientific community and three members of the UoA had an opportunity to visit abroad.

The unit organizes weekly seminars on a wide range of topics, workshops on project idea and departmental days on its strategy. It has taken the wise decision to rotate tasks (section leaders and directors of studies) among staff every three years. A strategy has also been developed including 'work environment' and 'support and infrastructure' with clear objectives, activities and responsibilities. The unit has been very innovative in creating a stimulating, intellectually vigorous and productive environment and this has been demonstrated by the high quality of scientific output, global leadership in its field of specialization and attraction of substantial amounts of research funding.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA takes staff development seriously and has clear instructions for follow-up of individual goals. This effort is to give freedom for young faculty to initiate collaborative research projects, and encourages them to engage in management-related functions and take leadership courses. Junior scientists are also given leadership positions under rotation which provide a balance between focusing on own research and to gain other academic experiences. Senior researchers encourage and assist junior researchers to write grant applications and young faculty members are also challenged to serve as co-supervisors for PhD students. Successful completion of 30 PhD students is a clear indication of a vibrant academic environment which encourages interactions between senior and junior members of faculty and graduate students. Recruitment of – mostly international - 16 staff and post-docs over the last five years is also an indication of an attractive and dynamic unit which attracts talent. The unit also organizes supervising courses to provide younger colleagues an insight into their roles as co-supervisors. Young faculty are encouraged to participate in conferences, study tours and take part in international exchange program. The UoA has created an informal climate to create a working environment where everyone, regardless of age, gender, geographical origin and position, is treated with respect.

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# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA has many collaborative activities. The integration of the Interbull Center makes the UoA the natural hub of a network of basically all relevant dairy cattle breeding countries in the world, currently in close to 40 countries on five continents, and possibly the UoA could capitalize more from this given asset in terms of scientific output and visibility. Historically, the animal breeding and genetics group at Uppsala played an important role in capacity building on the African continent. This network was partly lost due to a generation shift prior to the reporting period, but still SLU has a good name in Africa and would have the possibility to refresh some of the old links and activities beyond the currently established collaborations. Other initiatives, like the B3Africa project in which eB3Kit, a complete informatics platform for biobanks, was developed, have the potential to create links to target groups of different profile over a wide geographic range. Participation in an international master program in animal breeding and genetics (together with other European universities) has yielded a large number of international graduates, most of which have returned subsequently to their home countries, but will form a comprehensive and potentially useful alumni network around the globe. Different members of faculty are serving in various capacities influencing nationally and internationally. For example, faculty are severing as Editor/Deputy Editor of Scientific Journals such as G3:Genes, Genome, Genetics and EMBnet, the Global Bioinformatics Network, are leaders as President of Genetics commission of European Federation of Animal Sciences, EAAP; Executive Secretary of ISAG Board and member of ISAG Executive Committee, member of International Committee for Animal Recording, ICAR, etc.

These involvements, nationally, continentally and internationally clearly demonstrate the wide geographic coverage and prominence of the UoA.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The group is interdisciplinary and closely collaborates with various other UoA in SLU. For example, there are seven collaborative activities listed with other departments. Additional collaborative activities include works with the University Animal Hospital, the National Veterinary Institute, Plant Breeding, Ecology, Crop Production Ecology, Molecular Science, Energy and Technique and Economy, Aquaculture, Centre for Organic Food and Farming, and Organic Animal Production. The Mistra-Biotech inter-disciplinary program (where a member of the UoA served as deputy program manager) undertook a number collaborative research in the areas of social acceptance of GM plants and transgenic salmon, ethical aspects of GM and gene edited dairy cattle. Members of the UoA also served in the steering groups of the research platform Future Agriculture and Future Animal Health and Welfare, and the UoA contributed to a number of inter-disciplinary studies on sustainable consumption, construction of future scenarios for agriculture and domestic animal obesity. The UoA is an excellent example of an inter-disciplinary research program in various aspects of livestock genetics and breeding using various species of animals.

#### Score for Scientific Environment

#### 6

#### 1.3 Strategy for Scientific Development

#### 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA has clearly articulated its strategy for scientific quality and renewal. The strategy starts with a broad and higher level goal, saying that it strives to contribute to feeding human population in a sustainable way, and to increase human well-being via social interactions, recreation and physical activities together with animals, and high animal welfare. It has also put collaboration with stakeholders at the centre of the strategy and plans to work for new industry PhD students, funded by Sweden, EU and the industry. The UoA aims for a large project from Knut and Alice Wallenberg foundation, European Research Council and Swedish Foundation for Strategic Research to enable integration of all parts of the UoA and to continue to be an attractive partner in European projects The UoA also outlines the strategic research areas of focus as follows:

1) Develop and implement new international genomic evaluation, increase research on genetics and breeding for aquaculture.

2) Continue work with breeding, genetics, bioinformatics, and biobanking for low income countries.

3) Focus on functional genomics and continue to be active in Functional Annotation of Animal Genomes (FAANG) consortium.

4) Complement genome wide association studies and whole genome sequencing studies with additional functional studies such as transcriptomics, proteomics, and metabolomics.

5) Apply molecular evolutionary theory to better understand genetic variation underlying phenotypic diversity.

6) Continue to develop recording and evaluation methods for health, reproduction and behavioural traits to study how breeding can improve animal welfare and farm productivity.

7) Develop and improve methods for whole genome sequencing, transcriptomics, epigenomics, proteomics, and integrate these areas in studies such as individualized medicine.

8) Machine learning and deep learning as new tools for genomic selection and phenotypic predictions. Develop user friendly tools for integrated bioinformatics analysis workflows.

9) Develop automated data management and standard methods for studies of large data.

#### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

Many of the defined research areas are a consequent further development of methodological approaches that are already established in the group and/or are along the lines of the development paths also followed in competing groups. Timely addressed new fields of research are those linked to the fields of omics integration, big data and machine learning. The UoA certainly has the competence and potential to take a lead in or make major contributions to the indicated new research fields, but probably needs to extend its network of strategic partners both in academia and non-academia. Some of the areas (e.g. deep learning) require that an entirely novel expertise in areas where experts are scarce and highly sought is established, both from academia and the industry. It should be tried to maintain the holistic view of the field, including aspects of sustainability and ethical responsibility in breeding.

#### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The major challenge will be to maintain the well-established and successful broad and comprehensive research approach and combine it with the development of novel, very focused and targeted methodological approaches. Some of the methods require highly specified expertise which often has no or little association to animal science. A challenge will be to create a group of animal scientists, genomics experts, bioinformaticians, and data scientists, which still understand themselves as an animal breeding group and are able to communicate with, say, industry partners, funding agencies or other UoAs in the faculty. A second challenge will be to recruit a good mix of people with the required qualification and to establish the developed expertise in a sustainable form, e.g. by keeping PhD students as postdocs in the group to benefit from the investment in the training of the students. A third challenge will be the rapid (and permanently accelerating) technological turnover, meaning that the half-life of methodological innovations becomes shorter and shorter and investments in technology and training have to keep track with this.

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#### Score for Strategy for Scientific Development

#### 4

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The UoA will play a central role for other groups in the faculty, e.g. in the field of bioinformatics and exploitation of big data via machine learning techniques, which will be instrumental for many fields. Despite the fact that this UoA has an impressive track record in fields associated with 'big data' so far, this will be an entirely different challenge. Especially the area of artificial intelligence/machine learning will be a key technology of the future which will be required and used in many areas like precision (livestock) farming and will not be restricted to the animal science sector. It will be neither sensible nor efficient to develop the respective expertise in several units in parallel. SLU should consider to establish a core facility, which may be linked to this UoA and the bioinformatics platform, but should be aware that it is critical to provide sufficient resources and a clear policy to combine methodological research and development with service functions in such an infrastructure.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA strives for societal impact, in many different ways. Its primary stakeholders are breeding organizations in the area of farm and companion animals, for which the UoA provides new technologies, ready for application.

Cases presented for this approach are:

? Incorporation in routine genetic evaluation of the results on on-farm genetic studies on milkability in a robot milking system

? Inclusion of welfare-related traits in the selection of a pig breeding program

? Incorporation of new genetic tests on the identification of mutant genes in horses and dogs

? Implementation of breeding values for performance and conformation in horses and for hip and elbow dysplasia and fearfulness in dogs

? Discussion on alternative production goals with breeding organizations in Europe.

Research output related to gene discovery, for example the gene responsible for the special "toelt" gait of Icelandic horses, are of great interest to the general public and are prominently published (cover story of "Nature"). Genetics and genomics of health traits is part of the core output of the UoA.

The UoA hosts three centres of international standing and recognition, the Interbull Centre, the SLU Global Bioinformatics Centre and the Beijer Laboratory dealing with use of big data in dairy farming, donated by the Beijer Foundation.

A recent impressive output is a review paper in Journal of Dairy Science, produced by members of the UoA jointly with a professional ethicist concerning ethical considerations of genetic modification and gene editing in cattle. This was picked up by media across Europe and was followed up by a long radio interview about the topic.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The UoA runs a centre for parentage testing and genetic testing revealing carriers of recessive disorders in various species as well as a biobank for conservation of germplasm. These are of great value for livestock keepers as well as dog owners and are very frequently accessed.

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The Interbull Centre is extremely important for transnational cattle breeds, linking the data of breeding organizations across the world and making results and estimated breeding values directly comparable. A key case for this is the implementation of genomic selection procedures for the Brown Swiss breed in the 'Intergenomics' initiative, where national organizations did not want to share high throughput genotype data but gave it all to the Interbull Centre as a trusted third party, which runs international genomic prediction procedures for them. The Interbull Centre has recently grown and hosts substantially more staff than before.

The long term engagement of the UoA in animal breeding and genetics capacity development in SubSaharan Africa, in close collaboration with the International Livestock Research Institute (ILRI), has led to great appreciation of the contribution of SLU to genetic improvement of livestock in many countries of the region. The resulting online Animal Genetics Training Resource, https://dev.ckm.ilri.org/agtr/node/14, is routinely used in many university courses.

More recently, the SLU Global Bioinformatics Centre has developed a bioinformatics collaboration framework, B3Africa, linking European and African institutions to develop an informatics infrastructure for biomedical research across the continents to address global health challenges. A similar approach was chosen to link European and Latin American institutions in the framework of a project called DEANN.

The UoA has significant national, regional and international relevance and is actively engaged in and makes concrete contributions to solving real societal problems.

#### **Score for Outcomes**

#### 3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA understands roles, responsibilities and significance of research to meet societal needs. It considers genetic improvement of livestock to be economically valuable, and improvements of the efficiency of food producing animals being beneficial for both food security and the environment. Genetic improvement of health, behaviour and performance of sport and companion animals has a positive influence on humans' quality of life. This is the strong belief of members of the UoA, also indicated in the panel interview.

In 2017 the UoA developed, in a participatory manner, a strategy for 'interaction with society' with objectives, activities and responsibilities. This enabled the group to have stronger interactions with stakeholders and a better understanding of their needs. A strategic communications plan is being developed in recognition of societal needs, aiming at high visibility and easy accessibility of research outputs.

The UoA plans to write more popular science articles, participate in various media (radio interviews, press release, blog stories, twitter, etc), and improve the homepage. Priorities include development of a communication plan, a constant update, participation in conferences, meetings, presentation of scientific articles published in the homepage and of each project in popular science form. Persons to facilitate contact with stakeholders, to spread knowledge on the use of animal genetic resources, and to provide useful advice to breeding organizations and authorities have been nominated.

The recent gene editing review paper written together with an ethicist, attracting very high publicity, and the follow up media work are a reflection of this active strategy.

The UoA is in a strong position to implement these strategic goals. Incentives should focus on ensuring high quality research being relevant to society. This takes a lot of staff time and effort and often with no obvious outcomes. SLU should consider to provide support to deal with creating the appropriate balance between scientific work, collaboration with society and academic career. Biobanking is an expensive undertaking with high initial investments and long term values and benefits, and SLU should support the development of guidelines for its management and use. The global future depends also on the understanding of its animal genetic resources, to which such activities are an essential contribution.

#### Score for Impact Strategy

3

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The approach of the UoA to collaboration with society starts with joint identification of practical problems to articulation of research questions by researchers and stakeholder through discussions and dialogue. Successful collaboration is based on mutual trust and respect, as articulated by the UoA. Social capital is key to successful collaboration and the UoA also highlighted this by indicating that 'maintaining active contact with partners even during years where there are no on-going joint projects is essential'.

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Collaboration with authorities in the areas of development of regulations, policy formulation, capacity development, participation in research calls, etc. is crucial and gives credibility to the UoA. Maintaining a strong and cordial relationship is important to keep abreast of recent developments and to explore opportunities for funding.

The use of the Animal Genetics Laboratory by breeders and breeding organizations helps to maintain contact with partners and explore joint researchable issues, such as finding of the DMRT3 mutation in horses. The successful case study on breeding for improved hip and elbow dysplasia in dogs (HD and ED) is an excellent example of collaboration. The results were taken up by the Swedish Kennel Club (SKK) to establish a routine genetic evaluation for HD and ED, which is a great scientific impact. Involving a PhD student to this type of demand driven research led to a long and successful collaboration and the student was employed by SKK to create such an evaluation system in collaboration with her university supervisor, which is key to sustainable relationship. She also spends some time working at the UoA, which has enhanced the dialogue between SKK and SLU. Maintaining such a long relationship is an excellent example of trust, commitment and credibility. Delivering high quality of research relevant to society is a key value that attracts society to work with universities.

The UoA members are in very close contact with livestock breeding organizations. Based on the history of close collaboration, it has high trust of these partners. New developments, like genomic selection in cattle populations, are being taken up rapidly by these stakeholders.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The UoA is playing a significant role in the society and is delivering important scientific outputs and services that are useful nationally and globally. Managing collaborative activities with such a wide range of stakeholders is not an easy job, and the recent development of an 'interaction with society' strategy is a significant achievement. The range and scope of collaboration will continue and the UoA should position itself to be responsive to the ever changing demand from a multitude of partners and collaborators such as breed societies, breeders, consumers, associations, academia and governments for new frontiers and dynamic genetics work.

Genetics research of the UoA and others will further unravel a number of important aspects of our life, and the future of our planet depends heavily on new discoveries in genetics in the face of changing demands from society and also from external factors such as climate change. Rapidly evolving novel technological opportunities (genomics, big data, gene editing) will provide new opportunities, but also will make it necessary to re-define the UoA's position towards a responsible, ethical and societably acceptable use of the various options.

The UoA has a clear strategy of collaboration with actors outside academia, particularly in Sweden. Given its strong history, the panel recommends that UoA should continue to engage and expand work with governments and institutions in developing countries to enhance potential mutual benefits. SLU Global and the new SLU Platforms should be consulted and used in this context.

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Panel/ Research Animal Science field

UoA

Forage Utilisation (Ruminants)

#### Introduction

#### General assessment of the Unit of Assessment

The Panel welcomed a clear statement of the vision for the Unit to be a successful research group in grass and forage science with a strong focus on dairy production. The integrated approach along the dairy supply chain (from soil to dairy products) is a strong and relatively unique feature of this Unit within the SLU Animal Sciences programme. In discussions with the Panel, it was made clear that the Unit represented only part of a Department, with the remainder of the work being assessed under NJ Crop Science Grass and Forage Science. This artificial division made assessment of the interdisciplinary approach more difficult, given the strong links between soils, plants, animals and product quality. The Panel recommends that consideration is given to reviewing how this type of interdisciplinary approach can best be supported and developed within the structural arrangements of the University.

Whilst a small Unit, the integration of experimental modelling and research has been very successful with excellent progress in three key areas:

- Development of methods to determine and models to predict enteric methane production.
- Comparison of protein sources for dairy cattle and development of protein evaluation systems.
- Development and application of work on indigestible NDF to predict forage digestibility.

Overall, relative to the small size of the Unit, the Panel considered that it has achieved significant scientific impact internationally and the Unit is well connected with the global network of research organisations involved in forage utilization research. However, the composition of the Unit is a concern given the significant reliance on one professor and the Panel recommends that urgent consideration is given to an additional professorial appointment to build on the well-developed national and international links and high profile of the Unit. This is particularly important in the context of the need for ongoing research on the potential to further enhance product quality and reduce the environmental impact of milk production systems in Northern Sweden.

It is clear to the Panel that the Unit is well connected with dairy industry, the farming community and consumers and this is reflected in significant funding support from industry.

The impact case studies highlight important new research findings which will guide the future development of sustainable ruminant livestock systems. The underpinning research has been published with high impact achieved internationally and there is clear evidence of uptake by and relevance to industry and wider society.

### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

This is a relatively small Unit of Assessment with 9.6 FTE comprising one Professor, four Researchers, 3.7 Doctoral Students and one Technical support staff. Whilst small, the overall scientific quality of the Unit is high with excellent progress being made in three key areas:

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- Development of methods to determine and models to predict enteric methane production.
- Comparison of protein sources for dairy cattle and development of protein evaluation systems.
- Development and application of work on indigestible NDF to predict forage digestibility.

#### Depth and breadth of research profile

Given the small size of the Unit, split across two faculties and with only one Professor, the Panel are concerned regarding sufficient critical mass within the Unit and the need for effective succession planning. Further issues of concern include the limited core funding of the programme, reflected in the relatively short term nature of projects, and the very large overhead costs associated with elaborate farm infrastructure. Nonetheless, despite these limitations, the Unit has a strong national and international profile. Over the period of assessment 2013 - 2017 the Unit published ten high profile refereed scientific papers and four PhD's have been awarded. Major funding sources for the programme, in addition to core funding, include Formas (The Swedish Research Council), the European Union (FP7 and Era Gas programmes) and milk processors (RJN/Valio). Overall success rate in competitive funding is good relative to the size of the Unit (8 projects with a value of 25.1 MSEK ( $\epsilon$ 2.51m) equivalent to  $\epsilon$ 314k per project). The relatively low income per project seems surprising and the Panel recommends that consideration is given to exploring opportunities to secure fewer, larger contracts for longer term programmes of work.

#### Originality of ideas

The originality of research is excellent with the three main research topics highlighted above all being very relevant to current challenges in forage evaluation and livestock production. In particular, the Panel noted that the development of the in vitro system to predict methane production is world leading. Furthermore the work on revision of the "Karoline model" has significantly improved accuracy of methane prediction.

The Unit's research on use of rapeseed meal as a replacement for soya bean meal as a protein source for dairy cows is also globally significant. The work has also highlighted the need to revise current feed protein evaluation systems.

Work by the Unit on indigestible NDF in feed evaluation is also world leading, in particular the use of i NDF to predict rumen NDF fill, an important regulator of voluntary feed intake.

#### Choice of methods

Methodology used in research is appropriate and the Unit have a strong national and international reputation for developing new methods and technologies in forage evaluation. The integration of experimental modelling and research is particularly noteworthy.

#### Scientific productivity

Over the period of assessment 2013 – 2017 the Unit has published 10 refereed scientific papers in high impact journals and four PhD's have been awarded. The relevance and importance of the work of the Unit in developing methods to predict methane production from ruminants is reflected in the research paper associated with this work being recognised as the most highly cited paper in the "Nutrition Feeding and Calves" section of the Journal of Dairy Science in 2016. The Panel were concerned to note a very high dependence within the Unit on preparation of research papers by doctoral students and the Head of Unit, Professor Huhtanen.

#### Scientific Impact and Prominence in the field of science

The Unit have a very wide and comprehensive range of international scientific collaborators including Wageningen, Teagasc, INRA, Aberdeen University, University of Reading, LUKE, Norwegian University of Life Sciences and Aarhus.

The senior scientist in the Unit, Professor Pekka Huhtanen has an excellent international reputation, reflected in a strong publication record and numerous invitations to international scientific conferences. However, other members of the Unit are less well known internationally and this highlights the need for effective succession planning. Overall, relative to the small size of the Unit it has achieved significant scientific impact internationally and the Unit is very well connected with the global network of research organisations involved in forage utilization research.

#### Score for Scientific Quality

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

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As a small Unit, there is heavy reliance on PhD students and post doctoral students and this is achieved by offering high quality projects and effective supervision. In order to attract good students, the Unit maintains a strong profile by publishing in high impact international journals and presenting at high profile conferences. Good use is also made of the university research farm to organise courses and workshops which assists in raising the profile of the Unit.

The Unit has one professor, four researchers, 3.7 doctoral students and one technical support staff. Succession planning needs to be considered within the Unit with consideration given to increasing the number of professors and also more younger researchers are required (presently only one researcher in the 31-40 year category). There is a good gender balance in researchers (50/50). No information is provided on international recruitment on mobility.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

There is a strong programme of development for younger researchers. This includes participation in journal clubs, encouragement to undertake post graduate studies outside of the "home" university and participation in scientific conferences. The Unit particularly encourages younger researchers to write and submit grant applications early in their career. Once appointed as associate professors, staff are required to supervise students and to participate in mandatory courses in pedagogics and leadership. Within the Unit all staff share details of international contacts and provide advice to younger researchers on funding sources and potential projects.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

This Unit has strong international collaboration with the following organisations: USDA Dairy Forage Research Centre – USA Teagasc – Ireland Norwegian University of Life Sciences – Norway Aarhus University – Denmark Wageningen University – Netherlands University of Reading – UK University of Nottingham – UK INRA – France

The majority of the linkages above are associated with competitively funded research projects. In addition to the above the Unit has hosted ten visiting researchers over the period 2013 – 2017 and supported one visit abroad by a member of this Unit.

The Panel also noted the outreach activity by the Unit in organising and hosting several well recognised international courses for doctoral students:

- 1. Forage evaluation in ruminants
- 2. Ruminant nutrition and feed evaluation
- 3. Training School "Breeding for complex traits" in association with WuR.
- 4. Introduction to hyper-spectral imaging in livestock sciences.

1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

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There is evidence of significant and extensive activity by the Unit in establishing interdisciplinary projects with other platforms and centres at SLU. These include:

1. Umea Plant Science – lignification of cell walls and measurement of digestibility.

2. Strong links with Crop Science for many projects.

3. Host joint spectral/imaging lab with Dept of Forest Biomaterials and Technology.

4. Links with Dept of Wildlife, Fish and Environment.

5. Integration of research with Animal Nutrition and Management (VH) and Crop Production Ecology (NJ) at SLU-Uppala.

6. Swedish Infrastructure of Ecosystem Science – sharing of staff with the Unit of Field-Based Research.

7. Collaboration with Dept of Biosystems and Technology in SLU Alnarp in development of infrastructure and teaching research.

8. Collaboration with Dept of Molecular Sciences at Uppsala on milk quality research.

The Panel recommends that consideration is given to reviewing how the strong interdisciplinary approach used within this Unit can best be supported and developed within the structural arrangements of the University.

#### Score for Scientific Environment

#### 5

#### 1.3 Strategy for Scientific Development

# 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The Panel considered that a key aspect in promoting scientific quality and impact is being achieved by integrating crop cultivation and feed utilisation. This enables the Unit to focus on production and environmental aspects associated with sustainable milk production systems. Key areas of interest include greenhouse gas emissions and nitrates in water courses. This work links closely with the SITES network (agricultural and non-agricultural station network).

Other priorities include increased emphasis on production, provenance and product quality with milk (linking with SLU's focus on food). Within this strategy there needs to be major emphasis on plant/animal interaction under grazing. Further work is also planned to build the Unit's expertise in the spectral field eg. image analysis and other technologies to predict feed quality and environmental emissions. The Panel considered that a particular strength of the work programme is the integration of experimental/modelling research linking crop and animal science.

The strategy demonstrates a strong focus on interdisciplinary science linking crop and animal science in order to develop more sustainable milk production. The strategy is clearly described and correctly prioritises issues of major concern – air and water quality. Given the strong track record of the Unit in this area, the strategy is realistic and achievable.

The Unit indicates that they plan to strengthen international links (particularly Brazil and Canada) and have outlined how they plan to increase collaboration with SLU crop scientists. The Unit have also highlighted the need to increase/further develop collaboration with animal nutritionists and animal breeders. The Panel supports this approach but more detailed proposals around how this will be achieved are required.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The Unit have identified four major priorities for research associated with sustainable ruminant production: 1. Forage feeding value.

2. N utilisation at animal farm land.

3. Optimisation of grassland production.

4. Improving feed efficiency in milk production.

relatively small unit of research (9.6 FTE) can make a really meaningful contribution to all four areas? The Panel were informed that part of the reason for the inability to focus on fewer topics was the need to secure external funding.

The programmes of work described under the four headings are appropriate and describe the challenges and research gaps. Nonetheless, the Panel considers that key aspects which the Unit will need to consider in detail are:

i) Should the Unit focus on fewer areas in order to make greater progress?

ii) If taking all four priorities forward, there will be a need for deep and effective collaboration with other units in crop and animal science within SLU, in addition to strong international collaboration.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The Panel considered that key priorities include effective succession planning – recruitment of a new professor in ruminant production, appropriate costing of research infrastructure and larger, longer term (5-6 year) prograames of research with increased funding 20-30 MSEK (ie.  $2-3m\in$ ) per programme.

All of the above will be required to successfully implement the Unit's strategy. With reference to Section 1.3b, success in securing larger longer term projects is more likely with concentrated focus on one or two of the research priorities identified previously. The Unit should focus on building its expertise on fewer priorities – in this way it will be more likely to be successful in attracting larger longer term funded projects.

#### Score for Strategy for Scientific Development

4

#### 1.4 Additional comments

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The Unit has made a major contribution at a scientific level to three issues of key importance in ruminant livestock production.

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i) Development of methods to determine and models to predict enteric methane production.

ii) Comparison of protein sources for dairy cattle and development of protein evaluation systems.

iii) Development and application of work on indigestible NDF to predict forage digestibility, rumen fill and voluntary food intake.

Research in all three area is recognised internationally and is/will be used in developing improved feed evaluation systems for ruminant livestock.

In addition to the wider scientific community, outputs have been disseminated widely to other key stakeholders such as the dairy industry and farmers through the Unit's involvement in the Forage Research Centre and distribution of popular scientific publications (5-10 publications per year) both on line and via hard copy.

More recently, the Unit have established three industrial PhD projects involving:

i) Future feed evaluation, variety testing and plant breeding.

ii) Global work on greenhouse gas emissions from dairy production.

iii) Pathways of lactic acid bacteria from forage to dairy products (cheese).

The projects outlined above involve direct industry engagement and partners at SLU and other universities. The Panel note the value of industrial PhD's but it is important that this does not dilute the scientific training or requiorement for PhD students to publish scientific papers.

The Unit also works with a wide range of SME's including plant breeding companies, feed producers and dairy companies and with Swedish extension organisations on farm management concepts.

#### Score for Activities and Outputs

2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

At the outset, the Panel stressed that it is important to recognise that it can take up to 10-15 years for the full impact of science to be translated into farming practice. In this context therefore, it is too early to assess the full benefits to society of the Unit's recent work on protein evaluation and prediction of greenhouse gas emissions from dairy cattle. Nonetheless the Panel considered that the impact case studies presented highlight important new research findings which will guide the future development of sustainable ruminant livestock systems.

The development of reliable and robust predictions of methane production from dairy cows will facilitate a step change in our understanding of the effect of dietary and animal factors on methane emissions. An important finding to date is that low emission animals are often low fibre digesters which may also be reflected in low feed conversion.

In relation to the protein work, the Unit's research has challenged the validity of existing feed protein evaluation models. Furthermore the work has demonstrated that rapeseed meal can be used to replace soya bean meal in dairy cow diets. This has major implications for the production of protein feeds in Europe, given the potential to replace a larger proportion of soya bean imports.

Development of a method to assess indigestible fibre concentration will facilitate assessment of forage digestibility in ruminant feeding systems and could be of value in predicting voluntary feed intake in new feed rationing systems. The underpinning research has been published and work undertaken in commercial laboratories to predict i NDF using NIRS. This method is now routinely used for analysis of farm forage samples in all Nordic countries, demonstrating uptake by and relevance to industry.

#### **Score for Outcomes**

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

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The Unit considers that improvement in diet quality at all levels in society is more important than increased food production. In particular the Unit considers that increased supply of high quality protein from milk and meat is required to improve diet quality. The key opportunity is to produce high quality, healthy food at moderate price and low environmental impact from land which can only really be used to grow grass and forage.

The Unit is particularly strong in research expertise to reduce greenhouse gas emission from ruminants. However for the future the Unit considers other factors such as feed efficiency and plant breeding will be of increased importance.

The Panel considers that the Unit's strategic priorities are very ambitious and as highlighted previously, consideration should be given to focussing on one or two of these areas rather than all – for example feed efficiency and protein utilisation are large challenges which will require concerted focus and sufficient critical mass to make progress. The Unit has significant strength in having a wellequipped research farm and a strong local dairy sector. Key constraints are a lack of long term funding for large projects and absence of dedicated extension specialists.

The Panel also considers that the Unit need to fully evaluate the increased reliance on industrial PhD students. Whilst this will ensure good connection with industry, consideration needs to be given to issues concerning scientific training and development of the student and the opportunity to publish high quality scientific outputs. There is a danger that the latter could be compromised through over emphasis on industry connection.

#### Score for Impact Strategy

2

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The Panel considers that the Unit has achieved effective collaboration with non-academic partners. In particular, the 'whole food chain' approach adopted in relation to cheese quality demonstrates the Unit's ability to interact effectively with farmers and dairy companies. Furthermore, in this project the Unit had to interact with other academic partners to increase the range of scientific expertise. It is clear that the Unit have realized the interdependencies that are required in this type of project and the challenges of moving research from a 'controlled environment' to the real world. It is also clear from the example presented that did not go as planned that collaboration with private companies can also create challenges, particularly the need to retain scientific credibility, given that commercial interests can sometimes take priority.

# 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

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The Panel considers that this small Unit already has effective engagement with wider society – as evidenced by the range of commercial funders. The Unit offers courses in forage production and hyper spectral imaging and participates in a number of wider departmental initiatives including the Forage Research Centre, Nyttfran (popular scientific articles) and industrial PhD projects. This ensures that the work of the Unit is disseminated to industry and the wider farming community. In relation to communication with wider society eg consumers etc, the Panel considers that there is scope and opportunity for wider aspects of the work of SLU as a whole to be communicated centrally by the SLU Communications section – working in partnership with the individual research units.

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Panel/ Research Animal Science field

UoA

Animal Environment and Building Function

#### Introduction

#### General assessment of the Unit of Assessment

The panel acknowledges that the research conducted within this UoA is important for the SLU strategy. However, there is a clear need to link work within this UoA more efficiently to other groups at SLU. The UoA is very small, while the holistic approach of their research calls for expertise in a broad range of disciplines. Part of these areas are very strong in other UoAs, while the cooperation with these is not clear, and cannot be read from the publications included in the report. The specific research focus of the UoAs is not clearly defined, but very broad. The UoA does not provide a proper comparison of themselves to other groups, neither at SLU or in a broader sense, making it difficult to judge how well they position themselves in the scientific community. The research is very applied, and parts of it (esp regarding the new openings within PLF) is very dependent on expertise from outside, which makes its continuation unsecure. The applied nature of the research, however, indicates high potential for rather direct societal impact. The publication record is moderate. The composition of the group is far from optimal, with a skewed age structure and several central persons retiring soon. The UoA has a good record of collaboration with stakeholders, and thus have had a direct impact on development of certain aspects of animal housing. It is however, difficult to judge how actively the UoA utilizes their potential for collaboration in a wider sense: Although the UoA states that they works with industry, farming community and consumers, there is very little evidence presented for parts of this collaboration.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The research profile is very broad, and not very clearly defined, and there appear to be few commonly agreed strategies or concepts within the UoA. The research focus is instead very person-dependent. The UoA underlines that their strength is a whole-system approach, the focus on housing-animal interactions and a 'hands-on-approach'. The group does not indicate how they compare or identify themselves in relation to other groups. The areas of activities cover about 10 subject areas ranging from animal science to mathematics. The main focus of research encompasses three thematic areas: a) Housing systems – animal welfare, behaviours and production, b) Precision Livestock Farming (PLF) – to develop systems for monitoring animal welfare and health, and c) Environmentally Sustainable Husbandry.

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Most of the work has high applied importance, and some of the work is novel, while not very original. Except for the newly established research on PLF and image analyses, the methodology used is mainly routine. The main scientific impacts include research on different flooring systems to minimize the risk of lameness, claw and leg problems. These research results include aspects which have not been previously addressed. Also work on assessing slipperiness and foot-floor interactions is scientifically relevant. The UoA claims to be first in the world to develop an video image analysis method to automatically track and record interaction between cows. This work is scientifically novel, includes significant methodological development, and has good potential, but is still on-going work. The methodology is not yet fully explored for practical application, nor for commercial potential. Also, the expertise within this area within the UoA is totally dependent on one PhD-student, and continuing collaboration with Lund University, which appears to have made a major contribution to the success of this area of research. Thus, for this research focus to further develop in the group, strategic support is needed. The group has further worked extensively on holistic evaluation of organic pig production, including studies on the performance, behaviour, welfare, nutrient balance, and emissions in a stationary system of organic pig production. This work has good applied potential.

The publication record of the UoA indicates a fairly low scientific productivity, which might be partly explained by the applied, hands-on approach. However, the UoA representatives also report that it is sometimes difficult to find time for writing scientific papers, due to other duties, such as teaching (the teaching load is, however, reported to be rather moderate:10-20%, plus supervision of bachelor theses). Some results remain unpublished, or are not included in the report, due to recent retirements, which indicates a need for more collaboration and better leadership within the group to ensure continuation and less dependence on specific individuals.

The multi-disciplinary, holistic approach to animal housing, which the group represents, is important to the goals of SLU. However, this approach needs strong support from a broad range of experts. At the moment the UoA is too small, and the situation is made even more challenging due to the UoA facing several significant retirements in the near future. There is a clear need to further define the focus of the group, and to make better use of expertise and strengthen links with other UoAs at SLU. This could facilitate a better scientific quality in the future, without compromising the holistic research approach.

#### Score for Scientific Quality

#### 3

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The group is very small, with a regrettably skewed age structure, and a slightly imbalanced gender distribution (only 2/8 of the staff are female). The group has only one professor, who will soon retire, and several members of staff are currently working only part-time. There is only one PhD student, and no post docs, which leads to a poor renewal potential with the group. The measures taken to attract new staff, and promote a stimulating environment are in most cases very recent and the efforts are not fully convincing. Based on the interview, the group would benefit from improved leadership and a clearer organisation: at the moment it appears that each individual is responsible for his/her specific areas, with very little support from, or collaboration between scientists within the UoA. There appears to be no succession plan, or strategic thinking regarding how to focus upcoming recruitment efforts. International mobility level is rather low, and it is not clear how diverse the staff is regarding original nationality – no recruitments outside SLU are reported during the assessment period. Although there is effort to increase the size of the UoA, and to recruit more academic staff, including a new PhD-student, the number of staff presented is still small to make a significant impact in the area of research. Considering the current staff diversity and group size, the UoA does not appear sustainable, but will need more support from SLU to ensure continuation and development of research within this area.

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# 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

It appears that all members of the staff are allowed a high level of freedom, while due to challenges with organisation of the group, there is an apparent risk that the support for young faculty is not optimal. Also the fact that there is only one PhD-student, and no post doc researchers in the UoA makes it very challenging to maintain an encouraging environment for young researchers. The measures presented by the UoA are fairly standard. The UoA also reports that they encourage senior researchers to act as mentors for juniors in the UoA, but due to a low number of senior staff this might be difficult to achieve, and it is not supported by the output during the interview. Increased exposure of young faculty to other research groups, both nationally and internationally, could be a way to overcome the challenge. However, the UoA reports only limited collaboration with other groups at SLU, attracted only 2 visiting researchers during the assessment period, while no international mobility is reported for the staff of the UoA. One reason for the success and high motivation of the PhD-student within PLF might indeed be his close collaboration with the group at Lund University.

# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

Academic networks and collaborations are mainly limited to Sweden, and even though the PLF-work has an impressive collaborative network, this does not appear to be the case for other research areas. International collaboration is well-developed within the PLF-project, and the UoA also take part in one EU-level project on sustainable pig production. Further, they mention collaboration with Germany and Switzerland on the topic of floor-claw interactions. There is, however, much more potential for collaboration in areas which are currently of high international interest (eg. temporary crating and free farrowing of sows) and where Sweden could potentially act as a fore-runner. No true collaboration outside EU is reported. The UoA admits that due to the critical shortage of staff, it has lost competence, has failed to continue the employments of recently finished PhD students, and also has challenges in maintaining contacts both nationally and internationally.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The UoA underlines the importance of a broad expertise and of an interdisciplinary, holistic approach. However, they are trying to achieve this with very limited resources, which indicates the depth of the expertise in the different areas might not be optimal. It is difficult to assess the exact expertise of the staff members, as no staff profiles were included in the documentation. It is, however, evident that the full potential of synergies with other UoAs at SLU is not realized, and it even appears that the current UoA might not be fully aware of what other UoAs are working with. The publications listed in the report do not show co-authorship with experts from other UoAs at SLU. However, during the interview the UoA does indicate a plan, as well as some ongoing activities to improve this situation. The panel suggests that SLU supports a better integration of this UoA with other groups at SLU, as well as helps the UoA to define a more focused and unique research strategy.

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#### Score for Scientific Environment

#### 2

#### 1.3 Strategy for Scientific Development

# 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The panel acknowledges that the strategic goals set by the UoA are relevant, both from a scientific and a societal point-of view. However, they are also very broad and rather vague, which makes it difficult to assess how realistic they are. During the interview, the UoA indicates that PLF is one of the future strategic areas, as well as a continuous focus on emissions from animal production. Regrettably, they UoA does not report any concrete plans for how to make sure these goals are achieved. There appears to have been very little discussion on strategies regarding future recruitments and scientific renewal with the UoA, or with others at SLU. The focus on continuing work on image analyses as a tool for PLF is relevant, and the method recently developed in the UoA has potential, but no practical measures have been taken to ensure the relevant expertise will be available in the future. As it is now, the entire area is dependent on if the (very soon to finish) PhD-student will be able to continue at SLU (at the moment there is very limited funding for this), as well as on a continuation of close collaboration with Lund University.

The strategy lacks concrete plans for development of the both internal organisation and future partnerships within and outside Sweden, even though these are mentioned as important conditions for implementation of the strategy. The UoA has not clearly identified what they need to do to be strong enough to be an attractive partner in consortia. There is no mention of renewal and succession plan, particularly in terms of bringing up young faculty and recruiting both PhD students and other scientific staff, within and outside SLU. No evidence was presented to the Panel to indicate that the UoA has discussed internally which expertise is most needed when recruiting a new professor.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The plans presented by the UoA are relevant, but also very general, and it is not made totally clear how the UoA will act in practice to achieve the goals. In addition, due to the previously stated problems with group size and staff renewal, as well as the lack of strategic recruitment planning, it is difficult to assess the future potential of the UoA.

Although some of the areas of future research emphasis is a continuation of on-going activities, the UoA has also articulated new future research directions. Unfortunately, again, absence of senior researchers and the unclear succession plan, will probably limit the unit's potential for making significant contributions within these areas.

The panel suggests that future recruitment should enhance expertise within PLF, but in close cooperation with other UoAs with complementing expertise.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

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The UoA is very small, and clearly suffers from shortage of senior staff, scientific leadership, and absence of a clear succession plan, making continuity and sustainability a big challenge. The UoA considers themselves rather isolated from the rest of SLU, and could benefit from stronger strategic support. Given the current staff situation in the UoA, there is a high risk of lack of continuation. Networking activities are limited not only within SLU, but also nationally and internationally, and focus on specific research topics instead of being strategic. The UoA appears to have challenges in combining different areas of responsibility, such as teaching and research.

The Panel recommends that the UoA should evaluate ways to improve the understanding of the link between research and teaching, and to develop internal strategies for ensuring that teaching is not perceived as an obstacle for performing research.

#### Score for Strategy for Scientific Development

#### 2

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

Although the UoA has an important role as part of SLU's strategy, the current situation of staff allocation (small group, high age profile, many staff members working part-time) and lack of strategic recruitment plans will hamper the capacity to deliver high quality research within the focus areas. In addition, the focus areas for future research could be better defined, and discussed not only within the UoA, but also with other UoAs. The holistic, whole-system approach has great potential, especially if it can be strengthened by increased synergies with other UoAs at SLU. As it is now, the limited number of members in this UoA does not provide a realistic resource for in-depth expertise in all the areas needed. Cooperation with especially the UoA Animal Environment and Health is recommendable. To allow the UoA access to an appropriate critical mass and to enable them to better attract and encourage young scientists, the panel suggestd that a good option could be to merge these two UoAs. Further, partnership arrangements within and beyond Sweden should be facilitated.

### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The research of the UoA is very applied, and thus provides very good potential for developing good activities and outputs aimed at different end users. Indeed, the UoA displays a good record of activities and outputs directed to certain stakeholder groups, especially farmers and those working directly with farmers, such as extension services. Some activities have had very direct impact (such as work with flooring and lameness in cattle barns), while some have the potential to have impact when developed further in collaboration with stakeholders (such as the use of image analysis-based PLF in cow barns). One of the main outreach activities of the UoA is organizing yearly 'Industry days' where the latest research results of the UoA are presented to stakeholders. This is a very recommendable action, and could potentially be utilised even more by also inviting representatives from other UoAs.

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The UoA lists relevant stakeholder groups, but their attitude towards the collaboration with these appears mainly reactive. The UoA could potentially increase their societal impact by being more proactive. The impact could also benefit from focusing on a larger range of societal actors. The UoA mentions that they have a deep understanding of consumer expectations for animal production, but show no indication of this understanding, and document few activities aimed at engaging the general public. Further, societal impact could be increased by making sure the work of the UoA is relevant for a more international audience, and by taking actions to improve international visibility, both within the scientific community and beyond.

#### Score for Activities and Outputs

#### 2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

Some of the major outcomes of the group include the impact on decisions on flooring materials in cattle barns, and on the attitude towards lameness in cattle. In addition, they report their work on GHG emissions form animal production as a major outcome. The recent work on PLF techniques for monitoring cattle social interactions has good potential for high societal impact in the future, but it is only under development, and as the UoA state themselves, nobody knows at the moment, how the PLF-sector will develop in the future, and which technologies will actually be adopted by farmers in the end.

The UoA could further increase their societal impact by adopting a more international approach – at the moment they seem not to fully realise the potential of their research on the EU- and global field. One example is the issue of free farrowing, which is a very relevant topic in EU at the moment. Sweden has a long tradition of free farrowing, which provides an excellent opportunity to bring the experiences and hand-on knowledge to a broader audience. With their holistic knowledge of housing systems, the UoA has potential to become an important player on this topic.

As a summary, the panel feels that the full potential of the UoA for societal impact is not realized, even though the outcomes are good.

#### Score for Outcomes

#### 2

#### 2.3 Impact strategy

# 2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

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The UoA has a good understanding of the ways they can have impact on certain parts of society, namely farmers and related stakeholders. They also have a good potential for high societal impact due to the applied nature and holistic approach of their research. However, this is not clear in the formulation of their goals: There appears not to be a very well-formulated strategy for improving societal impact. Further, very few measures, which go beyond what the UoA are doing currently are mentioned, making it difficult to assess how realistic the goals are. Due to the lack of critical mass within the UoA, and the very broad goals for research, it is, however, questionable if they will manage to achieve their goals.

The panel concludes that the suggested measures are not sufficient for implementing the strategy in an adequate manner.

#### Score for Impact Strategy

1

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

# 3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA have a good record of collaboration with society, and report two interesting cases of collaboration, which both appear to be need-driven. The impression of the panel is that the UoA has a good understanding of the collaborative process, and on how to work together to set mutual goals even when initial motivation and interest differ. They clearly understand the value of collaboration, which is essential when striving for a high level of application of results, and for a 'hands-on' approach to research, as mentioned by the UoA during the interview. One of the senior lecturers is especially assigned to work with societal collaboration. The UoA take part in activities such as the 'Industry day' and the university – stakeholder platform 'Partnership Alnarp'. They further have a representative on the EU-level Animal Task Force, which provides an opportunity for further collaboration with stakeholders across EU. It is, however, not clarified how much activities have been initiated as a result of this position. Collaboration with society is to a large extent based on cooperation with industry, companies and farmers, but the UoA also mention contacts to authorities and policy makers.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The panel sees good potential for the UoA to further develop and utilize their potential for collaboration with society. Their work has an important role in society. The panel suggests that SLU takes measures to support and re-vitalize the unit. These measures preferably include increased utilization of synergies with other UoA at SLU. In addition, the panel recommends the following:

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The whole-system approach makes it possible to attract a large variety of stakeholders. However, as the size of the group is limited, there is a risk that the depth of the expertise within each area is not adequate to attract new collaboration opportunities in an optimal way. Therefore, the panel suggests that the UoA takes more advantage of collaboration with other UoA as SLU, to ensure that each area of the multi-disciplinary approach can reach high scientific quality.

The activities already in-place in Alnarp, including the Industry days and the Alnarp partnership could probably be utilized even more efficiently by, again, increasing cooperation with other UoAs. This could be achieved both by inviting other experts from SLU to take part in the existing activities, or by facilitating similar activities on other SLU campuses to reach a wider audience.

As the area of research within the group is one where direct competition from private companies is foreseeable, it is very important to both work proactively with companies. In addition, it is important to understand the factors that influence farmers' decision-making. In addition to economical potential of outcomes, also other factors, such as societal expectations and traditions should be considered to achieve maximum collaboration potential and impact.

Finally, by defining a more focused research strategy, facilitated by a paralleled renewal plan, the UoA could increase their research quality, and thus enhance their image as an attractive collaborative partner.

### Quality and Impact 2018 Kvalitet och Nytta 2018 (KoN2018)

### PANEL REPORT OVERVIEW

### Report Template for Review Panels - Overview of Research Field

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Research field/Panel (no. and name): 12 - Aquatic and Terrestrial Ecology

This panel has not presented a written overview. The text below is based on notes taken by the KoN team during the oral report held for the University management.

- The evaluators were overall very impressed by the Units of assessments.
- Groups are publishing in good journals and at high volume.
- Considering the size of the Swedish population and SLU:s broad mission these groups are performing excellent science.
- The spread/distribution of activities is perceived as good.
- There are no obvious organizational barriers, but some geographical barriers.
- The panel observed that a recurring comment from the assessed groups was the difficulty to become a professor. There is a real concern regarding junior faculty and retention of talent.
- Another observation was that a considerable proportion of the research was risk-avoiding riding on current trends and not necessary novel. SLU should encourage more "risky" approaches failing forward.
- There was a lack of large collaborative projects with grand visions (such as Future Forests). These kinds of projects should be granted long-term funding with results expected in a decade or so.
- The gender imbalance is augmented along the career path.
- Interdisciplinary collaboration must be initiated bottom-up. Such collaborations could include Anthropology and Social Sciences to include the human dimension and enhance important research within SLU:s mission.
- UoA:s were well trained to explain the geographical scattering as something positive...
- Strategic planning at the central level does it trickle down in the organization?
- Some UoA appear to have an "identity crisis" as an effect of many, different missions. UoAs with a clear mission achieves good impact. The panel experienced a lack of incentives for engaging in activities related to societal impact. People are in general motivated to make change. There should be a reward system for societal impact both on group-level and individual level.
- Formation of the UoA:s in general it was difficult to evaluate the UoA:s without knowing how they relate to the university organization.
- The Self-Assessments didn't give a justified view of the UoA:s. This in particular applies to the description of Impact and Collaboration probably because researchers are not familiar with describing this in writing.
- Strategic planning is needed when there are open positions regarding possible shifts between departments/faculties.
- Groups identify themselves with SLU but do not feel that they are appreciated. Rewarding Societal Impact could be the necessary incentives to feel appreciated.
| Panel/ Research<br>field | Aquatic and Terrestial Ecology |
|--------------------------|--------------------------------|
|                          | Fcology - S                    |
| Introduction             |                                |

#### General assessment of the Unit of Assessment

The panel was very impressed with the scientific productivity of the forest ecology group. They are doing important work in several distinct areas, and their contributions are recognized internationally. To maintain their high ranking, the UoA is encouraged to put more thought into strategic planning and future research directives and to be willing to take on riskier research initiatives. Their research has strong societal impact, but much of their outreach and collaboration in on an informal, ad hoc basis, and they are encouraged to set up a platform to make their collaborations with society more visible.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The scope of the UoA is very broad, ranging from forest biogeochemistry, biodiversity and species interactions to population ecology, trophic interactions (insect, carnivores), conservation, and wildlife management. This broad scope creates many opportunities for multi-discipline integration, but it also makes evaluation of this unit as a single entity difficult, especially considering the somewhat arbitrary separation between the two ecology units and the existence of other UoAs in aquatic ecology, animal ecology and soil science.

The UoA has a very high level of scientific quality and achievement. This is evidenced by the publications in top journals and covering a wide range of topics from basic research on lichen symbiosis to predation effects of carnivores and ungulates. The papers are generally well cited, and members of the UoA were co-authors on several highly cited papers, which is a good indicator of impact. The number of publications per researcher in 2016 was good (~2.35). Members have been invited speakers, including plenary and keynote speakers at international conferences, and they also serve on scientific committees and steering groups. They have been successful in obtaining external research grants.

SLU is ranked #1 in forestry internationally, although we assume this ranking is not specific to this UoA. This is an important endorsement of quality, but it also may reflect the size and breadth of the department. It is not clear if there are particular areas of expertise within forest ecology that the UoA is most recognized for, and we do not have sufficient information for evaluating the productivity and contributions of individual members of the UoA

#### Score for Scientific Quality

#### 1.2 Scientific Environment and Leadership

# 1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

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The UoA has been proactive in mentoring and leadership development. The implementation of department wide activities organized in three overarching schemes (landscape ecology, trophic interactions and conservation biology) provides a critical mass for annual meetings with prominent guests, project discussions and journal clubs to name a few.

The UoA is very conscious of the challenges of achieving gender diversity, in particular the importance of unconscious and institutional bias. Some of the challenges in achieving gender balance may exist at a higher level of SLU administration. All of the recruited professors are men. There is a good influx of international collaborators but more emphasis should be given to members of the UoA getting international experience and exposure.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

They have been proactive in providing funding to early career researchers, rewards for successful publication allowing participation in conferences, and encouragement to be workshop organizers. These are very important actions for promoting the development of early career researchers.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

They have access to SITES, including Grimsö, and they collaborate in research networks across Sweden and Europe. The report mentions collaboration projects with the University of Wageningen (Netherlands), BOKU Wien (Austria), USDA (USA) among others. During the interview a strong inter-European network became obvious particularly promoted by the success within the EU funding scheme.

#### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

Interdisciplinary research is typical of the UoA. The research program "Future Forests", for example, provides a platform for interdisciplinary research on both an individual level and the group level. Numerous examples emerged of individual researchers with different but complementary fields working together. Additional expertise is recruited outside the UoA by collaborations with political scientists, social scientists, economists, psychologists, forest technologists or chemists.

There is strong overlap with other UoAs, but it does noot appear that there are any significant administrative barriers preventing collaboration across administrative units.

#### Score for Scientific Environment

#### 1.3 Strategy for Scientific Development

### 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

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Strategy is based on their strong international connections to attract top-quality researchers, and to provide sufficient funding to develop their research area. It contains two unique aspects: (1) the support of newly recruited professors with approximately 1 Million SEK per year (apart the 100 % salary) to develop their research area and (2) the planned support for external funded academic staff who are on medical or parental leave.

The promotion of a positive working atmosphere by encouraging collaboration, sharing experiences and facilities and encouraging social activities is worthy of mention but also a bit vague. A detailed strategy for renewal was not provided.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

Four areas are listed: Interdisciplinarity, climate change, land use change, and plant protection. This does not indicate a great deal of strategic planning, which should be necessary for this UoA to maintain their top-rated status. "Interdisciplinarity" is a general approach, not a future direction, and is already considered the group's strength. Apparently, the idea is making connections between physical and social science, but progress in this area will likely require bringing in more social scientists to SLU (though not necessarily to this UoA) "Climate change" is very broad, and we did not hear a focused approach but rather a few individual observational and mitigation projects. There was no discussion of bringing in new technologies (e.g., remote sensing), maintaining SLU's legacy of manipulative climate change experiments, or a strong connection to Earth system models.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

Challenges for the UoA are to maintain effective collaborations within SLU and to balance breadth and expertise in focus areas. Another challenge is to take on riskier research initiatives that might enable groundbreaking work in forest ecology.

As mentioned by all other UoAs, the financial stabilization of staff is urgently required. The UoA addresses an increase of education engagement (e.g. establishment of a master course in ecology) as a possible solution for the latter.

#### Score for Strategy for Scientific Development

#### 4

#### **1.4 Additional comments**

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

When a recruited professor retires, the department has discussions about their research topic and whether it should be continued, which can then be the basis of a recommendation to the dean and Vice-Chancellor, but they do not own the process.

Educational programs should be improved. For example, there is no forestry education in the regions where most potential students live, and the ecology department competence is little used in ofrestry education.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

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The UoA has put a lot of effort in supporting governmental agencies and the forest sector in their work, which suits well in the applied research profile of the UoA. Similar activities include education of wildlife managers and participation in the Future Forests project. The UoA has also participated actively in the public discussion on hot topics of large carnivores and forest conservation. All this indicates high societal impact. Many specific examples of activities and outputs were provided, most of them related to outreach or participation in meetings or conversations. They all tend to be ad hoc and not derived from a coordinated or strategic engagement with agencies or the public. There are no specific department level objectives related to societal impacts, but all researchers have some involvement with stakeholders. Although there is recognition of the mandate for applied research, they do not think SLU puts sufficient importance on reports to the government, and they do not get sufficient credit for them.

#### Score for Activities and Outputs

2.5

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The case study on the pine weevil and the simple and innovative new method developed to protect pine seedlings from weevil herbivory describes a perfect match between science and practical needs, which has led to environmental benefits and even to a commercial application. The other two case studies (monitoring of lynx and wolverine, and the biodiversity effects of the logging residue harvest) also show clear connection to practice and have had impacts on reindeer compensations and storing systems of harvested logging residues.

#### Score for Outcomes

3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The primary strategy appears to be primarily in communicating ecological science to interested agencies and the public. To accomplish this, the strategy is to remain associated with Future Forests, increase engagement of adjunct faculty, develop web-based education, and make use of a communication officer. However, the UoA does not employ external collaboration specialists in three of their research foci, and outreach will apparently continue to be on an ad hoc basis by individual investigators.

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Given the vast experience of the UoA in collaborating with different levels of society, the goals and measures to reach them seem realistic and suit well in the research profile of the UoA.

It is also remarkable, that the UoA encourages its members to participate public discussion and debates on the topics of the researchers' expertise. Such communication with the society is especially valuable in the present day world with fake media and disinformation.

#### Score for Impact Strategy

2

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA has recognized the very important fact that collaboration with stakeholders and society in general needs both time and true will to understand the perspectives of all parties. The two case studies on the Future Forest program give a good example of such learning process, and the UoA can congratulate itself for not giving up after the first unsuccessful period of the project.

The UoA has also recognized another important issue about societal collaboration, the mutual benefits: the researchers find the most relevant questions by asking what the society needs and have a high probability that their findings are considered in practical applications, and the society gets scientifically based answers to its topical questions. In the field of applied sciences such two-way communication is essential, and the UoA seems to be well aware of this.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The UoA should consider setting up a platform to make their outreach program more visible within SLU. Having education (master's program) would make the UoA more recognized in the society. Individual researchers may be active, but there is no collaboration strategy. Having central stakeholder persons as coauthors would promote the impact on society. Publishing popular papers (in Swedish) is valuable and should be valued by the University. 114

Panel/ Research field	Aquatic and Terrestial Ecology	
	SLU Aqua	
Introduction		

#### General assessment of the Unit of Assessment

Overall, the quality of the research conducted within the UoA is very good and internationally recognized. The research addresses important issues in applied aquatic and fisheries ecology, and is frequently published in good journals. The number of papers produced is perhaps a little low; however, the mission of this Unit of Assessment (and therefore the staffing and resources) focuses on Environmental Monitoring and Assessment rather than academic research. Therefore, this group cannot be expected to generate the same volume of publications as other, more academic, units. Nonetheless, this group is encouraged to publish more, especially the work that currently appears solely in reports.

The societal impact of the research is very high. The Unit of Assessment excels in this area. Their work is of great interest to the general population of Sweden, and their research and EMA activities are critical for the sustainable management of fisheries.

Most impressive is the Unit's capacity to engage with collaboratively with society. This group is an example that the rest of SLU could learn from. It is clear that their ability to achieve high societal impact is a direct result in their capacity to directly and effectively engage society.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

SLU Aqua's vision is "Viable fish stocks in healthy waters". Their work includes everything from data collection to assessment and research. This gives them unique opportunities to develop knowledge on aquatic and marine ecosystems and the resources they provide. Their work focuses on three broad questions: 1) How do fish communities & food webs respond to fishing & environmental change, including species invasions, and climate change? 2) What are the drivers & consequences of genetic & phenotypic variation in fish & shellfish? Structure & function of aquatic foodwebs? 3) How can sustainable fishing be pursued in practice & its management best informed by biological advice?

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This UoA combines observations (EMA), experiments, dynamic modelling, genomic and microchemistry methods. Their approaches include novel forms of statistical analyses, the use of innovative ecosystem indicators, cutting-edge conservation genetics, and autonomous observation & sampling platforms.

The foodweb work of this UoA is well-known and highly valued in the marine-ecological research community. Additionally, their use of genetic analyses has been useful for identifying fish stocks and for salmon management. Though less well-represented in the peer-reviewed scientific literature their research on gear selectivity and minimizing interactions between marine mammals and fisheries is outstanding and critically important. The researchers from SLU Aqua are also important leaders of the research underlying the ICES Integrated Ecosystem Assessment efforts.

Although this UoA has180 employees and 198 MSEK in funding, this is somewhat misleading for this assessment. In fact, they have 53 researchers with 2 faculty professors, and the vast majority of their funding is for EMA. Given their funding and staffing, their productivity is quite good. Though they have fewer publications than more researchorientated units, the papers they do produce have high impact. Indeed, every 6th paper is among the 10 most well-cited in the field. This group is remarkable because of the productive synergies between research and assessments.

Although a strong research group, there is room for improvement. Because of the nature of the funding, researchers do not necessarily have an incentive to publish. For example, if funding is targeted towards gear improvement, research may be conducted, a report generated and then the research is implemented in the fishery. There are many similar examples of this in this UoA. For many staff in this Unit, the immediate societal impact represents the completion of the project. That is, the outcome occurs without the need for a peer-reviewed scientific product. Certainly, in some respects this is fine, and is even typical for in agencies. It also clearly reflects the Swedish Board of Fishery history of this Unit. Nonetheless, this unit would benefit from some clear incentives to publish more of their excellent work in the scientific literature. Not only will this help the individual researchers, it potentially will result in a larger societal impact since the research will be available to a larger audience. This unit would certainly benefit from dedicated funding to provide the time to publish. Additionally, mentoring from more research-oriented researchers will be important, but, again, this will require additional resources.

This unit compares very favorably to similar units across Europe (for example, National institute for aquatic resources Technical University of Denmark (DTU Aqua), Institute for Hydrobiology and Fisheries Science University of Hamburg). Comparable groups in North America do not really exist because University departments do not have EMA responsibilities and government agencies do not have high research expectations. Depending on the desires of the SLU leadership, it may be worth more transparently acknowledging the unique requirements of this Unit, and consider explicitly identifying a research group within the Unit. In this way, appropriate research expectations could be placed on that sub-unit, while not burdening EMA focused staff with unrealistic expectations.

In short, because of their history, SLU Aqua does not have as strong of an academic culture, as some other units at SLU. We suggest additional financial support targeting this group would help further the transition into the SLU community. This could be in the form of additional faculty (e.g. a fisheries social scientist) and/or research support for mentoring and training of EMA staff. We also suggest explicitly acknowledging and rewarding the unique and important EMA role of the unit.

#### Score for Scientific Quality

4.5

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

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The scientific environment appears typical for units at SLU. However, this unit faces some unique challenges because of its history and geography. This unit includes some excellent ecologists, but they appear to be having some difficulty integrating with other SLU units because they are not colocated with other ecology units, and because they, themselves, are spread out geography. This makes developing a coherent, cross-unit ecological culture more difficult. There are of course, a number of ways to overcome these barriers, and we would encourage the leadership to explicitly explore, support, and implement such solutions. These could include joint seminar series, joint guest professorships, etc.

In terms of diversity, like other Units, Aqua is male dominated. Again, given similar patterns in other units, there appears to be a structural issue that results in the loss of female scientists with increasing level. We encourage the leadership to engage staff to explore the underlying causes of this pattern. We heard comments suggesting the funding model employed by SLU unintentionally generates an anti-female bias.

There is good age balance in the unit.

Like other units, other aspects of diversity are not apparent. We asked ourselves the question, does the Aqua (and other SLU UoA's) staff mirror the demographic, ethnic, etc diversity of Sweden. The answer appears to be no. We suggest SLU leadership develop a plan that would enhance the presence of underrepresented groups. This, of course, is a longterm enterprise that might fruitful begin with developing the "pipeline" via undergraduate training.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

This Unit of Assessment appears to take mentoring of young faculty very seriously. They have resources dedicated to increase the number of competent supervisors, including the funds needed to support them attending pedagogical courses. There is evidence of quite of bit of active mentoring. In addition, the UoA promotes and encourages proposal writing skills in young staff. This has included internal workshops and courses. Younger staff are also engaged in teaching activities, including the planning and coordination of classes.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The research / academic community of SLU Aqua is geographically extensive. The group is broadly engaged across Europe. In some ways, the UoA is more connected to the marine / fisheries science of Europe, broadly, then SLU itself. Indeed, when we asked the Unit representatives to describe their "research community" they highlighted their colleagues across Sweden and Europe more so than SLU. This makes the regional influence of SLU Aqua research greater than it would be otherwise, but perhaps comes at a cost of increasing collaboration within SLU. Our conclusion was this patterns was largely a by-product of geography more than anything else. Thus, if the administration wishes to change this, it will require dedication to overcoming some of the inherent institutional barriers.

1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential. The level of interdisciplinarity is typical for a fisheries group. There is quite a bit of evidence of good collaboration across the appropriate natural sciences. The research unit is engaged in the "Water forum" as well as the Platform for Aquaculture—both excellent opportunities for interdisciplinary opportunity. We encourage additional collaboration with fisheries economists and environmental social scientists. Given that the locations of the Unit are often associated with fishing communities, and the Unit already has excellent engagement with the community, this UoA could easily grow to become a leader in fisheries Anthropology, should they choose to invest in this area.

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#### Score for Scientific Environment

4

#### 1.3 Strategy for Scientific Development

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The plans for scientific development of the unit were ambitious, intellectually reasonable, but perhaps, not quite realistic given the funding limitations. We feel that this UoA would benefit from a structured strategic planning exercise that generated a "Theory of Change" with appropriate "logic models" underlying the planning. Such a plan would not only have a clear Vision and Mission (to mesh with SLU's), but also include operational objectives that are specific, measurable, accessible, relevant and time-bound. We would suggest that by articulating a strategic framework that links research activities, EMA, and stakeholder engagement (with associated indicators) to societal outcomes, it would be easier for the administration to recognize and reward the Unit's excellent work.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The UoA is in a strong position to make significant contributions. The UoA focus on Ecosystembased Management (EBM) is excellent. This emphasis is in accordance with the general direction of fisheries research and management in Europe and the globe. The UoA is already a European leader in the science underlying EBM, and further work in this direction will further enhance this reputation.

Additionally, this UoA is participating in the ongoing technological revolution occurring for data collection in marine and aquatic systems. There are important challenges in this area, and we encourage the UoA to continue to invest in this topic. Importantly, this investment should include attention to publishing this research.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

As discussed above, there seems to structural issues that causes trade-offs between EMA, research production and fund raising. Successfully linking research and EMA is critical but very challenging.

#### Score for Strategy for Scientific Development

4

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

In general, the Unit has done some very good thinking in the strategic area. We encourage the administration to support the Unit in formalizing their strategic thinking, and ultimately implementing their plan.

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#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

This UoA is doing an excellent job in both methods and outputs. Their work is of high relevance, and in many regards this UoA could serve as an example for the entire University.

#### Score for Activities and Outputs

3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

This group is amazingly successful in its outreach via media (on average, 92 news articles per month!). The group also generates around 150 advice reports per year. This is an incredible level of activity that we hope is valued by the University.

The case studies do a great job of highlighting the societal impact of the UaA. Ecosystemmanagement research has led to practical measures for pike and perch protection and the development of indicators for monitoring. Analyses on eels led to EU-level actions. The investigations of selective fishing gears have also led to important societal outcomes.

80% of the UoA's funding is for EMA; data translates also to scientific publications, but most of it is in reports - which probably have a greater impact on society than the peer-reviewed publications would have. This should be acknowledged and valued by the university.

#### **Score for Outcomes**

3

#### 2.3 Impact strategy

# 2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

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The strategic goals of the UoA are excellent. This group is highly successful in this area, and draws from a range of specific strategies. This group has a high impact via a wide set of collaborators at all levels of society. The UoA's meetings with stakeholders are effective in providing the latest knowledge. Additionally, this has been an opportunity for the UoA to gain insight into emerging research.

We found the work of the UoA to be excellent in this area; however, we felt the Unit could do a better job of communicating how good they are at societal impact. This is particularly important internally at SLU. The UoA is an example for the rest of the University in how to achieve high impact.

#### Score for Impact Strategy

#### 3

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

We were impressed with the UoA's capacity in this area. They defined collaboration as an interaction when at least two partners (one of them non-academic) together reach a common goal that none could have accomplished alone. They noted that to achieve this, there is a high degree of interaction needed. They have invested heavily in this area and it show. They not only have capacity, they also have a nuanced understanding of the factors affecting collaboration, and the means to engage with stakeholders in order to achieve maximum impact.

Their philosophy is based on the notion that to do research on sustainable use you need to collaborate with the "users".

Their efforts in this area have allowed them to successfully move knowledge to action. We encourage recognition of this area of excellence, including using their knowledge as an example for other Units throughout the university.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The UoA is already excellent in this area. Our main recommendation is that this is better recognized and rewarded at the University level.

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Panel/ Research Aquatic and Terrestial Ecology field

UoA

Swedish Species Information Centre

#### Introduction

General assessment of the Unit of Assessment

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The research of this UoA is grounded in metapopulation and metacommunity theory. They study model species (mainly epiphytes, fungi) and their spatio-temporal dynamics in response to environmental settings and changes (landscape use, forest management, climate change to name a few). The UoA is part of ArtDatabanken, a collaborative Center of the SLU whose main task is Environmental Monitoring and Assessment (EMA).

A unique approach is the strong link to citizen science. Citizen Science Data (CSD) enter ArtDatabanken via Artportalen.se The UoA uses sophisticated and novel methods to analyze and interpret the data. In addition, they forecast the dynamics of species distribution and related ecosystem services. Consequently, the main approach of this Unit is the modeling of observational data on species occurrence, in concert with some field experiments, their own systematic monitoring and, with collaborators, population genetics.

The achievements (e.g. a systematic evaluation of CSD against systematic monitoring, the development of predictive models based on mechanistic principles using scarce CSD, the development of short-cut methods facilitating the analysis of CSD, as well as the development of management options to improve the diversity and persistence of key species in forest and the development of an analytic indicator framework for assessing ecosystem services supporting, e.g., the EU Biodiversity strategy 2020) are excellent and set the UoA among the world leading research teams. The Self Assessment provides a thoughtful comparison of the UaA with other international research institutions and groups working on meta population and meta community dynamics. It is noteworthy, that the UoA does not present only a list of comparable partners, but provides detailed and convincing information on the particular strengths and weaknesses (other groups and itself), which provides a convincing overview about the usefulness of the particular collaborations.

#### Score for Scientific Quality

#### **1.2 Scientific Environment and Leadership**

# 1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

Based on the nature of the research tasks of the UoA, the staff consists mainly of national and international Postdocs funded by third parties. The UoA is aware that a critical mass of researchers, as well as a critical mass of core topics is essential for a lively and creative working atmosphere.

The maintenance of a stable funding scheme is thus a priority of the UoA. Effective measures are implemented to promote a positive academic atmosphere, including weekly research group meetings, literature seminars and regular meetings with international research teams working on similar topics (like the British Biological Records Center, eBirds or ERA-Net).

To buffer the normal fluctuations in the number of Postdocs, the UoA takes care to provide a stimulating environment for the present Postdocs (connection to other SLU units and Artdatabanken stakeholders). Both could be improved (a) by breaking the physical isolation of a separate building and (b) by managing the language barriers between international Postdocs and the Swedish speaking stakeholders (Artdatabanken).

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA research is generally based on Postdoc projects. They are recruited from both national and international Universities and research institutions. The two senior scientists dedicate time and extensively support the young researchers to publish their research findings in internationally high ranked journals (see also publication record). The junior scientists write their own proposals for research funding. Regular meetings to discuss current topics or research provides a good daily environment. There are opportunities to participate in courses by SLU (e.g. proposal writing, career courses), to participate in international conferences, to organize workshops and symposia and to interact with various stakeholders are further important steps for the development.

The development of pedagogic skills in own courses are as supervisors of PhD thesis or master thesis seem to be missing since the UoA is not embedded in the educational programme of SLU.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The research and monitoring programme has a wide geographical scope and has a strong impact on regional scales, national scales as well as European Scales. Examples are

\* the development of options for forest management to maintain species diversity

\* the national important system to report CSD and the Swedish Lifewatch (a national biodiversity informatics infrastructure) relevant for the Swedish informatics infrastructure) relevant for the Swedish government, private companies and NGO.

\* the direct support of the Swedish government to achieve and evaluate the Swedish Environmental Quality Objectives (EQO) and EU nature directives.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

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The UoA collaborates with the most relevant research units of the SLU focusing on ecology and natural resource management (Department of Forest Resource Management, Department of Soil and Environment, Department of Ecology, Department of Forest Mycology and Plant Pathology, Department of Wildlife, Fish and Environmental Studies, as well as the Department of Urban and Rural Development).

A recent research application involves the Department of Work Science, Business, Economics, and Environmental Psychology.

Further links, providing more technical support, for example to other central SLU units (genomic data base, informatics etc.) could be interesting.

#### Score for Scientific Environment

#### 4

#### 1.3 Strategy for Scientific Development

### 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

With only externally funded researchers, the most important challenge is to maintain funds for linking postdocs to maintain the excellent quality of the research (5 postdocs 2018-2022). In addition, the UoA seeks to increase the number of guest scientists (goal is 2 per year), who stay 1 month at least. In order to achieve these goals, main focus is on high ranked publications as well as proposals submitted to national and international (mainly EU) funding organisations. The concrete goals formulated in the report (#senior staff to double from two to four until 2022, research grants from Vetenskapsradet and Formas) are appreciated, but could be also a bit overstated (2 publications in the Nature/Science journal family until 2022) since the latter does not only depend on the quality of the output but also on other uncontrollable factors.

Despite the generally positive vision of the group, the panel felt the UoA lacked a well conceived strategic plan.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The future research directions are reasonable and timely, although a bit risk adverse. They are partly based on the ongoing working activities (e.g., improving CSD-based modeling by considering /analyzing the behavior of the CS (reporters) in collaboration with behavioral scientists and science philosophers or the improvement of systematic monitoring). Other research directions go in more novel directions, e.g., the development of holistic management approaches for future multifunctional landscapes, and the spatial conservation priorization research. Overall, we found little to fault, but also, the panel had a mixed level of excitement about the future research directions of the Unit.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

To maintain the performance in periods of low funding and to develop new research fields besides the daily work, the suggestion of the UoA is realistic and fair: To use economic support of the SLU to buffer low funding periods, or during an initial phase of developing and establishing a new research line (in the sense of a 3-5 years blue sky project funding).

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#### Score for Strategy for Scientific Development

#### 4

#### **1.4 Additional comments**

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The research of the UoA has sound grounds in ecological theory and modelling, i.e. basic research. Nevertheless, the results can be and have been largely applied in different kinds of assessments and simulations, which, in turn, can lead to practical applications. Given the staffing (2 permanently funded researchers only), the activities and outputs are indeed good-very good. This accounts for the collaborative research with the Swedish County Administrative Boards, the Swedish Environmental Protection Agency and other stakeholders (including GOs and NGOs). Long-term conservation requires monitoring of suitable indicators, but this will be critical to maintain without permanently funded staff. Considering the importance of environmental conservation for the society, it is essential to support the UoA to fulfil this duty. The products are concrete and directly transferrable (e.g., Forest Impact Analysis, the development of indicators for the Swedish EQO "Sustainable Forests", or the CSD presentation at stakeholders' conferences).

#### Score for Activities and Outputs

#### 2.5

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The small UoA with a theoretical and modelling approach in its research cannot have a very strong impact on society or produce clear practical applications. However, the UoA has produced valuable information that provides important input in more practical applications. Two case studies describe the importance of modelling results in the national Forest Impact Analysis (colonization-extinction models for a red-listed forest species) and in developing the inventory methods of Woodland Key Habitats. The societal impact of the third case study, describing the development of a framework for the Mapping and Assessment of Ecosystems and their Services in EU, is not so clear.

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The three particular outcomes mentioned in the report have nevertheless a high societal impact:

(1) The meta population research stimulating the awareness and discussion of the need of landscape planning for conservation.

(2) The proof and quantification of the positive relationship between species forests.

(3) The increase of public awareness about the importance of citizen science and the increased willingness of the public to participate on monitoring that way.

#### **Score for Outcomes**

#### 2

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

ArtDatabanken is largely based on data provided by citizens and other stakeholders, including NGOs. Therefore, the connection to society is clear and straightforward, although the society's representatives perhaps do not necessarily always know that their observations have contributed to data in scientific studies and environmental assessments. The UoA has ambitious goals that reflect the strengths of the UoA's research and response to society's needs, including international responsibilities of the nation (EU's Habitat Directive reports and assessment of the implementation of EU's Biodiversity Strategy). These goals may not be entirely realistic, given the funding and staffing situation.

The impact strategy builds on two facts:

(i) the research of the UoA is important for various societal aspects since it links environmental issues, conservation with economic needs which finally essential for a long-term provision and this sustainable use of natural resources.

(ii) the members of the UoA directly connected to the relevant stakeholders, for example, due to their affiliation to Artdatabanken and the direct collaboration with major forest agencies. There is obviously a tradeoff between the need to increase the societal impact and the pressure of the scientific community particularly on early stage researchers to publish in international peer-reviewed journals, which do not reach regional and even national stakeholders. It is noteworthy that the UoA actively try to tackle this problem by accompanying each scientific publishing with a publication or press release in a public platform.

#### Score for Impact Strategy

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

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The basis of the UoA is in basic science, not in applied sciences. Despite this, the UoA has had ambitious goals of bringing the scientific and modeling approaches to (non-scientific) conservation and management assessments. In the example of assessing the biodiversity value of small forest set-asides the UoA was successful, whereas applying the Spatial Conservation Prioritization tool for Green Infrastructure planning was not accepted by the county-level governmental officers. The UoA concludes that the successful application of sophisticated scientific methods in more practical contexts requires understanding of the value of such methods by all project partners. Acquiring this understanding takes time, which was the lesson learnt by the UoA. This lesson will most likely contribute to successful interaction between the UoA and non-research organizations in the future.

The UoA has a capacity for collaboration with the society and is important for bridging the society and is important for bridging the world of science with the world of nonscientists. It provides a platform to motivate and stimulate the awareness of the public for nature, biodiversity, ESS and conservation; and it can help to further contribute to the awareness that the economic use of forests and natural resources is not in contrast to species conservation.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The UoA is strongly encouraged to continue providing its knowledge for environmental assessments in the society. The reported activity of the UoA in this respect is highly appreciated. It is valuable that the scientific community follows the processes in the society and actively provides its expertise where it seems to give added value for monitoring, assessments or decision-making. Examples of such processes include the Red List Assessments of species and also of ecosystems, reporting on EU's Habitat Directive etc.

The effect of the restructuring of the SLU departments and the new affiliation of the UoA to the NJ Faculty (instead of Forest Science) has to be discussed.

 Panel/ Research
 Aquatic and Terrestial Ecology

 UoA
 Animal Ecology

 Introduction

#### General assessment of the Unit of Assessment

Our panel gave the UoA outstanding marks for the applied focus of research, with moderate productivity. The majority of publications are in low- to mid-range impact factor journals leading to slightly lower scores for quality of research. But we found the societal impact and capacity of collaboration were among the highest of any UoA that we reviewed.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

Although the productivity was high, the quality of publications could have been higher. Although Wildlife Biology and the European Journal of Wildlife Research are likely to be read by wildlife managers, these journals have low impact factors and some of the papers easily could have been placed in stronger periodicals. The nature of much of the research was highly applied, as is to be expected. Current methods and themes in research were being used. In the wildlife management area the prominence of the group is solid with strong prominence, but perhaps a bit lower overall in the applied ecology area. Some papers are clearly cutting edge and greatly benefit the reputation of the UoA.

#### Score for Scientific Quality

#### 4

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The interaction among UoA members appears excellent such that the productivity is high overall. Gender bias appears with mostly males among older members, as was found in all UoAs that we reviewed. The international collaboration was among highest of any group that we reviewed, helping to ensure that research was fresh and timely. Recruitment of graduate students and young research staff from outside Sweden has helped to make this an outstanding place to do wildlife research.

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### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

Although young faculty have a stimulating research environment with good collaborations, there exist barriers to advancement thereby demoralizing researchers. The administration should ensure that there are regular opportunities for advancement and that productivity is rewarded. Strong lecturers will leave for other institutions if they cannot advance their careers within the SLU system.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

Although there might be some resistance by Swedish people to international collaborations and research, we believe that this is valuable for the profile of the program and helps to ensure broad applicability for research focus. The geographic scope of this UoA was greater than for most of the others that we reviewed. Research in Africa, Asia, and North America allows the UoA to develop international reputation and diversity in the research questions brought to Sweden.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

Generally good depth and breadth of interdisciplinary research, although we might expect to see higher productivity in human dimensions of wildlife research. Although the UoA recognizes the importance of human dimensions research, this is clearly a subject area that would benefit from recruitment of a professor in this area.

#### Score for Scientific Environment

5

#### **1.3 Strategy for Scientific Development**

### 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

Goran Ericsson articulated a powerful vision for the UoA and a sound strategy for its development. Under his leadership the UoA is fulfilling a valuable service for the resource users. He recognized, however, a serious impediment in his ability to advance his best young people thereby threatening the long-term future of the UoA.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

Continued engagement with hunters, anglers, and other outdoor recreationists will continue to be appreciated by the regional public. Given the powerful new tools of social media it will be incumbent on the UoA to adapt accordingly. We encourage the UoA to continue to work closely with resource users locally and regionally, and by using digital media the zone of influence can be broadened.

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### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The inability for strong researchers to advance through the system to Professorships is a serious impediment and ensures that the best people will leave for positions elsewhere. This is a barrier that must be rectified by the SLU system. Continued effort to collaborate with ecologists in Grimsö and Uppsala must be encouraged to prevent the geographic isolation from resulting in intellectual isolation.

#### Score for Strategy for Scientific Development

5

#### 1.4 Additional comments

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

Publishing in high impact factor journals will help to elevate the professional image of the program and ensure that research is recognized widely. Productivity of researchers is solid but the profile is not as high as might be expected.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA works in applied sciences, which naturally contributes to societal impacts. Besides the governmental commissions, the UoA has taken an active role in collaborating widely with hunters, anglers, NGOs and industry, including not only research but also training. The societal impacts cover several aspects of wildlife management, fisheries management, ecological restoration, predictive models for disease and even forensic applications.

#### Score for Activities and Outputs

3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

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The presented case studies describe nicely the diversity of topics and approaches of the UoA. Particularly the development of an early warning system for outbreaks of a zoonotic disease, and the innovative use of genetic methods in various ways (including monitoring of large carnivores and investigating fauna crimes, like poaching) are great examples of how scientific approaches and methods can contribute to practical applications. Restoration of forests is also an important topic, but from the description of this case study it is not possible to judge if the restoration methods used (gap cutting and prescribed burning) are actually restoring the forest, i.e. having a true impact, or rather just mitigating the negative biodiversity effects of timber production (which, of course is an impact also).

Besides the case studies, the UoA highlights the societal impact of targeted education. This important aspect is often forgotten. High-quality education can provide long-term impacts on societies and, as in the case of this UoA, the world-wide network formed by former students can help all partners to broaden their views on the local issues, share experiences and ideas and learn more from each other, which, in turn, provides added value to the local societies.

#### Score for Outcomes

3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

Given the open-minded attitude of the UoA towards the society and willingness to work in collaboration with stakeholders, the work of the UoA is likely to continue having a remarkable impact on the topics of its expertise. Particularly the encouragement of the staff to 'move beyond their comfort zones' is appreciated. Extending the studies to cover also other parts of the world (African savannah, Asian and South American river dams) extends the societal impact also to these places, but (possibly) also broadens the views on domestic cases

#### Score for Impact Strategy

3

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA has incorporated collaboration with society effectively in its research. The long tradition of collaboration has taught that successful collaboration requires time and an open mind, and the effort has been rewarded in the longer term with greater societal impact and collaborations have ensured fresh new research ideas.

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The case study of successful collaboration, however, is perhaps not the best example within the scope of the UoA. The study itself is interesting, but its approach sees members of society rather as objects of the study, than as collaborative partners. This impression, however, may be just because of the summarizing description of their self study, from which it is hard to perceive in all of its aspects.

The important lesson learned from the unsuccessful case study is that society can pose unexpected conditions to research. Particularly in experimental studies, the public (or a specific stakeholder group) does not necessarily accept experimental manipulations for ethical or other reasons. Things that cause no discourse within the scientific community may do so outside of it. This is an important lesson that all researchers should learn: the rules that apply in the scientific world do not always apply in the worlds of other communities.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

Generally the UoA is doing an exceptional job in collaborating with societal players. But this will be a dynamic issue and in the future more engagement with social media will be necessary.

Panel/ Research field	Aquatic and Terrestial Ecology
UoA	Aquatic ecology
Introduction	۱

#### General assessment of the Unit of Assessment

The UoA has a clear rising trend in research, both in quantity and quality. In general, the unit seems to have uplifted their research and has concrete plans for a future research strategy, both related to scoping science and securing funding for a critical mass of researchers. The group has good prerequisites for increasing their interdisciplinarity in research, and should do so as well. They are key-players in environmental issues in Sweden working in the interface between science and decision-making. The unit develops official guidelines and regulations and provides expert-support to key authorities.

The unit has great potential for societal outreach do to their hands-on work in both national and international monitoring and assessment. Water is an element that potentially interests everyone, increasingly so in the future. The unit has a solid administrative history of working with other governmental agencies and providing guidelines in water monitoring and assessment. They are also showing increasing signs of engaging the general public, a trend that could be emphasized even more.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA has a clear rising trend in research, both in quantity and quality. The group had a history of publishing in more limnological journals earlier, but has lately focused on a more ecological approach and journals with relatively higher impact factors (Nature, Global Change Biology etc.). From the information given to the panel it was hard to discern the exact contribution of the unit's researchers into these papers. But in general, the unit seems to have uplifted their research.

The unit highlighted a few research avenues that they want to pursue: biodiversity and long-term changes with anthropogenic drivers, disturbance and restoration ecology and strong development of assessment tools. All avenues are justified and timely. The potential to combine long-term data with anthropogenic-driven changes is a very fruitful and important combination to understand larger ecosystem-level changes. Additionally, geneticbased monitoring is a rising research field in which the unit can be in the forefront.

#### Score for Scientific Quality

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

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The UoA has been able to attract international guest researchers through a guest researcher programme and external sources. Turnover of temporary staff and collaboration within and outside the UoA have been seen as inspiring for new research themes and networking. The unit is driven by two male professors, with the UoA having a more even gender structure among the junior faculty. A clear plan on solving the gender structure was not presented, though this gender bias seemed to be quite uniform across the different units ie. more a problem of the whole SLU. The UoA claims to have international recruitment and mobility despite their relatively small size. The continuity and stability of the research scopes presented was a bit uncertain due to the narrow nature of the researcher number and age structure.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

Early career scientists are offered mentoring in proposal writing, encouraged to achieve pedagogic and leadership training. Career planning and periodical assessment is built in the structure of the UoA. PHD education is priorities, funding is allocated to participation in scientific activities (meetings, courses). All PhD-students are associated with research schools. After PhD student are encouraged to apply broadly for positions both within and outside of academia. The unit is quite small so national and international collaboration is essential.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

Geographic scope of collaboration and networks appeared to be quite large. Partly due to the broad monitoring assessment background, the unit collaborates with a broad variety of EU countries across both longitudinal and latitudinal scales. Collaboration also includes researchers and funding organizations from the United States and China. Despite the relatively large network, the impact of the unit on scientific debate in its field was not clear.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The unit collaborated with other closely related scientists from SLU, such as aquatic scientists and ecologists. Some more multidisciplinary collaboration has risen in specific projects with e.g. environmental economists and social scientists within SLU but the extent of which was not quite clear. Nevertheless, the trend towards increasing involvement of other research fields in multi- and/or interdisciplinary nature (especially social sciences, law and economic) is a positive initiative and desired direction. The unit is very hands on in their international participation in molecular science and development of new genetic tools on assessment of aquatic ecosystems in Europe. However, the panel feels the synergies between this UoA and other collaborative parties in SLU or outside SLU are not quite fully used and could be improved and strengthened.

#### Score for Scientific Environment

#### 1.3 Strategy for Scientific Development

### 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

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The UoA has a clear view of forming functional ecology research group with a new professorship. There is an aim to increase the critical mass of researchers by putting faculty funding into lectureships. Additionally, a strong focus was on incorporating molecular methods in aquatic monitoring and taxonomic identification. Plans for renewing remote sensing and obtaining experimental facilities were also presented. The UoA was concerned with maintaining and growing the Unit's strength and replacing the soon-retiring professors. The unit also expressed the desire to provide more financial stability and security for staff researchers, and to secure and increase international collaboration networks. The aforementioned plans seem strategically valid, but the panel was not able to evaluate the funding base for implementation.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The unit expressed three larger research themes for future development. 1) Biodiversity and its patterns from species level to ecosystem theories to ecosystem services. This scope, although important was relatively large and implementation a bit vague. 2) Disturbance and restoration ecology. Timely topic as well and would gain from strong interdisciplinary approach. 3) Assessment tools and their development. This section lies heavily on the units other mission as conducting government commissioned monitoring and assessment.

The UoA has a unique opportunity to get access to national and international long-term monitoring data through own governmental monitoring and trans-European assessment collaboration. The unit also plans to invest on new molecular methodology in taxonomy. These avenues with large data sets with new methodology have the potential of opening new research directions in which the unit can be at the forefront.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The largest challenges for this unit rely in continuity and succession of the research. Strategic recruitment and increase in the security of funding for staff are considered crucial. Also, improvement of research facilities, such as experimental infrastructure, to supplement field data in larger theoretical framework was considered important. Dual responsibility of research and outreach was considered to provide barriers on pure scientific merits.

#### Score for Strategy for Scientific Development

3.5

#### **1.4 Additional comments**

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

A broader comment for SLU across the whole organization is the ensuring of continuity of the careers of the researchers, both in career succession of the young but also strategic planning of the new research avenues (also geographically). Also, the balance between clearly evaluated and rewarded scientific achievements versus desired societal outreach does not seem to be rewarded. As SLU is the flagship for sustainable development and research, it should provide clear guidelines on how societal merits are rewarded.

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As a whole, water-related issues seem to appear in several units in a somewhat scattered and sporadic manner, presumably due to historic reasons. Some clearer unification of water-related research (and teaching) would be wise, as water is essential for issues related to sustainability, food production and human-related interactions in a very interdisciplinary manner. Alternatively (or additionally), instead of unifying water-related research, a clearer, cross-Unit strategic plan on water-related research would serve this Unit well.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

As the UoA describes it itself, "the UoA staff has a strong engagement with society regarding environmental monitoring and assessment (EMA)". This process is of great importance for the functioning of the society, and in this respect the UoA's societal contribution is clear.

The research of the UoA has sound grounds in modelling, ecological theories and modern tools, like metabarcoding and remote sensing. The good science of the UoA has been successfully employed also in practical applications, including development of tools for assessment, monitoring and decision making.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

All three case studies on the impact of the UoA's research are tightly linked to science. They are ambitious and successful attempts to apply scientific approaches to environmental assessments and monitoring (WATERS, CAFF, implementation of resilience concept), which, in turn, affect legislation and practical management guidance. Thus, the impact on society is clear, although the path from research to practice has many steps along the way. Perhaps, a more straightforward example of (to-be-realized) impacts is the project at Lake Mälaren, which names commonly recognized goods like bathing, drinking water and management of invasive species as its targets.

#### Score for Outcomes

#### 3

#### 2.3 Impact strategy

# 2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

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The UoA aims its expertise at several important processes in society, particularly in assisting governmental agencies in environmental monitoring and assessments of freshwater environments. The UoA is not only working on assigned commissions but also actively dispersing the its scientific discoveries within society and participating public debates.

#### Score for Impact Strategy

#### 2

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

## 3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA's collaboration is restricted to a narrow section of society, including basically only other research organizations and governmental agencies (regional, national and EUlevel), as far as it is possible to judge from the description. Collaboration with such partners differs fundamentally from collaboration with non-research and non-administrative stakeholders. Providing society with scientific knowledge is different from societal collaboration, where communication is two-way and all partners have active roles. True collaboration with society, however, is not a must for a research group, if there is no natural need for it. The Lake Mälaren project is likely to contribute to this aspect.

Note: Some processes (e.g. CAFF) have also non-research and non-governmental partners involved.

During our interview, it was noted that the lacky of Swedish language fluency by many researchers is a problem for collaboration.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

Increasing bottom-up engagement of the general public, increase of the open possibilities for citizen science. Modern use of social media, engaging and educational apps. At the SLU level or faculty level, hiring specialized people to be responsible for communicating to the third sector, public and outside academia in general. Introducing and strengthening an engagement plan of stakeholder-public-academia with a joint problemsolving atmosphere.

Panel/ Research field	Aquatic and Terrestial Ecology	
UoA	Ecology - N	

#### Introduction

#### General assessment of the Unit of Assessment

The UoA does world-class research in terrestrial and agricultural related ecology in both pure and applied science. The publication record, success on project applications at various funding regimes as well as their collaboration network show that the researchers of the UoA are highly acknowledged in the international scientific community.

Their societal impact and willingness to cooperate outside the academic world are also noteworthy.

For a further development of the UoA it will be necessary:

1. To stabilize faculty funding particularly to support young researchers.

2. To find a funding scheme that supports pilot studies for developing first-class research lines outside beaten tracks and mainstream research (which is a safer source for funds).

3. To development a conceptual and strategic framework for the research profile.

4. To modify SLU's evaluation system in order to acknowledge collaborative activities with public and stakeholders.

5. To develop a general SLU strategy for outreaching research outcomes relevant for society (building on the various information platforms which already exist).

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA does world-class research in terrestrial and agricultural related ecology in both pure and applied science. This is well demonstrated by the publication record containing prestigious journals (Nature, Science) as well as other high ranked peer-reviewed journals. The latter is particularly noteworthy because it demonstrates their high profile within the scientific community.

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The main focus is on environmental protection, nature conservation and agriculture management. The particular strength is in the combination of taxonomic knowledge, ecological modelling and molecular methods. This combination provides powerful tools to work on several spatio-temporal scales, which is important for the analysis of ecosystem functioning. The UoA is a pioneer in considering multiple Ecosystem Services (ESS) for developing tools towards a sustainable management of natural resources. So far, only those ESS are considered that are directly related to crop production. In this regard, the UoA could take benefit from their collaboration with the department of forest sciences, which targets its research on non production related ESS.

Highlights are studies on population vulnerability in response to land use changes and climate changes, as well as wildlife management in collaboration with farmers and other relevant stakeholders. Predator-prey as well as plant-pollinator interactions complement the portfolio as research on species assemblages. This particular strength of the UoA is highlighted with their internationally acknowledged bee research. The scientists of this team detected the negative impact of neonicotinoid type insecticides on bees (and particularly wild bees), and they could quantify the importance of the latter for crop pollination. These findings are the basis for the international leadership of the UoA in one of the most important and timely research directions in agriculture.

Most interesting, however, is the strong focus on ecological theory, which is essential for a strong applied science as well. The research on the latitudinal dependence of food webs and particularly predation pressure, the coexisting paradigm (letting predators coexist with people), and the quantification of the positive relationship between tree diversity and ESS, are evidence the superior performance of the UoA. This Unit certainly plays in the same league as the University of Wageningen, INRA Montpellier or UFZ Leipzig.

The only weakness is related to the funding system: researchers appear incentivized to conduct established, mainstream research. Risky research directions which could lead to unique, world leading research directions have to be avoided since they could also fail.

#### Score for Scientific Quality

#### 5.5

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The UoA acts as a unit with research goals. The researchers developed four overarching research themes: landscape ecology, trophic interactions, conservation biology and wildlife ecology, which provide a framework for grouping and forcing joint activities such as project presentations, literature seminars and joint writing of new applications. The annual departmental symposium with prominent guests is a particular highlight for stimulating and maintaining a lively scientific working atmosphere.

Common measures that have been proven to be effective like leadership courses for academic and administrative staff, mentoring of junior staff, invitation of world leading guest scientists or the internal reorganisation to streamline administration are useful to establish a productive and creative working environment. Gender equality was improved but needs much more effort. The latter is true for all UoA assessed.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

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The UoA has a strong strategy with important measures to support early stage researchers. Common measures are, e.g., the support for courses in pedagogics, leadership and supervision, the opportunity to cosupervise PhD students and master students, or the mentoring by senior scientists. Noteworthy and beyond the common measures are, for example, the provision of additional research funds based on scientific publications, the 2 years funding for the three most promising young female and male researchers, and the active inclusion of young researchers as co-applicants in larger research proposals and as co-organisers of workshops and conferences.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

They have extensive collaborations in Europe and beyond. This reflects success in various EU funding schemes and profound networking activities. The geographical scope, however, was not explicitly considered in the template of the report and can only be evaluated based on the provided information about on-going projects (this comment accounts for all reports of all UoA).

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The researchers of the UoA do work in theoretical aspects and also applied ecology. The latter is naturally related to various different disciplines and interdisciplinary work is key for success. The researchers actively collaborate with human and veterinary medicine, environmental lawyers, psychologists, social scientists, molecular biologists, engineers and practitioners in agriculture, conservation and wildlife management. The UoA participates in SLU projects like the Platform Plant Protection and in various national centres such as the Centre of Biological Control, Centre for Fish and Wildlife Research or the Wildlife Damage Centre. The latter is particular noteworthy since these platforms serve as information hubs about SLU activities to the public and various stakeholders.

#### Score for Scientific Environment

#### 4.5

#### **1.3 Strategy for Scientific Development**

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The strategy for scientific development focuses on strengthening the present situation by stabilizing the economic base of the

• Recruitment of new professors and

• Additional research funding for PhD students and young researchers based on their publication record.

Also, the fostering of collaborations in unifying research themes such as trophic interactions as well as landscape and spatial ecology appears to be a strategic direction. However, a borad, coherent vision is largely missing.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The future research directions follow the international trend of up scaling from genes to ecosystems. The unique part is the incorporation of novel findings in soil food web ecology and plant interactions in ecosystem models in order to achieve a mechanistic understanding being essential to forecast future impacts of environmental changes. They want to do more research that links ecology with social sciences, such as linking entomology with medical science and conservation ecology with legal systems, which would clearly strengthen both the profile of the UoA and the portfolio of SLU. To better accomplish this within SLU may require bringing in more social scientists.

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Noteworthy as well, is the consideration of big data, citizen science and the active involvement of farmers and other stakeholders. The latter issues, however, read a bit like buzzwords and mainstream science. They should be further developed jointly together with the overall research strategy of the UoA and the department.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

• Increase the collaboration between the UoA and other SLU departments (there are discrepancies to the reported interdisciplinarity in 1.2d).

• An intensive input by external researchers in workshops and seminars

• An increase and strengthening of bioinformatics related methods (statistics, molecular technologies, machine-learning), which will partly depend on a solid and stable funding for the relevant staff.

• Although the division of the ecology department across two faculties does not adversely affect the daily activities of individual researchers, it does create an administrative burden especially because of the different financial models for scientists working at the same location.

#### Score for Strategy for Scientific Development

#### 4

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

There is a sub-optimal use of local capacity in basic education. The report mentions several times that the UoA wishes to extend the current educational programme to develop new master programmes as part of a broader programme (e.g. ecology or biology). SLU should actively support this intention.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The research profile of the UoA indicates high societal interest and impact, including plant protection, crop pollination, reindeer herding, tick-borne diseases and even urban lawns. These impacts also seem to be realized. In addition to these impacts of the basic and applied research, the UoA is engaged in several evaluations and monitoring processes lead by governmental agencies, and all these likely contribute to high societal impact. Citizen science for data collection (participation at ArtDatabanken) connects researchers with school kids and hunters. Furthermore, very concrete ways of contributing to the society are the Wildlife Damage Centre and the National Reference Lab for Bee Pathogens, both run by the UoA.

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This shows that the UoA has lively and very active research activities that attempt to bridge science with the society. However, the multitude of activities seem to be based on the willingness and engagement of the particular researchers rather than on a general strategy that would significantly increase the performance and visibility of SLU in Sweden and beyond.

#### Score for Activities and Outputs

#### 2.5

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The case studies provide nice examples of the diverse ways the UoA is collaborating with the society. The caterpillar study shows both the potential of extensive international collaboration of researchers and the efficiency of global communication campaign, whereas the grassland study illustrates the importance of well-designed monitoring when assessing cost-efficiency of governmental payment schemes. The case study on bee parasites, on the other hand, highlights the importance of long-term thinking in research.

The UoA successfully developed indicators for the long-term monitoring of grasslands. The scientists coordinated the national monitoring programme of large carnivores (e.g. lynx, wolfs, brown bears) and developed methods for the pest management for Swedish farmers. The research has direct and important implications for the local and regional environmental management and conservation; and is also acknowledged at the governmental level (support to the Swedish Parlament to shape the Swedish EPA and to acknowledge and address Ecosystem Services in Policy (SOU 2013 68).

#### Score for Outcomes

3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA seeks to strengthen the collaboration with various stakeholders and policy makers towards a sustainable food production and agriculture, in agreement with nature conservation and wildlife management. The strategic goals like the development of cost-efficient habitat management and restoration plans jointly together with land managers and the government, the reduction of the ecological foot prints of agriculture and measures to provide long-term sustainable pollination services jointly together with the beekeeper association is timely and achievable.

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Considering this, the societal impacts of the UoA are clear, including the assessment of the efficiency of the funding of environmental grassland management, monitoring the populations of large carnivores and wildlife damages, developing pest and pathogen management methods for agriculture and bee keeping, and exploring green infrastructure of urban areas. Besides providing expert opinions on governmental initiatives and collaborating with a variety of stakeholders in research, the UoA is also actively communicating its findings to the society via media releases, websites and social media.

#### Score for Impact Strategy

2

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The capacity for collaboration with the society is high.

Outreach is strongly supported by several extension lecturers, dedicated communication officers and the central support of the Communication Division of the SLU. Nevertheless, this machinery does not cover the full needs and could be strengthened and improved by a solid and additional funding. The latter is particularly true for nature conservation and research in agricultural soil settings.

In the field of ecology, it is not common to see collaboration with the non-research organizations and stakeholders, ranging from governmental agencies to practitioners of different fields (farmers, bee keepers, reindeer herders, hunters). The case study on bear predation on reindeer illustrates very nicely true collaboration of the UoA with non-research and non-governmental partners, namely reindeer herders - who participated not only in planning the study and collecting data but were also co-authors in the publications. The other case study, in turn, points out the importance of patience in the collaboration with society. It takes time to build trust and find common ways to work, and the UoA seems to have learnt this lesson.

As mentioned above, the collaboration of the UoA includes not only topics of applied ecology (e.g. bees, large carnivores) but also theoretical ecology where citizen science is used in data collection. The latter promotes the participants' understanding in ecological patterns behind the phenomena of interest and contributes to general understanding of ecology by the public.

The researchers clearly give the impression that they actively seek collaboration with society and don't see it only as a mission, but also as a door-opener for finding relevant research questions and as well research funds.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The UoA shows advanced and diverse collaboration with the society and will continue on this path. Further development can be achieved by adding an institutional outreach strategy to the present individual-based activities.

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It will be particularly important that SLU actively creates an environment that rewards collaboration with actors outside academia. A multi-criteria system, which adds relevant indicators to the present system focusing exclusively on the academic research output, is essential to support and acknowledge researchers' performance in internal evaluations.

Report Template for Review Panels - Overview of Research Field

Research field/panel name (no.) 13: Economics, Business and Management and S	statistics

*General observations:* This research field covers five UoAs of varying size across Department of Forest Economics, Department of Economics and Department of Work Science, Business Economics and Environmental Psychology.

The field is largely a social science/economics research and teaching area. Across the five UoAs the staff comprises of 10-12 chairs/professors, around 25 associate professors, lecturers and researchers, 8 post docs, around 20-25 PhD-students. Thus, around 70 researchers plus the research support staff, which includes research assistants, teaching assistants and other similar staff.

A bulk of the research areas are concentrated on various forms of agricultural and resource economics, environmental economics, business economics and management, but also areas like e.g. resource policy, rural development and entrepreneurship and work science is covered. A group of economic policy researchers and analysts is placed within the field, and a translational outreach facility (KCF) has been established within the field too. Several of the chairs/sub-groups carry considerable teaching responsibilities, whereas others less so.

*Strengths and weaknesses*: For SLU, a strong research environment in this research field is indispensable. It is fundamental for securing research and educations targeting the key questions of how we can understand the human-nature relationship, resource based business sectors, and how we can tailor policies and developments for sustainable life. The aggregate size of the research field at SLU, in terms of volume, is sufficient as a fundament for ensuring *research quality and excellence*. Taken together the field seems to have grown in both quantity and quality over the past years, though development is not uniform. It includes several areas of strength and high international research quality contributing the definition of research fields. It also includes areas of good and internationally recognized quality, where room for improvement is more evident. We find that in most of these cases, researchers are aware of this and working hard to improve their standing. Further strengthening of international mobility and collaboration is essential for the success of the fields concerned. We find examples of excellent and outstanding scientific leadership skills and nowhere does scientific leadership seem in shortage at unit and Department level.

We find the uneven distribution of teaching access to be one possible source of weakness for both reasons of intellectual stimuli as well as structural stability. The physical distances at SLU are also an inherent risk for efficiency, intellectual growth and synergy, which seems to be amplified by organizational borders. Finally, the organizational set-up around chairs is potentially also a source of weaknesses, which we return to below.

Regarding *societal impact and collaborate capacity*, there is considerable potential in this research field. There are several strong, promising examples of impact, and the units have on their own taken steps like the KCF facility and the strategy for a stronger integration between the policy analysis unit and research unit. However, the potential is much higher and the field should be supported to pursue this. The exploitation of this potential may be a strength for all parts of SLU, due to the direct policy relevance that this field may add. However, while some research groups have taken commendable steps and some structures are in place, using the full potential requires that SLU overall builds a much more anchored philosophy and approach for this ambition. It requires supporting infrastructure and capacity, which are beyond the means of the individual chairs and research groups.

*The field's future potential:* An internationally leading group of researchers in this field is indispensable for SLU. The field is overall well on track for this and has strong potentials. A number of global agendas and research trends will provide options for funding, for engaging in larger international research collaborations, and hence improving research excellence and quality further. The area should also be well positioned for attracting more students, and perhaps develop additional courses and programs. Finally, the field has the potential to enhance the societal impact profile of SLU considerably.

*Collaborations between UoAs:* The collaborative environment among UoAs and chairs/research groups within the different departments appeared to be frictionless around both research and education. Across departments and faculties, this is less evident, in part because of organizational borders and physical distances. There are obvious areas of complementarity between groups across the three departments and campuses, that should be exploited further both within e.g. environmental and resource economics, business economics and management and within approaches and capacity structures to enhance societal impact. Pursuing increased collaboration across Department of Forest Economics and Department of Economics may also be a suitable response to current needs to develop further the PhD education program.

*Research Infrastructures and Support:* This field has modest demands on infrastructures. However, three of the UoAs express needs for an experimental lab infrastructure to further advance their research agenda. Given such a lab may also be of relevance to other parts of SLU (e.g. environmental psychology, food science etc.), we believe there is a good case for fundraising to such an infrastructure. Turning more broadly to other forms of infrastructure, we identified a clear need for capacity and support for outreach, communication and impact and perhaps improved support for fundraising efforts too.

*Concerns and Recommendations:* In spite of the aggregate number of researchers in the field being sufficient to ensure quality and excellence, and an overall and on average suitable mix of external, teaching and basic funding, we find almost all research units express concerns over scale and appear to perceive themselves as in a vulnerable position. The panel finds this concerning, in particular as SLU appears not to be under financial distress as a whole. It is counterproductive and an impediment to improving research excellence. Such sense of vulnerability likely reduces risk taking by the individual researcher and may result in unwanted staff changes and difficulties in attracting and retaining research talent, in particular for mid-career researchers. We suspect the SLU budget model, the chair-based budget unit and the value-laden rhetoric around the external funding for mid-career researchers creates unnecessarily stressful perceptions among researchers. We suggest SLU considers organizational models that allows for more risk pooling, e.g. at Department level, and communicate a stronger collaborative and collective approach to handle funding fluctuations and other challenges.

We believe we identified a concerning gap in the SLU career model caused by the chair-based professor system and exacerbated by the above funding model aspects. In essence, the system is constructed in a way that is likely to demotivate any strong and talented mid-career researchers to apply for or stay in mid-career jobs at SLU. And certainly so in any research unit, where professors are not fairly close to retirement. This in turn will challenge the performance of new chairs hired, because they will likely face fast turn-over and loss of the most promising mid-career researchers in the unit, and hence lack talented collaborators. We strongly suggest the leadership of SLU reconsiders replacing the chair-based model with a set of tough, but transparent and motivating criteria and incentive systems. In combination with a revision of the budget model, this will eliminate many concerns, create a motivating basis for enhanced performance and increase SLUs strength in recruitment and retention of research talent.

We furthermore recommend the SLU considers options to enhance a more balanced grounding in teaching across the different areas, and the proclaimed aim to double student intake represents a non-zero-sum opportunity to pursue such a goal. This may require careful attention to possibly counterproductive budget and decision systems across faculties, departments and campuses.

We find SLUs focus on societal impact and collaborative capacity in this research evaluation to be commendable. We have some concerns, however, that there is a gap between top management's ambitions for and commitment to this, and the operational and capacity realities in the departments. We recommend that resources are directed away from other administrative activities to develop and maintain society interface structures like advisory and stakeholder boards, communication and outreach etc. Within this field we point to the collaborations around the policy analysis unit and the KCF (Competence Center) as possible models for inspiration.
Panel/ ResearchEconomics, Business and Management, and Statisticsfield

#### UoA Resource Economics

#### Introduction

#### General assessment of the Unit of Assessment

Scientific quality: Strong past publication record and high standing in the academic community working on environmental and resource economics. For this assessment period, both the number of publications and the share of high profiled publications are down compared to the previous period. The resource and environmental group (REG) still publishes reasonably well, but the review panel is of the opinion that the group's scientific potential has not been fully utilized. Given its resources, the REG's move into CERE and its wide international contacts have helped reduce its decline.

Social impact: Given the REG's strong scientific quality and relevance of fits research questions for society, the evaluation panel feels that also on this part, the group's potential is not well utilized despite having a strong presence in the public debate on issues related to its research areas.

Collaboration: Again, given the REG's capabilities and relevance of its research, the panel views that the potential of the group has not been sufficiently utilized. Admittedly, the REG has strong international collaboration and a deliberate strategy for researcher mobility, in particular for its jr. staff, but at the domestic level they somewhat underperform compared to their potential. One reason for this is that the REG has not developed relations with stakeholders in line with their potential. Building such relations for mutual exchange will be important for the group's development.

The panel observes that the REG has a low share of staff at the associate professor level, and improvements in this area appears necessary if the group is to regain its strong position.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

It is difficult to assess the performance of a resource group without considering the group's size. The resource economics group (REG) is quite small, counting 9 persons, but less in terms of the number of full time scientists (4.1 FTE). Our evaluation therefore needs to be seen in this perspective.

The REG has a strong but declining publication record, with the sr. member of the group, Prof. Kriström, naturally carrying a large share of the group's publications in a long term perspective. Some jr. staff (doctoral students and post-docs) publish in new areas for the group, particular behavioral economics. Academic transition and moving into new, but still related areas appears wise although the short term impacts on overall publishing may be negative.

One of the challenges of a small group is to balance what older members have done with the contributions of its younger (jr.) members. The past "bread and butter" of the group's work has been within the areas of non-market valuation/benefit-cost analysis (BCA), and policy issues as the group's self-evaluation indirectly points out. The theoretical and general scientific impacts have been most significant within valuation and BCA, where there have been several profiled papers over the last 10-20 years. Some of these papers have also had a methodological twist on the econometrics of non-market valuation and nonparametric approaches.

On the applied side, energy markets have gained increased attention, in particular the last ten years. Some of these publications have been under the Center of Environmental and Resource Economics (CERE), a joint undertaking with the University of Umeå. The CERE umbrella has been productive both in terms of quality publications, and it enlarges the REG's access to skills and competence outside the (small) group's key areas.

Related to the applied work on energy issues, the recent development of a CGE model for the Swedish energy sector is a major achievement, although this work has yet not manifested itself in any profiled scientific publications in the materials submitted to the panel.

During the period covered by this review, the 29 papers that have been in 21 different journals. This enlarges readership and citations. Altogether 79% of the papers published in the period are cited, and 24% of these papers involve international cooperation according to the information submitted.

The REG is part of the Department of Forest Economics at SLU. As such, it is a positive quality indicator that only six of the 29 articles are published in forestry related journals. Or positively put, that 23 articles are published outside the traditional sector orientation that haunts sector departments.

The REG has continued publishing some in its past important areas in recent years, but with a larger emphasis on behavioral and experimental economics linked in particular to nonmarket valuation, and lately on catastrophic risk. Behavioral and experimental economics are "natural" extensions of the group's past work on non-market valuation. This has been a productive expansion of the group's core publishing platform with publications in quality publication outlets like Journal of Choice modeling and Environmental and Resource Economics.

Catastrophic risk is closely related to the group's work on BCA. Here, the bibliometrics and citations appear less convincing. However, catastrophic risk is a growing and challenging sub-discipline of BCA that could pave the way for future profiled publications.

On the applied side, barring energy economics, the REG has published papers on predatorprey issues, and bioeconomics. The latter is an area of growing practical importance. The policy impacts of these publications are not well documented in the group's self-assessment.

Another dimension of scientific quality relates to the capacity of writing chronicles and opeds. While the submitted bibliometrics do not contain information on these publications, a check of the group's publication record in these categories is quite strong, with several chronicles in Dagens Nyheter and papers Ekonomisk Debatt.

Despite its size, the REG continues to have a strong international standing, partly helped by the beforementioned formation of CERE and its long role as a host for the Ulvön conference in environmental economics.

A strong PhD program and a group of talented post-docs further enhance the REG's academic standing. Still, the panel is of the view that the group's full potential is underutilized.

#### Score for Scientific Quality

4.5

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

As already mentioned, the REG is a small unit in terms of number of people. The panel sees CERE as a targeted and well-motivated measure to compensate for the group's small size.

The REG has a deliberate and followed strategy of bringing in visiting scolars and sending own young faculty/doctoral students abroad to widen their horizon. In particular, the 25 year old history of the Ulvön conference in environmental economics is to be applauded – it has effectively maintained the group's international standing, and openness to contrasting perspectives.

Strong cooperation internationally in resource and environmental economics, though only 24 % of publications have international collaborators. Less strong on cooperation with the other economics and business units at SLU, and with other disciplines than economics.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The REG has continued its excellent "mobility" program for young faculty exchange and development. Together with the hosting of the before-mentioned Ulvön conference, the academic environment for PhDs and post.docs must be viewed as excellent.

There are some concerns related to the REG's future possibilities of offering PhDs under more stringent external (national) requirements related to macroeconomics in its doctoral program. With its low number of faculty, this puts a successful doctoral program at risk unless measures are undertaken like closer cooperation with the applied economics environment at Ultuna, or with the economics department at Umeå University. Unfortunately, for the PhD program these requirements require resources and draw attention away for the REG's strong areas of research.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The REG has wide and strong international network within resource and environmental economics. Being able to maintain this network is imperative for the future success of the REG.

Over the years, the REG has been a profiled participant in the academic discourse in its strong areas, in particular nonmarket valuation and benefit-cost analysis. Low number of faculty at the associate level constitutes a challenge to maintain this visibility and contribution in these areas, and to expand into new areas like the before-mentioned field behavioural economics.

The panel has noticed that the SLU business/economics groups at Ultuna are also into behavioural economics, albeit with a focus on consumer behaviour. Increased cooperation on behavioural economics and the necessary lab-infrastructure would benefit both units.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

Last year the REG launched the ECOS (ecology and society) initiative. This is an example of an innovation and well-designed educational novelty to create more interdisciplinary cooperation within SLU.

The ECOS initiative is probably not yet fully developed as it was launched last year. The panel sees room for further developments here. It would be beneficial for interdisciplinary work at SLU if the ECOS initiative could spread or be replicated at Ulltuna. The panel recognizes that distance matters, and believes one needs to test ECOS further at the Umeå campus before expanding it or launching similar programs at other SLU campuses.

#### Score for Scientific Environment

#### 4.5

#### **1.3 Strategy for Scientific Development**

### 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

Strong past orientation on nonmarket valuation, benefit-cost analysis, and policy analysis. Expansion into behavioural economics marks a logical extension of past research, in particular related to nonmarket valuation. This expansion marks scientific renewal.

The REG already has strong links to other strong research environments internationally working on behavioural economics.

The panel views this addition as a natural step to widen the scientific base for its work on nonmarket valuation and a possible platform to enhance other areas of its research activities, in particular related to consumer responses to energy saving requirements and other policies in the energy sector.

The newly developed CGE model for the energy sector is also a scientific investment that the panel expects will lead to interesting research and increase scientific publication rates.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

As already mentioned, the addition of behavioral economics appears a sound extension that is expected to provide a stronger scientific foundation for the REG's work in nonmarket valuation and energy markets. The CGE model of the energy sector also appears like a sound choice given the recent changes in funding for applied research in Sweden (less available funding on traditional environmental economic issues and more funding on energy issues).

The REG's traditional approach to funding (of applying for research funds on areas where they have competence) is problematic given recent years' decline in funds available for environmental economic research. As such, the panel believes the group could have benefited from developing closer relations with stakeholders both to influence research calls from the various funding agencies, and for attracting partners in research projects. The latter is particularly important if the REG continues to thinly staffed at the associate professor level, which means attracting needed skills externally is a way to solve this skills issue, in particular in the short run.

The publication strategy is also important in this regard. The REG has a rather conventional publishing strategy with a focus on peer-reviewed journals. In addition, REG staff has been visible in the public discourse on issues related to REG research areas. Engaging more with stakeholders is not only an approach for having more impact in the public discourse and on society, but also a way of expanding the funding base.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

Major challenges for the REG and its future are:

(1) The group's size, with few faculty members at the associate level. This also gives some causes for concern related to succession at the professor level as the group's current leading professor approaches 60 years of age.

(2) The funding situation, both internally and externally. External research funds in the REG's main area related to resource and environmental economics. The panel is of the impression that the REG has received less funding (partly through a lack of ownership of its own courses and little access to teaching) than similar units at SLU.

(3) Student recruiting at the bachelor and master level. While these issues are not directly related to research, having more students and a larger portfolio of courses provides some flexibility in terms of managing personnel resources.

#### Score for Strategy for Scientific Development

4.5

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

With the economics department at Uppsala also venturing into behavioural economics, the panel sees a scope for increased cooperation. Increased mobility, in particular but not restricted to doctoral students, between the SLU campuses would also benefit the REG as well as the other units in business and economics.

We also observe that departments we have reviewed are under different faculties and wonder if this creates artificial barriers for increased collaboration, both generally and specifically for the business and economics area.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

Clear outcomes related to performed research are presented. However, given the description of the research there might be a greater potential for activities. The potential for outreach by being a part of the CERE centre is not addressed.

Regarding activities, a larger number of stakeholders could have been more directly involved. Some of the described activities are commissioned research in collaboration with public and private actors. However, it is not clearly described how or if such activities bring back valuable perspectives to REG.

Potential for larger impact if more emphasis was put on building stronger and long lasting relations with major stakeholders.

Credit for being a visible participant in the public debate on issues supported by the group's research.

#### Score for Activities and Outputs

2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

Outcomes are presented. One of the examples shows also how the outcomes have been used by interested parties/stake holders.

Again, the group deserves credit for being active in searching for cases and research questions from the outside. However, they appear quite selective and not so open for mutual exchange/joint development of research with prospective stakeholders. Again, we observe that the group's potential is not fully utilized, and we assign a grade of average outcome performance.

#### Score for Outcomes

1.5

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The submitted materials from the REG describe potential of the unit's research to contribute to societal needs and challenges by for instance deliver decision support or by providing specific knowledge inputs. By performing relevant research of high quality, the REG expects the demand from industry as well as public sector continue. No clear impact strategy is presented with no goals or ambitions stated. The REG seems to be rather reactive rather than work proactively to find new relevant societal challenges.

As society changes, so will the issues of concern to society and decision makers. The group takes a static perspective in this regard according to the group's own assessment.

#### Score for Impact Strategy

1

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The REG gives a good description on benefits of collaboration for research and expresses important aspects of a successful collaboration. The case is a typical example of a collaboration project with mutual goals for both partners. The collaboration case builds on long relation between the collaborations partners.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

Given the presented networks of stakeholders including the CERE, the panel's impression is that there is a greater potential for collaborations, which in turn can increase the unit's possibilities to contribute to societal impact as well as identify new research questions.

The panel recognizes the small size of the REG and the staffing issues associated with low staff numbers at the associate professor level. We realize that this puts some constrains on what is feasible. At the same time, our impression is that the REG have not been very proactive, which also implies that some interesting possibilities most likely have been lost. Given the staffing situation, the panel perceives it is important to identify some "low hanging fruits" for the REG to expand and perform better regarding collaboration outside academia.

Panel/ Research field	Economics, Business and Management, and Statistics
UoA	Agricultural and environmental economics and applied analysis
Introduction	

#### General assessment of the Unit of Assessment

There are three research groups within this UoA that include: Agricultural and food economics (AFE); Applied analysis, (AA); Environmental and resource economics (ERE). We were impressed with the group's level of internal collaboration and a highly positive degree of collegiality with a clear degree of energy being infused by the addition of a new professor. The presence of the Applied Analysis (AA) group adds tremendous value to the unit by providing well-researched and high-quality data and recommendations for various stakeholder groups with the national government as a primary audience. We were also somewhat concerned that with the AA unit being in Lund, that there might be cultural or communication disconnects. In listening to the group and witnessing their interaction, they clearly are well-integrated and truly function well as a team, leaving us with no concerns about the distances between core groups.

Overall: This UOA has made significant advances over the last five years in a very competitive environment. The group is collegial and energetic and a newly-appointed professor increases research leadership and critical mass as well as apparent leadership energy. There are 8 FTE research support staff. The key responsibilities and of research support staff was not discussed in detail, although the assumption is that they are linked to projects and thus salaries are financed by external income.

The review panel was impressed by the research-oriented culture of the group with a strong focus on quality, but there was also a clear recognition of the need to connect to the broader stakeholder groups that exist in Sweden and internationally.

The group articulated a clear vision for societal engagement, talking about a circular approach: engaging appropriate stakeholders in formulating research questions; engaging external people in research design and data collection; and then designing, delivering and evaluating appropriate outreach in the form of written material, conference activities, and use of modern delivery mechanisms (such as blogs, social media, and electronic media).

On the topic of increasing societal impact, more work is needed to define specifically what is meant by impact, but this is not specific to this group.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

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Staff within the UOA are research-active both in terms of their academic output in scientific journals and what are termed popular publications. Overall the group is very productive in terms of quantity published, it has a strong publication record in leading field journals like J. Agricultural Economics and J. Env Econ and Mgt. The group has a strong citation record, and contribute with papers of high international quality that has the potential to help the field redefine itself in the longer run.

The general areas of interest are in some instances focused economic solutions to real-life problems with a diverse range of issues. There is a direct attempt and mechanism through the AA to supply NGOs with research information to influence policy in forest, fish, equine, animal health, and energy areas.

Clearly, the unit and personnel representing its three structural elements displayed a strong and coherent presence particularly following the interviews that were held. We believe that the unit displays a strong international presence, being viewed regionally and perhaps beyond for its high quality of research with great future capacity and exciting changes that point to a positive future trajectory.

The group clearly collaborates with other groups in the Department, but also expressed an ambition to reach out and increase collaboration with the related group in Umeå (300\_1 Res\_Econ), which could increase joint quality of PhD education.

#### Score for Scientific Quality

#### 5

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

There is a creative, vigorous and productive environment. The UOA is well-balanced with a dynamic newly appointed professor. Some staff are clearly focusing on complex issues while seeking to publish in highly-ranked journals. Others produce very well cited applied works in strong field journals. The staff in the AA unit are producing large numbers of technical briefs, data summaries, and technical supports – these are different types of activities and demand different skills that compliment academic writing for journals, but the AA unit is clearly highly respected across the unit. There are commendable activities to support a research environment, but the unit stressed the challenge to retain the mid-career talent present in the organisation. Clearly staff are focusing on output and increasing bid writing, which is understandable and necessary given the management structure. The gender balance mirrors the usual development in these fields, and there is international recrutiment both a junior and senior levels.

On the whole, the review panel saw current excellence in leadership and a strong and vibrant future for this unit based on leadership and a future vision.

1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The new professor coming from another UOA should bring synergies and leadership experience hopefully leading to new opportunities. The post-graduate researcher and early career researchers are obviously encouraged and supported to engage in research, and the supervisor teams appear to be consciously constructed around the PhD-students. They are also encouraged to attend conferences and apply for grants, and to visit foreign university environments.

The notion of research mentoring for all staff appears to be informal and collegial in nature. From the general material provided by SLU, it is not clear if this reflects more formalised guidelines for these processes. PhD students are engaged on teaching opportunities, and a system is in place to ensure that their PhD grant is prolonged. Nevertheless, it is important to see that this option is used with care to avoid excessive use.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

Although staff within the UoA are developing a much wider profile, how this fits into a future strategy should be better communicated. The most recent reported visit of a visiting scholar appears to be in 2014. It might be useful to consider how the UoA can strategically manage the relationship with the internal and national stakeholders listed in 1.2d and 2.1a. We wondered what are the real relationships, and how are they managed for mutual benefit? For example, there is little discussion of what internal events are held for both internal staff i.e. research presentations etc and for internal and external staff i.e. research symposia (funded), staff seminars: getting published workshops; colloquia and for other external stakeholders i.e practitioners; the public. The geographical scope is somewhat restricted to Nordic countries and EU (with some exceptions), which is perfectly acceptable. Altogether 51% of articles involved international collaboration, which was the highest percentage in this panel.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

Overall, the UoA has developed some good links across the university, and the unit expressed a clear mission in being a social science group involved in important interdisciplinary research questions. The group may in some cases to perhaps be more reactive, rather than proactive in nature. However, the research and leadership talent in the group can clearly sustain a proactive leading role also in interdisciplinary research projects, making further use of their potential. A case study is provided on a successful program dealing with animal health (MRSA) and many partners were involved. A second example of collaboration on nutrient leakage was provided.

#### Score for Scientific Environment

#### 5

#### 1.3 Strategy for Scientific Development

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

Given the size of the team and the format of the SA the UOA has a well-articulated and ambitious strategy particularly for internal and external collaboration. The unit is well underway in a succession phase where older professors are replaced by younger professors, thus representing the conclusion of a renewal strategy that must be considered successful.

In the interview, the group further elaborated on a good strategy for seeking input for setting research agendas through the AA unit and a collaboration with the KCF unit in Alnarp. This may inspire applied research and impact strategies.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The group also saw strong potential and interest in leading new models for societal engagement. In addition, when asked about the potential to receive "new" resources, the group clearly articulated a vision for having another researcher or professor working in domains that cut across AFE and ERE and focused on development economics, as this area often attracts several international PhD students.

Thus, future directions look positive. There is a sense of leadership and vision that is accelerated by the addition of a new professor and the ongoing succession. The group also displayed a positive attitude toward participating in new future-oriented "platforms." Though, the level of enthusiasm about platform participation was variable, suggesting that SLU leadership more generally needs to work more purposely on connecting excellent researchers to the activities of the platforms. The group also saw strong potential and interest in leading new models for societal engagement.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The group's energy, plans for the future, and vision toward strategic societal engagement are promising, and they are likely only limited by resources in fulfilling their great potential. Thus, most important element is maintaining clearly articulated research leadership and providing the space, direction and resources to engage in meaningful research.

As a more generic issue, we note that having recently gone through a succession, the chair system of SLU may imply a danger for facing difficulties in attracting and retaining in particular talented and productive mid-career talent present in or needed by the unit. The lack of clear, performance-based career options for talented and productive senior midcareer researchers may prove difficult when succession will soon be in place for a longer future period ahead.

#### Score for Strategy for Scientific Development

#### 5

#### **1.4 Additional comments**

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The SLU should in general become better at supporting the researchers work to engage with society and pursue societal impact. This is needed to make sure that the SLU at-large purposely taps into a vision like those articulated for societal engagement by this unit. SLU should think about specific signs and signals and reward systems for societal engagement; not necessarily in terms of monetary rewards, but systems of praise and CV-building. Further, SLU should examine and strategically understand how and why the AA unit seems so positively integrated within this very strong and scholarly unit and use those learnings across other units that are dispersed geographically across Sweden.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The group is to be strongly commended in the area of societal engagement both in terms of their structure, but also their vision and attitude related to the importance of societal engagement. Specifically, the AA is highly respected as a research-based information authority by those outside SLU. Many of their "products" and the work of other in both AFE and ERE are being used in the real world by policymakers and other public-sector experts. It would be extremely helpful to better define and measure the specific, measurable impact in terms of changed practices, economic benefits, improved environmental conditions, changes in efficiency, etc. Professor Hansson presented a compelling vision for true stakeholder engagement showing very good promise for the future, and if realized, the potential for true excellence.

The group stated that "even more could be done oriented directly toward the agricultural industry, and as we pursue external projects there can be a shift from knowledge transfer to engagement and involvement of those outside SLU." This can include external stakeholders who help select data collection strategies, assessment, and even creation of research hypotheses. Further, the group talked about stakeholders returning to have an active dialogue to take one step farther on crafting how knowledge can be used. One thing that could help facilitate this visin is the creation of an external advisory group for this unit to increase levels of support and connection to external communities and interest groups.

#### Score for Activities and Outputs

#### 2.5

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

None of the groups that we examined clearly articulated a great deal of specific, quantified impact-related information, though this unit appears to produce a very good amount of information for external use and the quality is very high. This group has a large collection of activities and bulletins, articles, and technical reports directly intended to be used by external stakeholders with many being produced and made available by AA. AFE and ERE also appear to be engaged in similar activities though to a smaller scale, largely because outreach and technical support are central to the AA's primary purpose for existing. Engagement in AA's activities by those in AFE and ERE have also opened up new opportunities for international collaboration. The case study on animal health was interesting, yet again, detailed information on specific quantitative impacts was somewhat lacking. As a note across ALL units (and this one), additional "support" for societal outreach and engagement from SLU would be extremely useful. Some of this can be centralized, but capacities for communication, outreach, engagement, and related activities (writing, social media support, and helping researchers to "connect") should occur as close to the unit level as possible. Centralized communication and publishing units that only produce "glossy" print materials for various stakeholder groups usually mean that only a small percentage of all of the research will ever be highlighted and efforts will not be owned locally. Instead, the focus should be on more local resources and professional development to help all interested researchers to communicate their work more effectively.

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#### Score for Outcomes

2

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

See previous notes about defining and measuring "impact." More work and support is needed to articulate impacts in ways that go beyond transfer of knowledge. The group appears to understand and have a compelling vision for methods that go beyond simple knowledge transfer that will further lead to excellence in this area in the future. There are clear opportunities to engage with society's stakeholders across the unit. We encourage the continued support and leveraging of AA skill and capacity to engage. SLU's incentive system impacts the willingness and motivation to pursue societal impact activities. This needs more thought and clear signals (the word used by those interviewed) from central management if SLU wishes to see this level of positive engagement across units. The UoA might also wish to consider the formation of input structures to gain the "view," support, and participation of external stakeholders (advisory boards, external listening sessions, strategic/planned opportunities for university people to sit in the same room with government/industry to learn and listen). Again, this should happen as closely as possible to the unit level.

#### Score for Impact Strategy

2.5

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

There is a clearly identified external collaboration with the Applied Analysis unit (AA). This group, while located in Lund, appears well-integrated based on comments made within the interview with even more potential for collaboration – perhaps suggesting the potential to examine expanding their audience well beyond governmental ministries. Comments made in the narrative suggested long lags (up to10-20 years) between new research and the ability to "use" that outreach in collaborative efforts. This timeframe seemed excessively long to reviewers, and more discussion is needed to expedite the movement of research findings into real-world-applications. Cases show good potential for expanded collaboration in the future – two important and related issues are animal health and animal welfare, but in both AFE and ERE, the review panel felt that the unit was working on many more issues of tremendous societal impact.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The vision articulated by Dr. Hansson for a larger, holistic engagement model in combination with the capacities and culture of the AA unit shows great promise. SLU will need to consider signals, reward/incentive systems, and other methods that truly show that societal outreach is a priority for continued growth and realization of that vision.

### Panel/ ResearchEconomics, Business and Management, and Statisticsfield

UoA

Business and management

#### Introduction

#### General assessment of the Unit of Assessment

Scientific quality: This UoA has made significant advances in their scientific excellence, research quality and quantity over the last five years in a very competitive environment. We were impressed by the strong scientific environment which encourages original research and internal collaboration (both within the UoA and within broader SLU). Two of the three units (Decision-making & Managerial Behavior and Rural Entrepreneurship) comprising 17 staff are functioning relatively well. The Food Value Chain department was absent of representation in the interview. The units are proposing to the Dean of the faculty the formation of a theme-based approach around value-chain networks to span over the entire department. The UoA has generated substantial increase in competitive external funding which appears to have leveled off somewhat in the past four years as the individuals reach a capacity threshold for research output as they strive to meet teaching demands. The three components in the UoA represent 75% of the teaching in the department. The teaching load is a significant strain on intellectual resources that are expected to produce more research output. The unit is is nevertheless publishing in highquality journals, working collaboratively, and demonstrating a good impact.

Social impact: The UoA has an extensive list of outreach activities. The outcomes indicate that there is some societal impact. A needs arising to contribute more strongly to the competitiveness of farmers and Swedish agriculture was identified. The UoA would likely benefit from a further refinements of its societal engagement strategy.

Collaboration: The UoA could be more proactive in communicating its findings in a popularised way. The increased use of novel communication tools, such as their blog or other social media, is recommendable. Emerged collaboration with KCF is a promising step towards this.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA is producing high-caliper original research, which influences the field of research, in a relatively broad area of business and management related to key agricultural and societal issues. This indicates a productive and impactful program. In one key area, they are investigating food choice and food labeling related to Swedish foods, with a significant number of publications in the journal Food Quality and Preference. Other key contributions included an enhanced understanding female entrepreneurship challenges and engaging youth in the entrepreneurial process. This UoA is using experimental methods to answer research questions; an approach that is not a prevailing one, but one in which they have gained success. Their desire to obtain equipment for a physiological experimental laboratory (which they have not as of yet been successful in obtaining) would position them still early in the competition for this emerging discipline of consumer behavior and decision-making. Bringing in Resource Economics and Business Economics to utilize these new resources would be a sound collaborative strategy for SLU.

The publication activity appears to have increased strongly in recent years (88 articles since 2009, of which 60 in the last four years). Articles have been published in a large number of journals, including high-impact factor journals such as Food Quality and Preference and 44% of them included international collaboration. Members of UoA also serve as editors in well-recognized journals in the field of applied economics. Other indications of high quality work are requests from Parliament and stakeholder groups for research presentations.

They are highly engaged at the international level, as highlighted through the ACCELLERATE program (a multinational stakeholder partnership). Papers have merited awards at international meetings. Establishing collaboration with the top groups in the field can be considered as a fruitful approach to strengthen theoretical basis for research. Interdisciplinary collaboration appears to have increased in the past years. Scientific approach of this UoA benefits from interdisciplinary work because their research is more applied than some of their peer units. A lot of international collaboration appears to be with developing countries.

#### Score for Scientific Quality

#### 5

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The scientific environment appears to be very strong and has only minor weaknesses. The environment encourages original research that substantially influences their research field. They appear to be diligently striving to maintain a creative, interactive and productive environment. For example, the RUR group regularly attends the ISBE Conference in the UK each fall where they have been rewarded three times with the best track paper. All members of the group strive to prepare an abstract for presentation, including the Ph.D. students, post-docs, and faculty. In order to prepare, they plan and engage in a retreat where they limit discussion on teaching and focus on writing. This three-day event focuses their energy on current and future research, engages the members of the UoA, and drives their common agenda. It appears to be a pivotal exercise in the focus and dramatically leverages their productivity by allowing the staff to focus only on science during the retreat. Most importantly, it virtually commands the attendance of all participants and keenly focuses attention on the individual and shared research agendas.

Total number of staff is 24, which includes two professors, two senior lecturers, three researchers and a post doc. One third of the staff are doctoral students. Overall, UoA has fairly balanced gender distribution, although professors are male and most staff below 40 years (including doctoral students and support staff) are female. According to the data provided, there is a relatively small number of experienced staff. A more meaningful benchmark might be across the whole of department or faculty.

The major collaboration between the three groups is related to the methodological background and to the business background. Cross-pollination within the UoA can be further strengthened.

UoA has invested in internationalization through recruitments (such as a guest professor) and expanded its expertise towards psychology. International mobility to UoA is highlighted, but researcher exchange to and from SLU to abroad could be strengthened.

Altogether, the UoA has a substantial proportion of grants and commissioned research with approximately 20% of total external funding from highly-competitive international grants. Self-assessment indicates a substantial increase in external funding, including success in H2020 funding, which is very competitive and requires scientific excellence. The UoA was not coordinating major international research projects. However, it has led international commissions during 2013-2017.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

Overall, there is a positive and supportive environment for post docs and Early Career researchers. Ambition regarding publication is a clear strength of the unit and supports the development of creative, intellectually vigorous and productive environment and promotes researcher careers. PhD students are encouraged to publish peer-reviewed articles and to be engaged in the unit's development. This can provide them with merits to advance in their career and teaches essential skills and academic culture. Offering tailored courses is also a merit that supports career paths.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The documentation shows some strong publications which contribute to the scientific debate substantially and are cited frequently, such as Lagerkvist and Hess (2011) article in the European Review of Agricultural Economics. The unit's academic network is broad and extends throughout Europe to Africa and North America. Geographical focus of projects of UoA is on one hand in Sweden and on the other hand in developing countries. Established international collaboration with the top groups in the field can be considered as a fruitful approach to strengthen theoretical basis for research and to support scientific excellence. Clearly, there has been great benefit from the appointment of Alistair Anderson as a guest professor. This is an idea that emerged after the previous KoN. Staff within the UoA are developing a wider profile. It might be useful to consider how the UoA can strategically manage the relationship with the internal and national stakeholders listed in 1.2d and 2.1a and what kind of skills and international and national networks are needed in the future. Co-supervisors of PhD projects being from other departments or universities encourages networking.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

Overall, the UOA has developed an exceptionally strong research path and excellent links across the university and the outlook is very positive. Their "bold and persistent" ambition drives them toward success through a high level of scientific leadership. Interdisciplinary work includes research on rural development; forest land; animal health; animal welfare; reproduction in fish; efficiency and sustainability of future animal food; farm business development; sustainable intensification of maize-cropping systems. Interdisciplinary collaboration appears to have increased in the past years. Scientific approach of this UoA benefits from interdisciplinary work because their research is more applied than some of their peer units. Successful examples on this collaboration were presented during the interview, for instance in the context of animal sciences and animal welfare. The unit is also linked with the future foods platform. Interdisciplinary research related to crop production farming seems not to be major focus area at present. As the unit carries out food-related research and would like to establish a behavioural studies laboratory, it may be relevant to consider closer interdisciplinary collaboration with food science in the future.

#### Score for Scientific Environment

6

#### 1.3 Strategy for Scientific Development

### 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The overall strategy for scientific development is very strong and viable. Given the size of the team the UoA has a well-articulated and ambitious strategy particularly for internal collaboration. The goal of scientific quality and peer-reviewed publications is realistic and it contributes to the excellence of UoA and to the renewal of UoA. Relevance of research depends on information needs of stakeholders and academics. With externally funded research, where stakeholders are engaged in planning the research, the needs can be expected to be met in the future.

The unit has presented five priority areas for future development:

1. Promoting further collaboration with other researchers within our area requires networking. As the group has a good track record, they can be ambitious in this respect and target towards establishing long-term strategic partnerships.

2. Promoting interdisciplinary collaborations especially within SLU is also an essential area. There is a lot of potential for internal (SLU) collaboration and that can provide complementary skills and infrastructure, some of which has already successfully realised during the evaluation period.

3. Recruiting and developing top talents within the UoA's area is highly essential for increasing excellence. PhD students are a natural way to develop talents.

4. Maintaining and increasing external funding is essential to develop the previous areas (recruitment, collaboration). Success in this respect requires networking and continuous development in the national and especially in the international arena.

5. Increasing interaction with society is also very relevant priority area, and has a lot of potential. Increasing science-to-society interaction, such as popularized writings, talks, social media, and collaboration with the industry is part of this.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The self-assessment does not state in detail how the UoA could develop state of the art and what output there would be. Possible direction presented include: The development of the bio-physiology/social science lab is an interesting future direction, which could expand the scope from economics towards biology/psychology etc. However, the resources could be strategically leveraged if other groups (e.g. Resource Economics and/or Business Economics) could be brought into collaboration.

The Food Value Chain appears to be a small team. The proposition to reorganize the Food Value Chain as a theme across groups would unify this UoA and approach a socially important area for which this group has great potential and expertise.

The Rural Entrepreneurship group is interested in pursuing empirically innovations in the context of both food and energy issues. The topic is societally interesting.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

Already for some time, the UoA has been on a trajectory progressing towards high-quality research related to individual decision-making relevant to SLU topics. The most important element is providing clearly articulated research leadership and providing the space, direction and resources to engage in meaningful research. This may mean that significant questions are being asked about the critical mass of the UOA and the research groups.

The main challenges include continuous development of current staff and recruitment of top talents. Additionally, the attractiveness of mid-career staff's position and their continued success requires access to external funding. To advance with state-of-the-art science and high-quality publications, the group needs to ensure that there is sufficient amount of expertise available in each of three research areas, and safeguard that all groups have an approach that is well-focused.

#### Score for Strategy for Scientific Development

5

#### 1.4 Additional comments

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

In terms of science, the UoA has shown positive development in recent years and has produced good research that has societal impact. The list of most important outreach activities is extensive and covers different types of activities and outputs. The UoA has started to carry out outreach to farmers, food industry and stakeholders working with farms and is running two blogs. A number of presentations have been given to stakeholders. The KCF, which is a needs-based initiative, has the potential to facilitate the adoption of research in Swedish agriculture. Collaboration with KCF has a high potential for societal engagement but it appears to have faced also some challenges, one of which is related to bridging scientific excellence and practical approaches.

In the context of rural development, there seems to be good engagement with rural development actors. Strengthening the links between research, training and outreach especially in the fields of (rural) business management, marketing and entrepreneurship could be one way to expand societal impact.

As the UoA covers both agriculture and other industries, the activities need to be tailored so that they are accessible to both agriculture and non-agriculture audiences. The field where the UoA is operating (business and management) itself is a field that can potentially benefit a large range of stakeholders. Hence, outreach activities likely require strategic partnership with different outreach platforms covering the food value chain and rural areas.

The field of research that is under the food value chain group seems to have less interaction with business stakeholders. However, this is a field which potentially could interest business stakeholders thinking about the development of their business strategies. The FVC appears to be under restructuring which may be beneficial for the future impact.

#### Score for Activities and Outputs

#### 2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

Outcomes are seen over longer period. Visibility with TV broadcasting has the potential for reaching large audiences and rural development project have potential for impact at large. Linking with the bread industry can lead to new business ideas which have an impact. The use of experimental approaches in research, which is one of strengths of UoA, and outputs based on that are not clearly highlighted here, although it may be implicitly included.

The outcomes indicate that there is some societal impact. Achieving an impact requires adoption of research results. As the group has the potential to provide results which are important to farmers, the adoption aspect should be considered as one of the priority areas for societal engagement. The group has identified needs arising from the farming sector to contribute to the competitiveness of farmers and Swedish agriculture.

There would be more potential to do targeted work that involves interaction with food value chain companies and developers of rural areas as well as to facilitate the dialogue between food producers and food consumers. Their role can be essential when adopting results.

The SLU should in general become better at supporting the researchers work to engage with society and pursue societal impact.

#### Score for Outcomes

#### 2.3 Impact strategy

#### 2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA's scientific excellence produces original research that substantially contributes to the field. However, realizing the potential of research impact might be strengthened by considering whether it is necessary to further refine the outreach strategy. The goals are realistic and plausible, and they are based on the core expertise of the UoA. The implementation of impact strategy would benefit from more clearly articulated discussion of what impact actually means for its stakeholder group (who, what, how, when to impact). Identification of the target groups for societal engagement should be specified and implementation of activities be planned ahead.

Most of the unit's work is applied. Policy-makers are well reached, but business aspect can be strengthened. The activities include several interactive modes of working (workshops etc.). UoA has recognised the need to support Swedish agricultural sector with knowledge. There is great potential to achieve this through contributing to the KCF platform.

The UoA could be more active in communicating its findings in a popularised way. The increased use of novel communication tools, such as their blog or other social media, is recommendable. Strengthening interaction with the public as well as with the farmers will add potential for greater impact.

It is mentioned that the staff in this UoA is heavily involved in teaching and is responsible for most of the courses in Business Studies at the Department, which may limit the generation of other outputs.

#### Score for Impact Strategy

2

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The group is highly interdisciplinary and has a rising track record. UoA has expertise in participatory methods which provides a background to interact with different stakeholders. Rural research is well-positioned to tackle societal challenges and seems to have interacted with e.g. municipal stakeholders. Food is an important issue from societal perspective and the sustainability of food production is a greatly debated issue in the society. The group has identified that there are possibilities and need to increase interactions with society in in issues related to food and food production and behaviours related to food choices.

#### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The UoA would likely benefit from a further refined, clearer vision about the societal impact. This includes further defining the stakeholders to work with, activities that would need to be prioritized and impacts that would need to be achieved in the first place and outreach activities that will be required to meet the goals. Scientific impact is achieved through high-quality, well-cited publications and editorial services in key academic journals. Scientific excellence is necessary to tackle with problems faced by business. Their challenge seems to be in how to translate this into information that directly benefits the business stakeholders. In this, the choice of appropriate partners to work with is a critical factor.

Panel/ ResearchEconomics, Business and Management, and Statisticsfield

UoA

Work Science and Business Economics

#### Introduction

#### General assessment of the Unit of Assessment

The strength of this UoA, distinguishing it from other UoAs in the economics, business, management and statistics cluster is the interest in and approach to collaboration with stakeholders in the industry. This ensure that the results are made available to industry as well as helping to ensure that the extension work creates impact. In one of the case studies an impact assessment showed that the research and engagement work had resulted in a reduction in injuries and fatal injuries in agriculture. The group therefore has shown that it has knowledge of the full process required for creating an impact and has carried out work that has created a great impact.

The group has a number of publications in appropriate journals for the work being undertaken, a few of the papers are well cited showing at least that there is an academic interest in their work. The group work in an area where there is a lot of scope for societal impact (as noted by the publications around work health and safety in agriculture) and appear to have good links into the industry to enact the findings of the research. The case study on Health and Safety demonstrates a clearly defined case of reducing in deaths and injuries. The case study around the purchase habits of consumer and climate show promise to enabling a change in behavior and it is good to see this linked into a good theoretical framework of Protection Motivation Theory. This is an area where collaboration is going to be important if the research is going to be translated into action and there appears to be some good links but this could be strengthened.

Considering the low number of staff, the group has quite a large number of focus areas. In addition the group has a very heavy teaching load. The time available for research is therefore limited. It may be worth considering reducing the number of research areas within the subgroup Business and Management thus allowing for greater depth and understanding in the research undertaken.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

This grouping of areas appears to be reasonably new and has much potential to grow in the research space. The overall quality of the work in some areas is defining and shaping their field (e.g. Nilsson, Kerstin;(2016).; "Interventions to reduce injuries among older workers in agriculture: A review of evaluated intervention projects"; WORK 55(2)) with other pieces of research providing significant insights for Sweden (e.g. Nilsson K; (2016).; "Parents' Attitudes to Risk and Injury to Children and Young People on Farms";PLoS ONE 11(6) and Lundqvist P, Alwall Svennefelt C;(2014).;"Swedish strategies for health and safety in agriculture: A coordinated multiagency approach.";WORK 49(1)).

Given the small team and heavy teaching load, the publication numbers are higher than what you would expect, noting in the work safety areas there has been an increase in the number of publications over the review period. A number of the papers have been published in industry appropriate journals which may reduce the wider circulation and research impact metrics of the research (i.e. Impact Factor of the Journal and citation record), however this is where you would expect these publication to appear as this is where their peers will be reading. The number of publications dropped over the period with a jump up in the last year of the review period. Overall 49 papers were published of which 39 are contained in web of science. About half (47%) of the papers are in the top 50% of papers referenced, however we are not sure about the usefulness of this when considering that for agricultural work safety there is a small group of journals internationally that is interested in and would publish this work. The breadth of work in the wider sense is narrowly focused on food and agricultural work safety, however within these two areas there is a reasonable breadth and thus from a depth perspective the opposite is true with a reasonable depth to the food work and agricultural work safety at a broader level. There are limited original ideas from a methodological perspective, however the work and issues they are addressing are influencing research in the field.

The team has undertaken some valuable work on these issues, improving our understanding and providing 'real world' solutions to some of the challenges faced. For example the meat guide has the potential to influence sustainable retailing. The opportunity for the two groups to increase research output and to continue to improve the quality of the research is present, although they need to continue to explore how they work as a team.

This is a very applied area and a range of methods are being used to explore the issues. There was some discussion of the use of leadership to enhance the studies, which is an exciting area to explore and think about, however this is not reflected in their current publication record.

The work health group has been involved in an international collaboration around dairy safety which has had a significant impact across the globe on working towards improving work safety in dairy farming and this is then reflected in the publications in this space. For example:

• Depurate D, Stallones L, Lunner Kolstrup C, Nonnenmann M, Pinzke S, Hagevoort G, Lundqvist P, Jakob M, Xiang H, Xue L, Jarvie P, McCurdy S, Reed S, Lower T; (2013).; "Work-Related Injuries and Fatalities on Dairy Farm Operations"; A Global Perspective; Journal of Agromedicine 18(3)

• Lindahl C, Lindahl C, Pinzke S, Keeling L, Lundqvist P;(2015).; "The Effect of Stress, Attitudes, and Behavior on Safety during Animal Handling in Swedish Dairy Farming

.";Journal of Agricultural Safety and Health 21(1)

• Lunner Kolstrup C, Ssali T;(2016).; "Awareness and Need for Knowledge of Health and Safety among Dairy Farmers Interviewed in Uganda"; Frontiers in Public Health 4

• Karttunen J, Rautiainen R, Lunner Kolstrup C;(2016).; "Occupational health and safety of Finnish dairy farmers using automatic milking system .";Frontiers in Public Health 4

We note with the score that while we gave a score of 4 this reflects the combined nature of the 2 groups and that if the work safety group was assessed on its own it would have scored higher.

#### Score for Scientific Quality

4

#### **1.2 Scientific Environment and Leadership**

# 1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

This grouping of the two areas appears to have come together in a positive and supportive environment which is willing to learn from each other and grow their respective fields. The links to stakeholders in the community who they are working with are bringing questions to the group to help with answering their 'real world' problems and this appears to positively influence the productivity of the group and intellectually in exploring the challeges around how they will address the issues identified.

There appears to be a larger group of females in this area which is reflected across all career level. At least a couple of the senior members sit on international committees and regularly attend international conferences and organise for international meetings and workshops to be held in Sweden, however it is not clear how this is reflected more widely within the department.

There is limited international people employed within the areas, but the international collaboration from the work safety group would be bringing new ideas and thoughts to at least the work safety space. The group has recently succeeded to initiate internationally funded research projects.

It is hoped with the development of the KCF that this will engage more in the social media space which will help to continue the 2-ways conversation between the researchers and the academics.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

There was an expectation within the UoA that young faculty make their own independent choices around their research areas. Except from offering training opportunities it is not clear what support is provided.

We would recommend the development of a program to support students and that there is strong links to international networks and people who are able to enhance the work of the UoA (for example a strategic visiting fellows program). We also note that while there has been a good number of PhD students graduate it appears that the number have not been consistent over time which reduces the ability for students to support each other and create their own networks of peers.

We also note due to the lack of middle level academics and one of the professors taking on higher responsibilities that the level of support for PhD students is not as strong as it could be. This may be mitigated to a certain extent with links to international / national collaborators.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

There is a growing network with the work safety area which appears to mainly focus on the US with an expanding network into Europe and to lesser extent New Zealand and Australia. It was good to see a number of workshops and conference meetings organised by the group. We also note the excellent engagement with a range of organisations in which this group is involved.

The KCF has the potential to increase collaboration with industry to address their research questions. We note that this model is a good example being explored by the rest of the SLU. This should reflect positively on the group and help ensure their growth and productivity.

We would encourage the market and marketing issues group and the business management group to explore collaborations both within the SLU as well as nationally and internationally as there are a number of groups across the globe who are interested in and working in this area.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

This research area has a significant multiple disciplinary group and also approach the issues in a multidisciplinary way. There is room for continuing to increase the multi-disciplinary nature of the work force. We encourage the groups to think strategically about the skills required and how these can be shared across the UoA as well as other UoAs.

Areas for consideration in the work safety area might include: agricultural engineers, health professionals including health communication experts, as well as strengthening the links with economists. In the food area the engagement with others can enhance their work for example an ethicist or anthropologist could add a significant new dimensions and strengthen their work in understanding links with people around food and sustainability.

We note that the setting up of KCF which will bring in a communication specialist and we hope that this may also include some research around how to communicate and how effective the communication is.

The leadership in the marketing and business management areas could be enhanced as reflected by the professor in this space taking on additional responsibilities.

#### Score for Scientific Environment

4.5

#### 1.3 Strategy for Scientific Development

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The scientific quality in the work safety side when compared to opportunity was very good (i.e. there are a small number of journals which accept this type of work and where they are published have reasonable impact factor) and could be ranked at a world leading level. The other parts of the team should be encouraged to continue working on increasing the quality of their work and also aim for journals of high ranking. The areas where they are working lead themselves to being published in some very high ranked journals as long as the quality is present.

For this group overall there is good opportunity for scientific renewal, it is predominately a younger group, however as the leadership ages it is not clear what the strategies are for bringing in new people or helping others to upgrade their positions. A clear strategy around this would add value. Ensuring some overlap between the changing of professor would help to ensure that the institutional memory around research methods / links to industry and international collaboration / areas of research continues to grow and not need to be reinvented.

It was interesting to us that the group did not talk about things like journal clubs, writing retreats, and links with international partners (visiting scholars) to help improve the research quality.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

This relatively new group has a good strategy about where they would like to see their research develop, exploring marketing and green marking will continue to be an important issue and they may also like to cross over around the marketing of health and safety which would be an interesting side issue and link with the work safety area. Consumer behavior around sustainable food consumption has a lot of value and good potential research, publication and societal engagement value, but requires coordinating collaboration opportunities with other socio-economic research groups of SLU. Exploring issues around sustainable management, entrepreneurship, strategy (which is a bit vague) and leadership are all good areas for research however the areas of entrepreneurship, strategy and leadership need greater elucidation around what areas they want to research. Linking this to work safety and also to sustainability would add value.

The group has developed some excellent collaboration with industry and society groups. It is not clear if these are individual-based or at an organizational level. Further work to solidify these linkages so that if people leave the partnerships will continue, is essential.

There is capacity to increase the research output as the more junior members mature. However, we noted the concern around teaching loads and this will need to be managed appropriately. They may also like to explore other journals in which to publish, especially those with a higher impact factor.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

Strategies to optimise the partnerships to address 'real world' problems is important however this takes time away from research to nurture and support networks which can then help to support and translate the research into actions. Increasing the size of the team as well as ensuring the development of the research will be important. Engagement with KCF will be essential for the success of this group as their research is very applied and they will need to ensure they are engaging with stakeholders and ensuring a 2-way conversation around the development of research will be instrumental in their success.

Developing a succession plan to replace the professors will be essential for the success of this UoA. Ensuring that they have a range of research from identifying issues, development and impact of policies, attitudes, outcomes of interventions, understanding of a range of views etc.

Leadership as a research area was also identified as a potential link between the 2 merged groups, however to date this is an untested area which has value but will need support and further development. This group also need to continue to evaluate its skill mix to make sure that it has a wide range of skills available to address all the issue they are wanting to explore.

Ensuring there is a continuous flow of PhDs and post docs in this area will be essential for its success.

#### Score for Strategy for Scientific Development

#### 5

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The merging of the two units has created a challenge for this UoA. The work safety group has undertaken some very good applied research and the impact of their research around reducing work related fatalities in agriculture has been a success that is the envy of the world. Their follow up international work around dairy safety is an excellent international collaborative group who are producing papers from a range of countries around the issue and developing potential strategies.

The horticultural group still has not performed as well as the work safety group, however the development of the KCF will allow both groups the opportunities to operationalise their research and engage with the stakeholders, who will hopefully bring some of the challenges they are facing back to the group. The knowledge and strategies used by the work safety group can be extended to the horticultural group to enhance their research activities.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

In terms of impact on society, the work of this UoA has in the last years been a success. They have listened carefully to the industry and found ways to pick up and do projects that are relevant and based on needs in the sector.

The creation of KCF is the result of a collaboration process with the industry, by answering criticism that SLU was not doing enough to support the agricultural sector when it was losing competitiveness.

To carry out a project with the aim of getting an impact of society it should include a number of steps.

a. Initiation/ identification together with stakeholders/ industry, i.e. what should we do? What need to be changed?

- b. Study
- c. Conclusions

d. Dissemination of results, spreading knowledge

e. Measures to create an impact, f.ex. changed decision making/ behaviour etc.

f. Impact assessment and if the outcome of (f) is not satisfactory go back to (d) and (e) and do something differently.

Looking at the large project on work safety it has all these stages, including the final assessment. The assessment shows that the extension work spreading the conclusions of the study has decreased injuries as well as fatal injuries. Therefore the potential of this work to create an impact on society has been realised.

The work on guidance to meat consumers has led to the creation of a meat guide (step e). However, in this case no impact assessment or follow up has been carried out (stage f). The guide is now managed and used by the WWF.

As the evaluators have a limited number of examples it is hard to say to what extent projects in general have been taken through all the stages of the impact process. However, the group clearly stated that its primary aim is to create an impact and showed that they have a strategy for achieving this aim.

There are always ways to further improve the outputs. One way could be to increase the use of social media and other electronic tools.

#### Score for Activities and Outputs

#### 2.5

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The impact of the work preventing injuries in Agriculture have a great impact on society by reducing both fatal and non-fatal injuries. To the impact on individual's lives, impact on families and communities in which they live & work and also provides great savings for society in reduced costs for injuries.

It is much harder to assess the impact on for example consumers' behavior from a meat guide as no impact assessment has been carried out.

A full assessment of outcomes would require a more thorough examination of projects than this evaluation admits.

A number of outcomes points to the work being known internationally and being highly respected: - The signing of a Memorandum of Understanding with South Korea.

- Invitation to speak in the Irish Parliament

- Peter Lundqvists appointment as chair of International Society for Agricultural Safety and health (the first chair not from N. Am)

#### Score for Outcomes

#### 2.5

#### 2.3 Impact strategy

# 2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The culture and attitude of the group was very positive. They clearly pointed out that creating an impact is their primary aim. As the present incentive system is primarily based on publications in top ranking journals this also expresses courage.

The creation of KCF in cooperation with industry and other stakeholders and the group's activities in terms of holding seminars, using teaching to spread knowledge and employing a communication officer shows that the group has a clear strategy and also the ability to realise its intentions of communicating back to stakeholders and wider society.

The work has also included arranging 10-15 seminars and workshops for farmers and extension people. Another strategy being undertaken is to include health and safety issues in Management and Leadership courses across the university, thus seeding in skills currently missing and increasing impact.

Given the limited number of researchers working with marketing & business issues, it may be advisable to reduce the number of focus areas. A smaller number of focus areas may enhance the possibilities of making a significant impact.

The work safety group has areas that are closer and that can give more opportunities for synergistic effects, with the exception of "the burden and cost of agricultural bureaucracy". An important subject but one that does not fit as closely under a common heading as the other work of this group.

The UoA has two clearly separate focus areas, marketing & business and work safety. It's difficult to judge whether it would be most beneficial to split or bridge them, although we note that they have a strategy to try and work together. As the areas are so different, the groups will need two competent leaders with deep knowledge of respective subjects to ensure the development of these research areas.

#### Score for Impact Strategy

3

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The group has a very positive approach to collaborating with society and has shown that it can realize its intentions to focus on impact. We have discussed a number of these issues previously.

We note that when looking at the outcomes in terms of the creation of KCF, this was the result of input from the industry, and the outcome of the agricultural health and safety project, it shows that the group knows fully what the collaboration process requires from start to end.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The group has already done a great deal as described in the previous sections.

In their impact strategy, which is already well on its way, they could define the impact process all the way from initiation to assessment, possibly leading to adjustment of extension activities. In applied work that aims to have an impact on society, it can be used already at the planning stage to make sure that all these stages are taken into the plan of the project. This was done excellently in the large Health and Safety project which can serve as a good example in bench marking for all projects done in collaboration with society and aiming for having an impact.

A long term strategy for impact on society must include having high research quality. This increases the status of the group and will increase both audience and response. The subgroup on marketing and business would benefit from further strengthening the quality of their own research as a tool to increase the impact of their extension work. This said, it may under present circumstances with few staff and a huge teaching load will be a challenging task. The group could benefit from recognition of the work done in terms of collaboration by getting support to strengthen some of its research quality.

The group has today quite a scattered portfolio of focus areas in its research in relation to the low number of staff. While keeping both subgroups, it may be worth exploring the benefits of focusing on a fewer number of focus areas thus facilitating greater depth and understanding of the issues studied.

Increasing the formalized linkages with policy makers would add value, this may be via a reference group which could include industry, policy and international players.

### Panel/ ResearchEconomics, Business and Management, and Statisticsfield

#### UoA

Forest Economics

#### Introduction

#### General assessment of the Unit of Assessment

Quality of Research: Questions are highly relevant from societal perspective, but with the small unit size and highly diverse areas of interest, it is difficult to reach high level of recognition scientifically. This may be also reflected in publishing dominantly in regular forestry journals, and resulting in overall modest publication record and no PhD degrees completed during the evaluation period. A new professor recruitment in forest economics, becoming effective in the fall 2018, and opportunities to gain synergies with Forest business administration researchers are avenues for Unit's renewal and development strategy.

Societal Impact: The group has, in spite of a period with a missing professorship and much teaching, been able to take on international network roles that has increased its potential for societal impact, in particular the EFINORD role. The overall outcome and the use of their potential has been average, but the outlooks are good given the recent development in the group and a fundamentally positive attitude to the challenge.

Capacity for collaboration: The level of international collaboration seems sufficient in terms of shared copublications. In terms of mobility and international outreach, EFINORD is perhaps the key factor in the UoA. Internally, it seems there are unused synergies between Resource economics group since research topics partially overlap and the units could benefit from collaborating more in terms of teaching at all levels.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The core area of research is forest economics and policy (including also forest and ecosystem management, the role of forests in climate change, private forest owner questions, conflict management, added with fish population modelling) with research staff of 5 persons. The unit is aiming at covering a wide disciplinary area and in both empirical and theoretical work when compared to the unit size. Computerized model of the forest sector in Sweden, forestry and reindeer husbandry and management of fish populations are mentioned as areas of scientific breakthroughs. These are highly relevant questions in sustainable use of natural resources, also visible in the aim of SLU strategy and show prominence for the future. Choice of methods is well justified and the methodological toolbox is up to date. Externally funded projects are few during the evaluation period, but show better promise in 2017.

The UoA consists of f persons and is also heavily involved in undergraduate teaching, being responsible for over 50 ects in forestry programme. They supervise annually about 10 Bachelor theses, but only 1-2 M.Sc. level theses. This heavy teaching load and the fragmentation of research topics within the relatively small group are likely underlying reasons for not reaching stronger productivity. In total, 13 scientific publications are listed in the bibliometric analysis and most of these are in regular forest and resource economics journals. The quantity and bibliometric impact is of modest size. The level of international influence and collaboration seems sufficient in terms of 38% international co-publications.

It is a challenge and an area in need of attention that no PhD degrees completed during the evaluation period, and currently only two ongoing PhD student projects are ongoing. This is a limiting factor for maintaining a progressive intellectual climate.

In the interview, it became evident that there will be added new key staff members, for example as an outcome of the recruitment of professor in forest economics. This will likely enhance academic leadership in this UoA. Combining this UoA with a group in Uppsala is ongoing since 1.1.2018, including a strongly established professor in forest business administration.

Overall the past performance has been of moderate quality, and we anticipate that the new people and volume will help them to develop performance.

#### Score for Scientific Quality

#### 3

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

There is diversity in gender, nationalities and age, but as mentioned above, there are challenges to secure productive environment due to high teaching load and lack of external funding until 2016. Managing a creative and productive environment has been a challenge for this Unit, one main reason being an unfilled professor position for several years and a situation in which a Researcher has had to step up and take a lead.

In terms of SAR, it has been difficult to secure competitive external funding, but in 2017 this improved considerably. Overall capacity for collaboration has been strengthened by the fact that one of the persons in the unit is leading the Northern Regional Office of EFI (EFINORD).

The degree of external influence through new international professor recruitment and combining forces with Forest business administration is not yet visible. International mobility is at a sufficient level (also due to Luke researchers visiting Umeå within EFINORD network).

The unit has been struggling because of unfilled positions and lack of luck in external funding, but has managed to get through a tough period, and now has landed new projects and new staff. Thus, overall management has been good in the face difficulties.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

Special attention is given to young researchers to build their teaching and other competencies by providing them a wide area of teaching tasks and supporting e.g. Swedish language lessons.

The group supported PhD students by supporting their visits abroad to stay with absolutely world leading economists and econometricians (Campbell and Hanley, both UK), that way bringing in valuable inputs.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

In Umeå region, some of the questions (like co-managing reindeer husbandry and forestry) are unique, and the involvement with policy makers and ENGOs (such as FSC) is a positive. Making more general impact on scientific debate is challenging with fragmented range of research topics and a high teaching load.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

There is good level of interdisciplinarity with both economics and policy in the core, and other disciplines relevant from ecological point of view. EFINORD brings added disciplinary value, as well as international networks and impact. Better use of connections and potential teaching synergies between Resource economics unit of the same Department should be pursued (in terms of doctoral training in particular).

#### Score for Scientific Environment

#### 4

#### 1.3 Strategy for Scientific Development

### 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

A lot of hope is put on the new professor recruitment in forest economics, which should become effective in the fall 2018. In addition, there are opportunities to gain synergies with Forest business administration researchers located in SLU Uppsala. This is a very novel development, but must be expected to influence the development strategy a lot compared to at the time of the SAR-writing.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

A lot of hope is put on the new professor recruitment and other staff additions, so a renewal in research directions will be dependent on the outcome of new people joining the UoA, in particular also the joining of the new business administration group.

The past strategy has been successful in terms of getting the unit through a difficult period, and with the new people coming in, the strategic outlooks are good.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

As mentioned, increasing productivity and making more serious impact on scientific debate has been challenging because of personnel shortage and heavy undergraduate teaching load, as witnessed limited activity in publishing in top-level journals and lack of PhDs completed. A new professor recruitment in forest economics will be vital in terms of adding more coherence in the Unit, as well as in doctoral supervision and also hopefully attracting higher volume of competitive project funding.

#### Score for Strategy for Scientific Development

#### 4

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

Combining researchers from Forest business administration will bring added challenges due to geographic distance, and since they have natural disciplinary synergies, also with the Business management and economics based UoAs located in Uppsala.

Building more effectively synergies together with the Resource economics group would seem to be a recommendable step; as they are also strong in terms of PhD education skills.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

In spite of the unit's size and the unfilled positions over the period, the unit has managed to engage in activities enhancing its network and societal impact potential. Taking on a role in the EFINORD initiative opens up channels through the European Forest Institute network for fast-track impacts at the EU policy level, through e.g. the ThinkForest policy conferences in the European Parliament. This represents an access and infrastructure of value to SLU at large. The Journal of Forest Economics remains also an asset raising the overall profile and impact in the international scientific community. In addition, the unit has been able to engage in other often international society impact activities at FAO and in the civil society.

The group is now expanding with the hiring of a new professor and a restructuring bringing in the forest business administration professor and group. This opens up for a stronger stakeholder engagement towards industry and business, which may be a strong match with e.g. the forest policy and modelling activities.

The group is to be commended for the initiatives undertaken in the period. The changes in and around the group have just discretely increased the potential societal impact, which is expected to grow in the future. We have in the panel decided to split up the grading scales in halves to allow for more variability and we consider 1.5 as average performance in this area.

#### Score for Activities and Outputs

1.5

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

As is the case for several of the units, the researchers are perhaps too modest here, and overlook parts of their impact. Simply because these things are not articulated. The UoA describes for example a case of research into conflicts between forestry and reindeer husbandry, which had an impact on the 2014 revision of the FSC standards for forest certification. Affecting such civic society and market-based certification schemes may have widespread impacts in the form of changed management practices.

However, if we look into the funding lists and the publications and other parts of the selfassessment we can identify the units work on forest economic models as an area of societal relevance, which has received interest from industry and others, e.g. for policy evaluation in relation to climate.

Likewise, several of the research project apply methodologically on approaches that involves stakeholder etc. in the research design, as research objects and as feedback mechanisms. While these may be directly limited and targeted groups, the interview revealed that the activities themselves has received publicity and a sense of ownership and interest for the projects and research already under the implementation phase. It is, if not a citizen science example, then a form of collaborative and involving research process typical for some fields of social science, which itself builds up ownership and prepares for greater societal impact, when research results start being fed back into the wider stakeholder and end-user community.

Again, the addition of the forest business administration to this group will open up further avenues of impact, both in the form of consumer studies and consumer involvement and value chain and industry relations. Thus, a promising potential awaits exploitation.

We have in the panel decided to split up the grading scales in halves to allow for more variability and we consider 1.5 as average performance in this area.

#### Score for Outcomes

1.5

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA impact strategy highlights the possible potentials of the EFINORD relation, which are certainly also of relevance and interest for the wider SLU forest research community in fact. If used intelligently and proactively not only by this unit, but by drawing in the surrounding forest research bio-economic network, this can open up stronger avenues for societal impact.

The unit strategy indicates that Swedish language could be an issue for SLU to be aware of when internationalization of academic staff and allocation of research support services are concerned. It is now common among other leading universities to offer support for new staff international staff members to learn the national language. This may enhance capacity for societal impact and in fact also recruitment as well as staff permanence and life quality.

While the unit has had a strategy much focused on the international policy arena (EFINORD, FAO etc.), the recent changes in the unit composition and staffing should open up resources to pursue a strategy targeting a wider group of stakeholders, cf. above. This, however, is not reflected well in the interview or the SAR.

In the interview, the group commented that they had hired a communication officer, but it was not clear if sufficient incentives and infrastructure is present. Such, however, should not be provided and implement at UoA level but at Department or Faculty level.

#### Score for Impact Strategy

#### 2

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

## 3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The self-assessment, their projects and their research reflects an ability for the involved researchers to interact with many types of stakeholders around their work and research, and also work in interdisciplinary teams around the research topic. The potential is there, the attitude is there, but the size and teaching work load of the group has hindered much impact.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The unit has suffered from a significant shortage of capacity, and this likely explains in part the limited number of collaborative experiences listed here. The new professorship may harness the group to increase its impact in research as well as in society, and the addition of the business administration group too. It will open up other avenues of impact.

Overall, we believe we have identified a need, not specific to this unit, but shared across many units, for better support and guidance from the SLU level, of what is targeted and how under societal impact. This calls for both incentives (not necessarily funding, but also simply recognition and praise) as well as infrastructures, e.g. society interface boards or similar to be established e.g. at Department level.
#### OVERVIEW OF RESEARCH FIELD

#### Research Field/Panel 14 - Forest Management

#### Introduction

SLU forestry is ranked number one in the world according to Centre for World University Ranking, in which the research component contributes significantly. Our assessment of the four Forest Management UoAs acknowledges this high international stature. However, in our evaluation we attempted to identify gaps in scientific quality and social impact. Below we summarize the strengths and weaknesses identified by the Forest Management panel.

Strengths	Weaknesses
Scientific strength is high	Unit-level strategies for future development
	needs to be stronger
Some units have good connections with forest	Inability to generate fully-funded professor
industry	positions and impacts on career paths for
	younger researchers
EMA (NFI, NILS, etc.) and experimental forests	Some critical fields are not covered by professor
provide excellent infrastructure and data for	position
research and teaching	
Campuses shared between SLU and other	More dialogue and engagement with
universities, e.g. Uppsala, Umeå	stakeholders needed
Research and teaching combined in UoAs	Limited incorporation of social science into
	research, e.g. economics
Diversity and cultural differences among units	Cooperation among UoAs and with other parts of
	SLU is weak
Long-term experiments and monitoring programs	Gender balance needs to be addressed
provide data for research	

#### **Future Potential**

- Export expertise through international expansion
- Potential for sharing data among disciplines; increased transdisciplinary research; incorporate social science into research
- Potential to be world-leading in new sectors, e.g. circular economy, climate change
- Futuring (systematic thinking about the future) of forest and forestry

#### **Collaboration between UoAs**

- Draw upon strengths of other people/organizations inside and outside of SLU to help meet objectives; coordinative capacity across SLU
- Collaboration currently is undeveloped; potential to incentivize?
- Use Future Forests as example and vehicle for increased collaboration
- Research infrastructure, e.g. EMA, experimental forests could be the basis for enhanced collaboration within and outside of SLU

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Panel/ Research field	Forest Management
UoA	Rural Development

#### Introduction

#### General assessment of the Unit of Assessment

The research undertaken by this UoA is applied and focused on issues of importance to governance and stakeholder's concerns. They are highly productive considering the small size and have leveraged their network of collaborators very effectively. The UoA has developed an extensive network of collaborators across the Baltic Region, eastern Europe and elsewhere. They have significant challenges in obtaining long-term funding, being separated from the rest of SLU, expanding their collaborator networks, and developing a succession plan for the long-term survival of the unit.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The Rural Development UoA engages in a broad array of research with numerous partners and a wide geographic focus. It has used external funding very effectively to develop many collaborations across the Baltic Sea region and elsewhere, and generate many publications, despite being a small and isolated research group. A particular strength of the group and its collaborators is a transdisciplinary approach that brings together biophysical science with social science in addressing real-world problems in sustainability and rural development. In addition, they have been very productive in publishing their work and engaging with high-profile international organizations (e.g. IPBES). Another strength is the level of engagement and participation of stakeholders in the research. However, the unit is spatially isolated and completely dependent on short-term funding and is therefore vulnerable to marginalization. The unit is made up of few staff and yet encompasses a broad range of topics which also increases its vulnerability. Overall the unit is productive but they do not publish sufficiently in high-profile journals. We see great opportunities for this UoA to develop collaboration with other SLU units, e.g. Alnarp.

#### Score for Scientific Quality

4

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

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The UoA leverages its extensive network of collaborators, its broad geographic reach and its transdisciplinatry approach to provide a creative and productive environment for young scholars. The staff gender balance is heavily skewed toward males in both senior and junior positions. International recruitment seems to be an area of focus, although the over all program is small so that the number of international researchers and students is low. The age of senior researchers is such that succession planning is critical to contiuned survival of the group, yet there is little evidence of such a plan.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

As in 1.2a, the unique aspects of the UoA program provides opportunities for young researchers that are seldom available in other programs. Opportunities for international research, extensive collaboration among other disciplines and other cultures and a wide variety of research problems with engaged stakeholders provide young researchers with a high-quality experience. However, lack of long-term funding may limit opportunities for young researchers in developing their careers.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA excels in developing extensive collaboration networks with research projects at national, regional and international scope which is impressive considering the small size of the unit. The group is well published and appears to be well-known in the area of forest landscape sustainability. The research is place-based and focused strongly on local communities, but it is not clear how far the results of the research extend beyond the local level. The broad scope is demanding for a small group and may dilute the impacts of their research.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The UoA places special emphasis on working in a transdisciplinary manner, integrating biophysical and social science and engaging with a variety of stakeholder groups. The small number of staff limits the depth of research. There appears to be some interaction with other UoAs at SLU, but it is important that this is increased to reduce the vulnerability of the UoA. There is great potential for greater interaction among UoAs.

#### Score for Scientific Environment

4

#### **1.3 Strategy for Scientific Development**

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The strategy is to continue building collaboration networks, engaging with stakeholders and addressing problem-solving research and collaborating both within and external to SLU. The key is to obtain funding and the UoA is well aware of the importance of this. Clearly the continued success and expansion of the UoA's work will be determined by how successful they are at obtaining funding, and they are realistic in recognizing this. They have had past success in obtaining funding and in building collaborative networks, but it is unclear how successful they will be in the future. The staff tends to be older and we did not see evidence of a strategy for recruiting younger researchers to ensure the continued existence of the unit.

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### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The UoA seems to have thought about the areas for future research that are innovative while aligning with the unit's strengths and past success. Given their past success in collaborative research and high productivity from a small unit, the ability to make significant contributions is high. Given the small staff size and predominance of older faculty, succession planning needs to be addressed. The need to constantly search for funding limits their ability to think and plan strategically.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

Small staff, lack of critical mass for long-term viability, aging senior researchers, reliance on external funding, need to identify new collaborators, lack of long-term funding, need to work outside of Sweden, physical and disciplinary isolation from other units at SLU, need to further develop and enhance their identity, i.e. Forest Landscape and Society so that they will be recognized within SLU.

#### Score for Strategy for Scientific Development

#### 3.5

#### 1.4 Additional comments

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

It's not clear why this unit exists as a separate unit instead of being more strongly integrated into the rest of SLU.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The focus of the UoA is applied problem-solving research dealing with real-world issues of importance to stakeholders. Societal impacts are the central concern of the unit's activities, at which they excel. However, the small staff reduces the impacts of the unit's research.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

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As above, the focus of the unit is on research applied to real-world issues of natural resource governance, supported by biophysical and social science research. Most of the unit's outcomes are local or regional in scope but have the potential for being national or international.

#### Score for Outcomes

#### 2

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The unit stresses research that provide both high-quality biophysical and social science and policy-relevant outcomes that can readily be translated into improved governance. Their impact strategy consists of continuing their commitment to place-based research related to sustainability and searching for funding to continue this work, i.e. a strategy for survival. They will need to develop a strategy for further cross-fertilization and collaboration with other related units of SLU while not losing their identity. This could promote stronger integration between natural and social science for the faculty as a whole.

#### Score for Impact Strategy

#### 1.5

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

Given that the unit's focus is on applied research and collaboration with stakeholders, and seeing the success they have had in this area, the unit's understanding of the collaboration process is outstanding.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

As long as funding is obtained, the unit will continue to focus on collaboration and engagement with stakeholders. Give their limited resources, the unit's ability to continue collaborative research is extremely impressive.

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Panel/ Research Forest Management field

#### UoA Forest Management

#### Introduction

#### General assessment of the Unit of Assessment

The quality of research is very high, societal impact is moderate, capacity for collaboration needs a concrete strategy and training. The UoA needs to strike a better balance between basic and applied research.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA carries out applied and basic research and many aspects of forest science and management ranging from regeneration through growth and harvesting. Important results have been published in the highestquality journals. The UoA compares itself with world-leading forest research programs in Europe and North America. The unit recognizes the need for research that will be relevant as the physical environment and national policy (e.g. bioeconomy) changes in the future. Although there are some groups within the UoA that undertake cutting edge research (e.g. FTIR applied to root research), overall the UoA's publication rate is comparable to the other units assessed by the Forest Management panel.

#### Score for Scientific Quality

#### 5

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The UoA recognizes the need to provide a welcoming environment for all staff and has several mechnisms in place to encourge interaction, both formally and informally. This also includes research-related interaction among staff and students. While the overall gender balance is not ideal, junior positions include a high proportion of females, so that the 'new generation' gender balance will be more appropriate. International recuitment is mentioned in terms of encouraging visiting scholars but is not listed as a high priority.

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## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA emphasizes interaction between senior staff and PhD students/junior researchers and has recruited several new junior researchers of whom more than half are female. Support is available for helping junior researchers to find new research directions.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA collaborates extensively within SLU, with some research incorporating both biophysical science and social science. The UoA led the 'Future Forests' program which is the largest forest research program ever in Sweden. Collaboration is central to many applied forest management research questions.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

As above, many complex forest science questions require interdisciplinarity and this UoA should expand their collaboration with other SLU units and external partners.

#### Score for Scientific Environment

5

#### **1.3 Strategy for Scientific Development**

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The main elements of the strategy are renewal of professorial Chairs, attracting young researchers and PhD students and increasing the involvement of researchers in teaching, and developing a more stable funding base for researchers. The funding issue is critical, but there is no discussion as to how that will be done.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

Future directions include 3 avenues: forest management with a lighter footprint; forest management for multiple ecosystem services; and the impacts of climate change and human activity on ecosystem processes. These will be accomplished based on process-based ecosystem research and the use of tools related to Big Data. This will require collaboration within and outside of SLU. There was little evidence of a strategy for defining emerging research issues, particularly with regard to social demands for forest management.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

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The main challenge is the reliance on external funding due to lack of SLU-based funding for staff salaries. This results in teachers with little research activity, and researchers doing little teaching. In addition, the UoA seems to have limited capacity to engage with social change occurring in the wider world.

#### Score for Strategy for Scientific Development

4

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

As with other UoAs, long-term stable funding is essential for success, and incorporation of social science is needed.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

Examples of societal impact include a new N fertilizer and rainforest restoration in Malaysia. The case studies include work validating forest management practices related to methyl mercury and new practices for riparian buffer management. They have also organized well-received extension courses on the use of prescribed burning for restoration. The panel would like to see more examples of applied research in collaboration with forest managers and society in general.

#### Score for Activities and Outputs

#### 2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

While there are some examples of research being applied to society's needs (see above), there seems to be little evidence of collaboration with forest managers in government or industry, or the broader society. The panel is aware of work done through the Future Forests initiative, but compared with other units, this UoA has had less interaction with forest managers and other stakeholders.

#### **Score for Outcomes**

2

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

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The UoA recognizes the need to provide science to underpin sustainable forest management, but does not provide a concrete strategy for improving that relationship. Recent hires may bring stronger relations between researchers and practitioners, as will several guest and adjunct professors. However, a specific strategy for societal impact is absent.

#### Score for Impact Strategy

1

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

Both case studies in Section 3 illustrate how collaboration and stakeholder engagement are required for successful collaboration with society. While the UoA seems to be well-placed to undertake these kinds of collaborative projects, the UoA does not adequately demonstrate the willingness, the skills nor a well thought out strategy for enabling and expanding these kinds of collaborations. These skills should be sought in new hires.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

More interaction with forest managers regarding problems that need to be solved. Stronger engagement with stakeholders and building trust so that long-term relationships can be developed. Training for staff in two-way communication skills and stakeholder collaboration. Interesting examples are the journalist hired by the Alnarp UoA, and the variety of collaborations developed by the Rural Development UoA.

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 Panel/ Research
 Forest Management

 field
 Forest Resource Management

#### Introduction

#### General assessment of the Unit of Assessment

The quality of research is high, with an emphasis on applied research of interest to stakeholders based on efforts to collaborate between social and natural science. Societal impacts are high and range widely across many stakeholders and a variety of topics (modeling, forest planning, EMA, etc.). Capacity for collaboration with society is high based on extensive interaction with stakeholders and learning from past experiences.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA demonstrates a strong mix of scientific research and applications to sustainable forest management. Research combines biophysical and social science which strengthens the applicability of the work. The range of research extends across modelling, EMA, human dimensions of forest management, development of advance sampling designs for EMA and advanced remote sensing. All of these areas are important to advancing the state of SFM. The UoA's research results are widely applied to SFM. The originality of the research is high, particularly in the areas of combining natural and social science, advanced remote sensing and the development and application of Heureka forest modeling system. The UoA compares itself to advanced forest management programs internationally, but there seems to be little mention of international collaboration. Challenges are similar to the other UoAs, in lack of long-term funding, ability to promote junior staff to senior positions. Need to also explore how national EMA responsibilities (NFI, NILS) support broader program goals and provide opportunities for further collaboration.

#### Score for Scientific Quality

5

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The UoA seems to have a well-developed strategy for each subject area with on-going follow-up. Funding has been allocated so that senior positions are recruited in each topic area. Staff development is available to enhance their ability to supervise PhD students. The UoA is involved in a variety of research networks in Sweden, the EU and internationally. The UoA promotes gender equality, as shown by the recruitment of female staff in Associate Senior Lecturer positions. There appears to be little international recruitment.

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## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA has created four new Associate Senior Lecturer positions. The UoA tries to employ new PhD students and supports post-docs to spend time working outside of Sweden. UoA encourages all staff to participate in short-term scientific exchanges, research networks and international conferences.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA research is widely applied in Sweden and comes out of involvement in many national and international research networks. Given their leadership in several topics important to SFM, it seems that they have some impact in the field's scientific debate, but it is not entirely clear from the self-assessment.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The UoA has a strong focus on interdisciplinarity in which both social and biophysical science are brought to research projects. An example is the use of the modeling platform Heureka as a nucleus for cooperation with researchers and practitioners. In addition, the wide range of research topics suggests that their work is applied across a broad range of SFM applications e.g., inventory, planning, EMA, forest operations, etc. The UoA could be more active in recruiting post-docs in order to create synergies through the use of their extensive datasets.

#### Score for Scientific Environment

#### 5

#### 1.3 Strategy for Scientific Development

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA's strategy is based on its strengths in existing areas complemented by seeking innovation in these areas through new technology, enhanced engagement with stakeholders, stronger integration of social and natural sciences, and building on its programs in EMA. The strategy is incremental and realistic because of its focus on building on existing strengths and seems to have captured many emerging issues related to forest management and sustainability. The UoA has the capacity for significant international leadership which should be developed. They should be supported to further increase their cooperation with other disciplines outside of SLU, e.g. computer science, big data analytics, artificial intelligence etc.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

As above, the UoA plans to build on its existing strengths and continuing to carry out applied research to strengthen SFM in Sweden. This will be based on applying new technology, and on strengthening the integration of social and natural science.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

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As with other units at SLU, this UoA requires stable long-term and flexible funding, further integration among research, education and EMA, more development of undergraduate education, stronger engagement with stakeholders and better dissemination of research results, and funding for positions rather than project-specific funding which will allow more flexibility for staff recruitment.

#### Score for Strategy for Scientific Development

5

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

It's not clear from the self assessment how much international engagement plays a role in the UoA's research strategy, this should be clarified.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA places strong emphasis on conducting applied research that is highly relevant to stakeholders. It's based on a combination of advanced technology, applied modeling and the integration of social and natural science. They appear to be highly productive and work with a wide variety of clients including forest industry, forest owners, Sami villages and government (the EMA program). The UoA could undertake work to expand the use of their tools (e.g. Heureka) in other countries and regions.

#### Score for Activities and Outputs

3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The UoA has a strong commitment to applied research and engagement with stakeholders. They have thought through how this can be continued and expanded with new technology and the integration of social and natural science. The first two case studies provide examples of how the UoA's research has been taken up by a number of agencies and companies. However, it's not clear that these are societal impacts rather than impacts for the specific clients (Swedish government, IPCC). The third case study is a good example in showing the dissemination and use of the lidar-based forest data by a wide range of organizations and individuals.

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#### Score for Outcomes

3

#### 2.3 Impact strategy

# 2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA has a well thought out strategy in undertaking research relevant to society's needs. The combination of SLU research and the UoA's responsibility for EMA is particularly useful in this regard, as is the wide range of topics under active research. As will other UoAs, a challenge in delivering this societal impact is lack of long-term stable and flexible to support senior researchers and professors, and to promote junior researchers to senior positions.

#### Score for Impact Strategy

3

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA appears to have a very comprehensive understanding of how to establish collaboration with members of society. Factors such as trust, communication, mutual understanding, frequent dialogue and needs assessment among partners are all identified in the assessment or the case studies. It appears that the understanding of collaboration is strong, and the UoA has identified areas where they can improve.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The UoA has identified the important factors as indicate above: trust, communication, etc.

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Panel/ Research Forest Management field

UoA

Southern Swedish Forest Research Centre

#### Introduction

#### General assessment of the Unit of Assessment

The UoA's quality of research is high, particularly in the area of applied research and its use in SFM. The unit focuses its research on issues relevant to southern Sweden. Given the mandate for applied research and stakeholder engagement, the societal impact and capacity for collaboration are high. The panel would like to see a more specific strategy for improving societal impacts and a more forward-looking and strategic research agenda.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA pursues research on a broad range of topics with a strong emphasis on applied research in collaboration with stakeholders. Given the small staff, the productivity and impact is high. Prominence is high in some areas (e.g. pathology, silviculture) and recognized in others. Challenges include lack of long-term stable funding, mandate to do applied research and limited staff. The UoA is working to address these concerns. The panel would like to see a strategy for improving societal impacts and a more forward-looking and strategic research agenda, e.g. collaboration with the Rural Development UoA.

#### Score for Scientific Quality

4

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The UoA leads the BECFOR program within SLU and the FRAS research program. They provide mentorship for female researchers to assist in career development. Excursions, seminars, journal club and other activities promotes staff interaction, and the unit actively participates in international research networks which provide additional opportunities to researchers. However, the research staff is largely male.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA provides career mentorship, writing workshops, funds participation in exchange programs and meetings within SLU, and support international students. They strongly support PhD students by encouraging publications, lead a research school and a wide range of PhD courses in areas external to forestry, e.g. statistics with R, philosophy of science, etc. The unit provides a data analysis consultant to assist students.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The unit's collaborations include extensive interactions with other SLU units, leads a Horizon2020 project with several partners. Collaborations extend across Sweden, the EU and internationally.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The UoA has a strong applied science mandate and frequently engages with stakeholders. Research based on this approach requires interdisciplinarity, in particular the integration of social and natural science.

#### Score for Scientific Environment

5

#### 1.3 Strategy for Scientific Development

### 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The unit's focus for further scientific quality and renewal is on addressing society's increasingly diverse values that are desired from forest landscapes, and how this may be affected by climate change. They intend to strive for an open and collegial working environment with higher levels of funding, more publications, balancing their gender profile and funding more PhD students and post-docs. They mostly address what they want to accomplish but leave some uncertainty as to how they will do this. A concrete strategy is required.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The unit's future direction will focus on multi-functional forests, climate change and the diverse values on these landscapes. Research will include work on forests' role in the bioeconomy, mixed species forests and continuous cover management. Also important is investigating new species for climate change adaptation, continued work on forest pathology, and research on future fire risk under climate change. The degree to which social science will play a role in the unit's future research is not clear.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The UoA sees challenges in the unclear career paths at SLU, lack of stable long-term funding, and loss of researchers to high-paying positions in industry. The unit needs to develop a strategy for maintaining a balance between basic and applied science, given the pressure to publish in high ranked journals. They also need to address how to integrate international staff into the Swedish forest sector.

#### Score for Strategy for Scientific Development

4.5

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

Long-term funding is a common issue across all UoAs. It is unclear how difficult this will be to address, but it seems like the most pressing issue among all of those identified by the units.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA is taking many steps to achieve a higher social impact. This includes the EUROFORESTER program, staff dedicated to extension work, hiring a media specialist, and partnerships between SLU-Alnarp and the southern Sweden forest community which includes a wide range of organizations and various levels of government. Also important are the FRAS program (industry-based), and an outreach program focused on issues related to game animals and forestry. Another example is the set of long-term field experiments that are used for outreach and communication (e.g. field excursions).

#### Score for Activities and Outputs

3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The unit has a strong mandate to carry out applied research, and the self-assessment provides much documentation of their success with this across a wide range of both research topics and stakeholders. SLU could explore opportunities for adopting similar approaches for northern Sweden. The outcome of the EUROFORESTER program is impressive in its ability to create a large cadre of well-trained foresters who deliver SFM in numerous countries.

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#### Score for Outcomes

198

#### 3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The strategic goals are based on further work in silviculture, multi-function forests and continuous cover management, managing forest pathogens, climate change adaptation, use of dendrochronology for climate projections, and work on society's needs from the forest. All of this work is supported by a robust outreach agenda.

#### Score for Impact Strategy

2.5

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA has a long history of collaborating with many different members of the forestry community, e.g. municipalities, small forest owners, forest companies, Swedish Forest Agency, NGOs and others. This demonstrates that the unit very well understands collaboration and how to make it successful.

3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

As indicated in the assessment, the unit suggests that communication, especially with environmental NGOs could be improved.

#### Panel 15 - Molecular Science; Biomaterials and Technology

#### **General Overview of the Research Field and Recommendation**

The panel was impressed by the overall scope, quality and impact of the material and teams evaluated. The panel was in full consensus regarding the following:

1) The research field of "Molecular Sciences, Biomaterials and Technology" contains a wide portfolio of activities, with pockets of excellence in basic and applied sciences. Overall, the topics assessed by the panel lacked coherence. Hence, it is very challenging to find a unifying identity of vision or topic spanning both basic and applied research. For example, there was little common ground between the group performing applied research on forest machinery in northern Sweden and the very basic research group in chemistry in Ultuna situated in Uppsala.

2) The level of infrastructure provided by the university is impressive and the potential for collaboration within the new structures is enormous but unexplored.

The SLU has created a dynamic and diverse working environment, however we noticed following areas of improvement:

#### **Regarding Quality of Research**

- We identified a general lack of strategic thinking and planning for how to become world leading in respective research areas.
- The research areas within many units are not coherent and could benefit from a greater degree of integration.
- Most units showed a lack of ambition to publish in high impact journals resulting a lower visibility.

#### Societal Impact

- Few units showed, despite a great collaboration with industry, neither deeper strategies nor action plans for how to reach societal impact.
- The outcomes could be improved by better true multi and cross-disciplinary collaborations project, making a higher impact on society.

#### Capacity for collaboration with Society

• Most units have a great capacity for collaboration with society, however this capacity is not exploited to its full potential.

#### Recommendation

• SLU management could ensure that their research and innovation services are used effectively to encourage the research groups to take lead in large international collaborations (e. g. EU-financed programs). Preferably in collaborations that are cross-disciplinary i.e. include economists and social scientists

- An award for students and or postdocs with the best social impact achievements.
- Use the Future Food platform to clarify the overall SLU strategy for future research and societal impact within food-related science.
- A similar approach should be used to clarify the overall SLU strategy for future research and societal impact within biomaterial-related science (non-food)
- University should clarify its strategy for Wood Science and its leadership
- University should clarify its strategy for Microbiology and its leadership
- A more proactive strategy on translation and dissemination would improve the outcome and societal impact.
- Introduce incentives for proper succession planning that not only guarantee a critical mass but also retain built up knowledge from leaving seniors.

Finally, we recognise the challenges faced by the Units that were evaluated by the panel. However, we consider that the problems that we have identified are tractable (i.e. not insurmountable) and can be solved by better guidance and incentives.

We appreciate that University has conducted this external review and we recommend that this excellent initiative is quickly followed by formation of an international advisory group that meets annually to keep track of progress and ensure that the issues are resolved in the highlighted areas.

Panel/ ResearchMolecular Sciences, Biomaterials, and Technologyfield

UoA

Forest biomaterials and technology

#### Introduction

#### General assessment of the Unit of Assessment

The Forest Biomaterials and Biotechnology unit performs excellent research in collaboration with industry and has a strategic location close to some world leading manufacturers of forest machines that can be further explored.

The panel has found the UoA needs to improve its proactivity in planning its work and develop its shared vision, goals and strategies for its scientific development.

It also needs a better proactivity in choosing and organizing collaborations in direction of their vision and goals. The panel asked the question whether the group knows the value of having them as partner?

The panel reflects that the groups close location nearby some of the world leading manufacturers of forest machinery is a real asset.

The panel suggest that SLU should encourage the group to have an internal process to develop their vision, goals, strategies with an ambition to be more international recognized.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA has a strong position in applied research and the panel encourages its scientific leaders to publish in more recognized scientific journals, and to develop a more clear publication strategy.

The group is encouraged to focus on some area of expertise e.g. small forest machines and biomaterial harvesting and wood material deconstruction.

#### Score for Scientific Quality

#### 3.5

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The UoA is working actively to find new interesting project to the group and to develop their Scientific environment and leadership.

The panel finds that gender balance within the UoA could be improved.

The group can work more actively with international mobility and get influence from other groups, also working with physical deconstruction of biomass and machinery development. Maybe some exchange focusing on experts in other sectors, as e.g. agriculture, food industry, mining machinery, etc., could become fruitful?

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA has high ambitions in helping young faculty members to develop. However senior staff needs to help them with strategies and plans for choosing publications and taking scientific leadership.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The geographical scope is mostly regional, but being placed in a region with world leading industry is a real strength.

They need to plan for how they with their geographic strength and their strong collaboration with industry can take themselves into the international scientific debate in their research areas of e.g. small forest machinery and physical biomass deconstruction.

The panel recommends the UoA to put more effort in expanding their academic networks internationally.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The UoA shows great skills in collaboration and works closely with other universities in the northern region in Sweden. They are passionate about their projects and collaborations.

The panel suggests the UoA to develop a vision, goals and strategy for their scientific development, which could lead to a more active dialogue with other research groups both within SLU and with research groups in other universities.

#### Score for Scientific Environment

2.5

#### 1.3 Strategy for Scientific Development

#### 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA is active in developing a strategy for scientific development. It shows understanding of the problem and is aware of its current lack of this strategy.

The panel strongly recommends the UaA to develop a strategy including vision, goals, plans for publications and a process to get the whole group to get a shared vision of scientific development.

#### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The strong networks and collaboration with industry and surrounding universities provides a good potential for developing fruitful plans for future research directions.

Questions regarding efficient harvesting and logistic of biomass are internationally important in the development of a bio-based economy.

The UoA needs to realize its potential in a future bio-economy and develop a plan for directions of future research.

#### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The UoA needs a plan for a scientific strategy, and it is aware of the lack of that today. The unit has a strong local position and it is actively interacting with industry. The UoA can be even more successful by developing and executing their plan for scientific development.

#### Score for Strategy for Scientific Development

#### 2

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The panel points out that it is important that the UoA takes its responsibility for developing a scientific plans for the UoA by themselves. That will take time and efforts and it is important for SLU to encourage this process. Done properly it can be a success.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA performs their activities in a excellent way, in large and impressive networks with other universities and close to industry.

The panel reflects that maybe the UoA is not aware of their full value for its networks and may play a more leading role in the projects. Properly done it can give them a stronger financial situation. That may give the group more time to execute other parts, scientific and international outreach for example.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The UoA's strong skills in collaboration seem to lead to good outcomes.

The outcomes might be even better with a more ambitious plan for how to get the ideas and results more spread within international networks, especially discussing broader questions regarding bio-economy.

#### Score for Outcomes

#### 2

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA have strong impact in the pellets industry and small forest machinery industry.

The group may even gain larger impact, with a more developed strategy for how to get into a more active dialogue with society, on broader bio-economy issues, regarding e.g. logistics and supply chains of biomass.

#### Score for Impact Strategy

#### 2

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA shows excellent collaboration skills, especially at the regional level, and there is a great potential for the unit to collaborate with society on an international level.

The group might profit from greater awareness of that its areas of expertise can be valuable for wider networks and open up for new kind of dialogues on bio-economy related questions, of interest for the developing society.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The panel recommends the unit to orient itself towards taking a more active part in international discussion and debate within their areas of expertise. The panel recommends the UoA to develop a plan to collaborate more with actors outside academia and to contribute more with their knowledge. Panel/ ResearchMolecular Sciences, Biomaterials, and Technologyfield

#### UoA Biosystems Engineering

#### Introduction

#### General assessment of the Unit of Assessment

This UoA contributes significantly to the development of sustainable rural systems and to the future utilization of natural resources. Special focus is on studying and assessing food, bioenergy and nutrient recycling systems.

The panel recognizes the importance of the work undertaken by the UoA and the high quality of the outputs. The UoA has been successful in attracting competitive funding from national and international sources as well as funding from regional sources. The range of output including patents and publications is appropriate to the number of staff in the unit. The general working environment within the UoA is of a very high standard and inclusive of all levels of activity, the PhD students and junior staff in particular taking an active part in activities and decisions.

The panel evaluates the activities being started up within sensor technology, real time data analysis and open data utilization to be both insightful and of great importance for future system studies. This will provide possibilities to develop both research methodology and areas of the UoA as well as of others.

The panel recognizes that this UoA offers a high level of support to other UoAs in providing statistical expertise and essential underpinning analytical capability. The panel recommends that the UoA continues to identify important research questions and possibilities, especially where its expertise in system analysis and statistics may be combined with competence of other subject area groups.

The panel recognizes the activities being started up within e.g. sensor technology, real time data collection and open data utilization, and that it shows insight and understanding of the technologies great importance for future system studies. However, with research and expertise within this area being developed by other research groups at SLU, the necessity of creating a specific group for this within the UoA may be questioned.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

A major goal for the research of this UoA is to contribute to the development of sustainable food and energy systems based on rural resources. Special focus is on studying and assessing food, bioenergy and nutrient recycling systems.

The UoA has a number of research groups working in a very broad range of subjects; statistics, systems analysis and geoinformatics, energy systems and bioenergy, environmental systems analysis of biomaterials and energy, environmental system analysis of food chains, environmental engineering and closed loop systems, and logistics and transport systems.

The combination of in-depth disciplinary competence in biometry, system analysis and technology with strong applied expertise in systems directed towards food, bioenergy and the environment is successful. Within this UoA there are a couple of such research groups.

The scientific productivity is good. The panel notes that there are as many as three authored books. International collaboration is however fairly low. The number of awarded PhD degrees and Licentiate degrees has been high. Considering external funding, the UoA has been successful in attracting competitive funding from national and international sources, but also funding from more regional sources. Researchers at the UoA have received a couple of major awards and prices – among them a silver medal and an honorary doctorship.

The panel recommends that the UoA continues to identify important research questions and possibilities, especially where the units expertise in system analysis and statistics may be combined with competence of different subject area groups. The panel furthermore encourage the UoA to increase the level of international collaboration.

#### Score for Scientific Quality

4.5

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The UoA is promoting an open and non-hierarchical working environment with mutual respect for the different scientific cultures. A "just and fair" system for allocating resources in the department is an important tool for maintaining a productive scientific environment.

The panel recommends that the unit focuses on maintaining the positive working environment and increases the number of external (international) recruitments in the future.

The panel recognizes that possible obstacles may arise in the future with regard to promotions and budget restrictions on the university level.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA has a strong focus on the importance of the quality of the PhD education and involves the junior faculty in research projects, supervisory groups and teaching networks. The young researchers are encouraged to participate in higher education teacher courses.

The panel recommends that the UoA maintains its strong focus on the PhD education and supports junior researchers.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

This UoA has very good national collaborations but the international collaborations are currently restricted to a limited number of groups. The panel recommends that the UoA extends its network of international activities across all groups.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

There is already a high level of interdisciplinarity within this large UoA. With high competence in system analysis and statistics there are surely further synergies to exploit. The panel recommends that the UoA takes the time to plan further interdisciplinary work and prioritize this activity.

#### Score for Scientific Environment

4.5

#### **1.3 Strategy for Scientific Development**

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The recent recruitment of a researcher in sensor technology is both insightful and important. It is a realistic strategic move forward for the UoA and provides strong support for other activities all over SLU. Large amounts of data are collected in activities related to the society of today but the analysis of these data still lag behind. The panel recognizes that developing skills in this field will provide enlarged possibilities to contribute. The UoA will require more resources with which to develop skills to exploit the future potential of sensor technology in agricultural research. This subject will offer many challenging topics for future PhD students.

The panel recommends that the UoA follows its plans to strengthen the links to national and international research partners.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

Recently the UoA developed a strategic plan for the next five years. The plans for future research directions are comprehensive and relevant. The UoA has potential to contribute to a wide range of fields.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The panel recognizes that it is difficult to recruit staff with the required competence because the competition for suitably qualified researchers is high. The UoA must be provided with the resources to be able to recruit skilled individuals at all levels. Therefore, a long-term stable funding stream from the university should be in place. Moreover, the UoA should continue to apply to external grant organisations to ensure the necessary support for further successful scientific development in the long run.

#### Score for Strategy for Scientific Development

3

#### **1.4 Additional comments**

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The UoA has a teaching responsibility, which is comparatively high from a SLU perspective. Teaching takes a lot of time and this might to some extent account for the slightly lower scientific productivity. However, a clear advantage of the teaching is the possibility to recruit skilled PhD students and degree projects students from relevant educational programs. The panel considers the co-operation with Uppsala University within technology related educations to be of great importance.

The unit provides statistical consulting services to researchers and PhD students all over the Ultuna campus, which takes a great deal of time. Again, this provides the possibility of future scientific collaboration and publication opportunities, originating from statistical issues in the consulting service.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

All research groups within the UoA present activities and outputs of high relevance for their respective stakeholders. The panel recognizes the contribution of this UoA to a number of important societal impact activities such as the Meat Guide, the Peepoo toilet and the SMART logistics system. The Meat Guide resulted in the receipt of a well-known award in recognition of this activity. In addition, the UoA has achieved one awarded patent and spin-off companies, as well as publications and other outputs that benefit society.

The panel notes that the UoA is very considerate of the undergraduate community and includes their undergraduate students in activities viewing them as important stakeholders.

#### Score for Activities and Outputs

#### 2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The innovative way of performing demanding system analysis gives this UoA societal impact of present as well as future activities.

The UoA has a large number of valuable outcomes for society. For example, the Meat Guide has had an influence on society. The panel recognizes the contributions to the governmental initiative "Fossil Free Gotland".

The case studies presented are all of high relevance for society with underpinning research of high quality.

The panel recognizes the efforts of this UoA with regard to societal outcomes and recommends that they continue in this excellent effort. However, a more structured strategy for future activities might be developed.

#### **Score for Outcomes**

2.5

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The panel recognizes that the focus of this UoA is on basic and applied science but the unit needs to improve general media skills so that the researchers realize their full potential for societal impact.

The UoA needs to develop a better plan for future strategic goals for societal impact. Better incentives and measures need to be in place to ensure a successful implementation of the strategy to reach society and to maximize good.

#### Score for Impact Strategy

2

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA shows a fruitful approach for collaboration with society. This is well developed according to the selfassessment. The panel finds that the UoA has demonstrated its competence in this area. The UoA has a sound and successful range of activities that demonstrate the strong transfer of information to society.

The panel was impressed by the UoAs understanding of the requirements of collaborative process. Moreover, the panel fully supports the efforts of the UoA to involve all levels of staff and students in their societal impact activities. The UoA fully understands the importance of dialogue and communication in its interactions with society.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The panel recommends that the UoA maintains this high level of interaction with society. They should however explore all avenues to develop their capacity for collaboration with actors outside academia.

Panel/ Research Molecular Sciences, Biomaterials, and Technology

UoA

field

Food Science

#### Introduction

#### General assessment of the Unit of Assessment

The overall goal for the UoA is to be one of the leading global players in the field of tasty, functional, healthy and sustainable food being more a vision than an immediate goal. The UoA addresses international and national goals in their strategy and future directions. They have active interactions with society as well as with a number of national stakeholders in all sectors. The panel recognizes the impact of this UoA as well as several other UoAs, which highlights the importance of food science as a key research topic for SLU.

With this in mind, the panel concludes that a clear overall strategy for food science at SLU is required. The link between the UoA and the Future Food platform should be sorted out.

The panel finds the quality of research at the UoA to be acceptable but can be improved. The number of scientific publications is only partly sufficient and the UoA is encouraged to have a focus on high impact journals.

Collaboration with national stakeholders in the field should be enhanced and the scientific leadership needs to be improved.

The societal impact of the research should be clearly seen.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA has changed their research focus from chemical composition and raw materials to a broader view, with the ambition of covering the whole food chain, as well as linking to human health. While the scope of this change is in line with both national and international goals, the UoA lacks a good understanding of the current scientific state of the art and global trends. Moreover, the UoA is too small to fulfil its ambition to cover such a broad scientific area. The vacant position for a professor (since 2012) has had a negative impact on the performance of the UoA.

The research seems to be fragmented and should benefit from better integration.

The merge of departments seems to have positive effects, but there is need to further improve the infrastructure and research capacity, especially with regard to a better understanding of mechanisms related to functional properties.

Scientific productivity surely could be improved, especially taking the relative high number of professors into account.

The link between food science and human nutrition should be enhanced.

It is not clear whether the UoA utilizes the technological infrastructure offered by SLU to its full potential.

#### Score for Scientific Quality

#### 4

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

How the UoA is capable of maintaining vigorous and productive environment is hardly seen. The activities at the UoA were presented rather unbalanced, mostly focusing on few specific activities.

The UoA has a good age balance, but an overrepresentation of females.

Grant incomes come from different sources, but seem to be for shorter periods and relatively low amounts.

International collaborations need to be increased to improve the visibility of the UoA outside Sweden.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA has a large number of PhD students and seems to have a good research environment. Workshops on how to write research proposals are highly acknowledged by the panel. The UoA actively engages with other groups and departments. However, their role and strategy within the Future Food platform is not visible and a clear strategy is missing.

Students take active part in research schools, both at national and international levels.

Many PhD students interact directly or indirectly with the industrial sector. However, the strong interaction of the unit with industry may influence future directions of research.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA has collaborative research activities in the industrial sector within Sweden. The UoA is part of GroGrund and the SLU platform Future Food. The UoA should be more proactive in initiating these interactions and might additionally need support from the SLU leadership.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The UoA has a long tradition of collaboration with other groups in Uppsala, both within the Department of Molecular Sciences and with other departments.

The UoA should strive for deeper interactions with the UoA in Alnarp dealing with plant product quality.

Plant derived alternatives to meat based product is an area where several alliances within SLU can be established.

Collaboration with researchers in the nutritional field is required.

With this in mind, the panel finds that Food Science could be strengthened as a general discipline across SLU.

#### Score for Scientific Environment

3

#### **1.3 Strategy for Scientific Development**

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

At the strategic level there is a lack of coherence within the UoA. Innovative ideas exist within e.g. climatesmart proteins.

The scientific quality could benefit from the establishment of a clearer link to human nutrition.

Innovation and identification of "out-of-the-box" ideas could be enhanced.

The UoA could increas its international collaborations, particularly in leading large research projects. Furthermore, the panel recommends that the UoA formulates a strategy on how to enhance its profile and uniqueness in the overall European food framework.

Participation in major European food programs will be beneficial.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The UoA has a large spectrum of activities. However, there is no clear strategy in place for the future evolution of these activities. Integration with the National Food Strategy is important for the future activities.

The UoA is recommended to take a more active role in Food Science Sweden (academia - national), the Sweden Food Arena (Swedish food industries) and start new international collaborations.

A stronger impact on the UN sustainable development goals could be made.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

Food Science is a highly important area for the future. SLU has a significant potential to build a strong profile within this area. The Future food platform can be used to strengthen food science and to define a clear strategy. The panel suggest support from the SLU management in this aspect.

A clear vision for food science at SLU is required.

To some extent the UoA seems to lack a general understanding of the political awareness and priorities within food science in Sweden and beyond.

#### Score for Strategy for Scientific Development

3

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The UoA needs to identify ways to interact effectively with the Future Food platform and the new Swedish Food Association. This will be important for future strategic directions within food science.

The UoA points to a lack of consensus regarding the definition of the subject "Food Science" at the SLU level. This can be an obstacle for further development of the UoA and SLU needs to address this issue. It appears to the panel that the establishment of the Future Food platform is not enough to overcome this problem.

Research linked to value addition along the food chain should be considered for the benefit of the industrial sector.

The link between food science and research within animals, plants, microbiology etc. should be strengthened, thereby providing SLU with a unique applied profile within the area of food science.

Molecular structures of food and their changes during food processing as well as impact on human health could be a research area that will fit the unique competences of the UoA.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA has a high level of industrial contacts and several PhD students working with the industrial sector. Several extension activities are underway including science festivals, popular magazines etc. Training for students/scientists in popular communication is a very good initiative. However, it is clear that the UoA could benefit from a stronger link to relevant stakeholders including governmental institutions as well as NGOs.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The UoA could benefit from increasing their visibility further in society, as well as internally in SLU.

It is recommended that the UoA strongly enhance its international visibility e.g. by writing review papers and oral presentations at international conferences.

The panel also recommends that all articles in popular journals as well as other communications are registered in the library system. This will ensure that all types of publications and outputs will be visible and ranked for future evaluations.

#### Score for Outcomes

2

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The food sector is of high interest for the public and to society. The UoA needs to develop a more clear strategy in order to reach a real societal impact.

The UoA should find ways to increase the international visibility, which currently is very low.

Several possibilities for patent applications exist and should be further explored.

#### Score for Impact Strategy

2
### Panel - Section 3 Capacity for Collaboration with Society

### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The external collaboration shows that the UoA understands the importance of interactions with society. However, the impact arising from such collaborations is not obvious and should be expanded to cover the entire UoA e.g. by using the capacity of the "samverkanslektor".

The UoA needs to define a strategy to ensure resources for this type of activity.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The panel recommends the UoA to develop its extension activities and to increase the scope of the activities and include more international activities e.g. international networks in the food area.

The UoA should take advantage of the increasing need for science-based information in popular discussion forums as part of an overall communication plan.

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Panel/ ResearchMolecular Sciences, Biomaterials, and Technologyfield

### UoA Plant Product Quality

### Introduction

### General assessment of the Unit of Assessment

The UoA has an ambitious and broad approach based on existing research within the division and relying upon external platform resources. Good presentation showing good leadership skills.

Actual research is lacking in depth in places, mainly due to the wide span of models, crops and a will to try to meet too many and too wideset goals.

### Panel - Section 1 Quality of Research

### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

Good onset with relevant focus on structural and chemical quality of biomaterials for food and nonfood applications. Access to good infrastructure through collaboration and own assets such as unique genetic material in wheat and field production resources (primarily horticulture).

The wide scope with limited size of the UoA and modest scientific profile results in a lack of depth except for specific areas.

Ambition to present relevant useful outcomes result in a recognizable originality, and the UoA has access to adequate methods.

Furthermore, the panel finds the productivity from a scientific point of view modest, but with more obvious impact in applied areas relevant to agriculture and horticulture.

Access to synchrotron and spallation source platforms in Lund is met with an ambition and scientific competence to take advantage of this collaboration possibility.

### Score for Scientific Quality

4

### **1.2 Scientific Environment and Leadership**

# 1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

From the presentation and interview as well as the written self assessment, the panel regards the leadership, integrity and leadership strategy as good. A fairly low output in PhD students in relation to scientific staff indicates that more effort is put into collaboration and output activities than education and succession strategy.

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

Currently the UoA has a number of post docs, which seem to stay within the UoA awaiting the possibility of being recruited for higher positions. This also improves the quality of the scientific work compared with undergraduate PhD students.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA has mainly a regional and national scope with upcoming plantbreeding platform GroGrund adapting relevant crops for the Scandinavian region with focus on sustainable production and health as an example. An international (worldwide) scope is expressed within specific areas, e. g. apples and wheat resistance breeding.

The UoA has Identified food proteins as a strategic area of research, and focuses to a great extent on that.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The wide scope, collaborations and a set of goals on applied outcome implies a high degree of interdisciplinary research. This is supported by the diverse research areas and competences of the UoA.

The UoA takes advantage of collaborations with other groups and national platforms in order to achieve synergies that increase the quality of the research.

### Score for Scientific Environment

5

### 1.3 Strategy for Scientific Development

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA has a strategy built on collaboration and use of external platforms and resources, which ensures continuous improvement of quality of research.

The UoA should be aware of not spreading their assets too thin, and focus more on specific areas (see above).

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The scientific strategy of UoA includes relevant areas of scientific development, but does not deal with the negative effects of the wide scope.

The areas brought forward are connected with relevant but general societal outputs.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The UoA needs to identify its strengths in order to focus on its areas of expertise where the qualified researchers can have impact on a national and international scale.

This has to be done without losing access to relevant biological, technological and methodological platforms, and without losing relations with key stakeholders (farmers, horticulturists, industry, surrounding society) within and without the Partnership Alnarp.

As a challenge, more attention could be put on publications, especially for PhD students and younger staff. The panel suggests the UoA to put forward a strategy for publishing in more highly ranked journals, in order to increase the visibility of the units scientifical work.

### Score for Strategy for Scientific Development

#### 4.5

### **1.4 Additional comments**

### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The UoA performs research on areas very similar to those done by other groups at SLU (and to a certain extent at other universities and institutes), especially on molecular structure. Here there is room for improvement through synergies and common infrastructure.

This, though, has to be done without jeopardizing the groups critical mass.

### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

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The panel finds the activities and outputs excellent with good methods of cooperation and with high relevance to the stakeholders, ascertained by close contact through collaboration structures and networks such as Partnership Alnarp.

### Score for Activities and Outputs

### 3

### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The outcomes are not as clear as the activities and the output, which could be explained by the relative newly made division/UoA.

The UoA cooperates with the communication department, which increases the UoAs possibility to succeed. The management has also initiated courses in communicating popular science including both written and oral training. This will in the long run have positive effects on the societal impact.

#### **Score for Outcomes**

2.5

### 2.3 Impact strategy

# 2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The strategic goals are set with an insight in relevant sustainability goals and society's demand for long term solutions on biomaterials. In order to be successful, this has to match the specific qualities of the UoA, which means that it may have to be divided into more achievable goals or milestones.

With the wideset goals in mind, there is a lack in the strategy on how to reach these goals, expressed in an action plan or milestones.

#### Score for Impact Strategy

3

### Panel - Section 3 Capacity for Collaboration with Society

### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The approach of the UoA to collaboration is open, both through projects, choice of methods and also through the active participation in Partnership Alnarp.

On personal and group level the UoA has long term experience of collaboration, especially with end users (farmers, horticulturists, industry), which has given the unit a good understanding of the process.

In the process of establishing the plant breeding platform GroGrund, the UoA has developed new methods and skills for dialogue and mutual development, as indicated during the interview.

Still, the panel concludes that the UoA needs to be more specific on its strategy to secure and develop these skills.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The panel recommends the UoA to further improve its communication skills with more outside in/target group perspective. This can be helped by putting forward a communications strategy as part of the collaboration strategy.

Further, the UoA should make the most of the platforms GroGrund and Partnership Alnarp in order to create new collaborations and relevant end user relations.

Panel/ ResearchMolecular Sciences, Biomaterials, and Technologyfield

UoA

Biochemistry and Biotechnology

### Introduction

### General assessment of the Unit of Assessment

The UoA contains both PBS (Plant Biochemistry & Cell biology) and SBB (Structural Biology & Biotechnology). The team gave an excellent presentation that provided a coherent summary of research activities and achievements. The team runs excellent technical platforms and has had considerable success in securing grant income, with a very good level of research outputs. They also have a useful career development strategy to attract and keep younger skilled scientists.

Given that the UoA covers a range of research areas from autophagy and programmed cell death, to structurefunction analysis of proteins, carbohydrates and lipids, it is a challenge to keep the UoA unified. However, attempts have been made to achieve research synergy for example, a Joint grant application was made to the Knut and Alice Wallenberg Foundation "Co-evolution of protease structure and biological function". Overall the panel was impressed by both scientific breadth and depth of the UoA research and activities. The UoA has also succeeded in creating a dynamic research environment that stimulates creativity and innovations. In the light of the clear success of the UoA in basic research and innovation, the panel considers that it is possible to improve its societal impacts.

### Panel - Section 1 Quality of Research

### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The Biochemistry and Biotechnology unit has a very strong position in its scientific field with possibility to reach a world leading position. The panel has recognised a number of assets characterising the unit, such as:

- Considerable breadth and depth of overall research profile
- The unit has a number of original and innovative projects
- The unit uses cutting edge methods and approaches
- The scientific productivity of the unit is good but it could be improved
- Scientific impact could also be improved
- The unit possess a strong research capacity in structural biology
- The Unit has succeeded in knowledge transfer towards industry

• Very promising on-going research on autophagy and programed cell death, as well as other key areas such as enzyme structure/function relationships and structural manipulation.

Score for Scientific Quality

5

### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The panel has noticed a very good gender and age balance within the UoA, and acknowledges the great respect between team members and the good interactions with other UoA groups, which indicates excellent leadership.

The research environment appears to stimulate scientific innovation and dynamic creativity, and the UoA has created a sophisticated infrastructure of in-house cutting-edge methods and has also shown good international recruitment.

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The panel recognises that the UoA has created strong career opportunities for younger scientists through an active strategy.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA presents good national and international collaboration, which secures mutual benefits from the collaborative activities.

1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The UoA shows a wide inter-disciplinarity within the research unit. Some interactions and synergies are already in place, however it is the panels opinion that the outcomes of these might still be improved.

### Score for Scientific Environment

5.5

### 1.3 Strategy for Scientific Development

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA has an insightful and realistic well-developed strategy, which it successfully follows.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The plans for future research directions presented to the panel are highly satisfactory with the potential to put the UoA in a world leading position.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

A challenge for the future, identified by the panel during the evaluation process and confirmed by the UoA, is the limited number of world leading producers of enzymes and additives, which are in strong competition with each other, and to a certain extent influencing scientific publication and making it more it difficult for scientists from different research centres to collaborate.

### Score for Strategy for Scientific Development

5.5

### 1.4 Additional comments

### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The panel suggest the board to support the unit to increase its critical mass and give new career opportunities by opening up for new positions.

### Panel - Section 2 Societal Impact of Research

### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The panel finds the activities and outputs excellent in its wide use of methods, scientific productivity, width and depth and relevance of a low but relevant number of stakeholders.

### Score for Activities and Outputs

3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The panels impression is that the UoA has not realized its full potential with regard to interactions with stakeholders, for example farmers, government and other actors. In the light of the excellent research undertaken by the UoA, the panel considers that the UoA could develop a much more ambitious societal impact strategy.

### Score for Outcomes

### 2

### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The strategic goals for societal impact of the UoA remain to be fully explored and developed.

#### Score for Impact Strategy

1.5

### Panel - Section 3 Capacity for Collaboration with Society

### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA shows a good experience in collaboration with society. This knowledge has been gained through participation in several collaborative international projects. However, they have not fully developed all the possible outcomes of their research in a broader societal perspective. The panel suggests that the UoA spends more time in developing a comprehensive strategy and action plan that will benefit both the UoA and society, beyond the scope of their direct collaborators.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

They UoA could be more visible and interact more with NGOs and other funders/ foundations such as the Gates Foundation.

The panel makes the assumption that the UoA does not fully realize its own research strength and its potential to make societal impact.

22

Panel/ ResearchMolecular Sciences, Biomaterials, and Technologyfield

### UoA Microbiology

### Introduction

### General assessment of the Unit of Assessment

The work of the UoA is primarily based on the characterisation and commercialisation of a wide spectrum of microorganisms covering areas from soil to the human gastrointestinal tract. The UoA combines fundamental and applied research and is generally doing very well. It is in spite of this suffering from a relative low critical mass, large reorganisations, teaching obligations and a high proportion of funding coming from external sources. The UoA has only one faculty professor and it seems problematic that several senior researchers will retire in the coming years. The social impact of the research of the UoA could be huge but is currently not fully explored.

The quality of the research is generally good with quite some innovative ideas. The panel further finds that collaboration within the UoA as well as within the Department of Molecular Sciences could be improved to the benefit of bothe the UoA and the department.

A more detailed strategy regarding research and social impact is required.

The panel draws the conclusion that the UoA has a great but unexplored capacity for collaboration with society covering areas with sustainability, agronomy, food safety, human health etc.

### Panel - Section 1 Quality of Research

### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The scientific quality of the UoA is generally high and internationally recognized. However, the research performed within the UoA spans a rather wide field compared to the number of staff employed. The panel appreciates that the UoA recognises this and that there is a lack of interconnection within the UoA.

The synergy within the UoA is lowered due to the width of the research. The panel finds that some original ideas are generated within the UoA, however the strategy behind these ideas and how to pursue them to their full potential seems to be more blurred.

The collaboration with other groups at SLU working within the field of microbiology could be improved.

The panel further finds that for scientific productivity, a stronger effort could be put to publish in higherranking journals.

The methodologies are well selected, especially when it comes to exploitation of anaerobic microorganisms.

Innovative ideas such as e.g. oleaginous yeasts are appreciated and important in achieving global sustainable goals.

### Score for Scientific Quality

4.5

### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The panel recognises that the UoA suffers from reduced resources and the long vacancy of the resident professor. More effort is required in order to adapt the research strategy to the current staff and level of resources, and to enhance research interactions.

The ability of the UoA to manage to maintain a creative, intellectually vigorous and productive environment is lacking due to the inability within the UoA to clearly identify possible areas of research and synergies from collaborations. The UoA would benefit from a more proactive approach. The panel suggests the Department of Molecular Sciences to give the UoA support to facilitate this process.

A stronger focus on recruitment of female staff could be emphasized in order to reach a better gender balance. Several senior staff members need to be balanced with the suggested recruitment of junior faculty. The degree of external influence through international recruitment and mobility could also be enhanced.

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The panel acknowledges that the UoA senior staff assists young researchers in reaching employability outside the UoA as stated in the assessment. However, it is important that the best candidates get positions within the UoA to ensure the continuation of the research groups.

The panel finds further that more focus could be put on supporting the young faculty to stay at the UoA. This could be done by e g giving more thought on how the young researchers can get their own grants. Scientific seminars across the UoA could be valuable to anchor skills and expertise.

The panel also recognises that tenure track positions are required in order to ensure sustainability of the UoA and may positively influence the continued recruitment of women.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The geographical scope and character of academic networks and collaborations vary within the UoA though international reputation and collaboration partners exist.

The panel suggests the UoA to take a leading role placing exploitation of non-conventional microorganisms on the global scientific agenda. The scientific understanding of anaerobic cultivation are relevant for several segments within the international industrial sector and could be expanded to cover other areas than biogas production.

Publication in more generic journals with higher impact factor and writing of review articles within the above mentioned disciplines would be relevant to enhance the international recognition of the UoA.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

There is a need for establishing a greater coherence within the UoA and with other groups at SLU performing work within the microbiology area. Some areas such as soil microbiology are really small. The panel notices the UoAs struggle to cope with the reorganization within the Department of Molecular Sciences and recognises that this has a strong impact on its ability to take up interdisciplinary activities.

From the panels point of view it appears to be several unexplored possibilities for synergies within the UoA.

The outreach to other UoAs within the Department of Molecular Sciences and to SLU in general needs to be enhanced, especially within cultivation and microbial safety.

### Score for Scientific Environment

### 3

### **1.3 Strategy for Scientific Development**

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The panel finds that the UoA lacks an overall strategic planning even though it seems to be in place at group or individual level. The UoA has only been a part of the Department of Molecular Sciences for one year, which partly could explain the current lack of overall strategic planning.

The panel draws the conclusion that a focused research strategy is required. The UoA needs to harmonize its research within the unit and ensure a better coherence. The number of activities is regarded to be too big.

Prominence in the field of microbiological science primarily exists within new antimicrobial components/antibiotics, anaerobe microorganisms and non-conventional microorganisms.

High through-put technologies should to a larger extent be embedded within the UoA. The UoA needs to enhance their use of the various technological platforms offered at SLU and at the national level. The outreach to other UoAs at SLU needs to be enhanced as the skills within cultivation and microbial safety are highly required at other UoAs.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

Even though a great potential exists, the panel identifies a current lacks of overall vision within the UoA.

The panel supports the UoAs plan to start interconnected research within "culturomics" and sees it as a possible link between the research groups within the UoA.

The research on anaerobic microorganisms, their cultivation and metabolic pathways is judged to be quite upfront and could be broaden to cover topics within the "food and feed" area.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The panel has identified several currently existing challenges for further successful development of the UoA.

The UoA awaits the employment of a new professor. To the panel it seems to be a major obstacle for a clear common strategy to be made before the position is taken.

The critical mass of the UoA is too low to really make an impact on the various topics and groups of microorganisms they currently are working with.

Especially within some scientific areas the UoA needs to be more visual at the international scientific level and establish new alliances. The potential for these collaborations is there.

Obstacles seem to exist for running EU projects being linked to gaps in overheads. Faculty or university support for this type of applications is required.

### Score for Strategy for Scientific Development

#### 2.5

### 1.4 Additional comments

### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The discipline of microbiology plays an important role at several research areas at SLU, even though microbiology often is a minor part of other activities. It is therefore quite important that microbiological activities are connected at the SLU level and even centred to a certain extent. The panel therefore suggests that SLU should ensure a strong microbiological unit to take the lead in the several microbiological aspects that SLU covers.

The scientific area has a great potential and SLU should take advantages of this.

It is important to ensure that at least one full professor is employed covering a broad spectrum of microbial competences.

It is suggested that a microbiological cluster is established at SLU to create an opportunity for microbiological staff members of different research groups to meet and exchange experience and ideas. The microbiological cluster could cover activities such as annual microbiological meetings, seminars on selected topics of mutual interest and to the extent possible support "sandwich" PhDs covering microbiological activities at minimum two UoAs.

### Panel - Section 2 Societal Impact of Research

### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

From an overall perspective the panel finds the level of activities and outputs to be excellent. The UoA targets areas of relevance for the industrial sector. However, it is important that the UoA manages to develop its own strategy. Currently, the UoA is quite dependent on industrial funding and therefore the research conducted seems to be more a result of the needs of the industries than being based on a defined research strategy.

Identification of new, antimicrobial compounds and secondary metabolites derived from microorganisms is a very interesting area. The UoA is involved in a quite big project in this area though not having the leading role. Within this scientific area there is a great potential for societal impact and to the panel it seems as if the UoA does not really take advantages of this.

It is not clear whether the consultancy services to the industry pays off.

The panel also suggests the collaboration with stakeholders should be widened.

### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The panel recognizes that the research activities of the UoA have quite some societal impact. The UoA has had a high level of external funding and researchers within the UoA interact with relevant authorities and take part in expert groups.

Stronger support from the SLU management for external outreach and collaborative activities is required.

The Department of Molecular Sciences should enhance the awareness about services offered by SLU to support larger international applications.

#### Score for Outcomes

#### 2.5

### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The panel recognises that the UoA has several opportunities to enhance its societal impact, but the UoA does not really take advantages of this even though their collaboration skills generally are good.

The potential societal impact could be massive, if a well-planned impact strategy is implemented.

The UoA seems to have some interactions with researchers in developing countries. However, it is not clear whether this is an area the UoA will enhance. Their knowledge on microbial safety aspects could have a great social impact and collaborations on microbial biodiversity could lead to areas of interest for the UoA.

### Score for Impact Strategy

1.5

### Panel - Section 3 Capacity for Collaboration with Society

### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA has a long tradition of actively encouraging research within topics of high societal relevance and strong links to the private sector. The UoA has a good experience from collaborations with industrial partners. Many of these collaborations have been on-going for many years and the UoA has a very good understanding of how to work with the private sector.

The UoA is active in several committees; however the panel finds the UoAs involvement in international committees could be enhanced.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The UoA has an appointed collaboration senor lecturer ('samverkanslektor') that is successfully active in external communication with focus on biogas and bioenergy. With this very favourable opportunity the UoA has the potential to formulate an overall strategy for how to reach out broader and also plan for how to be more pro-active in taking a leading position in international research projects.

The panel encourages the UoA to develop a strategy and action plan for finding new national partners and also reach out towards international partners in academia, industry and public organizations.

Furthermore, The UoA should take a proactive role to engage themselves as leaders for national and international collaboration projects. The UoAs role in solving global challenges should also be defined, taking into consideration e.g. the UN goals for sustainable development.

Panel/ ResearchMolecular Sciences, Biomaterials, and Technologyfield

UoA Wood Science and Technology

### Introduction

### General assessment of the Unit of Assessment

The panel got the overall impression that the Wood Science and Technology group is a small but scientifically high performing unit, and one of the core competence areas at SLU. The accumulation of relevant research equipment and methodology approaches within their laboratory is impressive. The planning of developing the research is presently not very active and the panel encourage the UoA to be proactive developing a strategy that help to develop cooperation also within the new faculty.

The relevance of the application of the UoA driven research is high and the outcome of their research activities is eagerly taken up by the industry and other stakeholders. The sizable collaborations with industry and other partners and stakeholders result in a high productivity and visibility. The panel got the impression that the UoA has not, however, been very active in developing goals for societal impact.

The collaboration with society is good, but as the group is very small and international, the panel suggests that cooperation with other UoAs at SLU might be the most fruitful way to develop this field.

### Panel - Section 1 Quality of Research

### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The Wood Science and Technology group is a high performing, small UoA (7 persons located in Uppsala) working from nano- to product scale with wooden materials. This group forms definitively one of the core competence hubs needed to be preserved at SLU. The accumulation of relevant research equipment and methodology approaches in their laboratory is impressive. In the past, the previous center of excellence (WURC) formed a fruitful, unique platform for collaboration within Swedish industry but nowadays financing, partners and ideas are international.

The approach to try to observe and understand the various phenomena that can be present in wooden materials, in the nanolevel, molecular structure, makes a clear scientific base to build up the present and future research profile on. The research performed has both depth (successfully combining both fundamental and applied research) and breadth (from trying to protect wooden material, to find the most optimal methods to process wooden structures). The UoA is the only group in Sweden with this profile.

The UoA works on a wide scope from basic structural and chemical understanding and modelling to commercial applications. This can be an advantage from an innovation point of view, but with the limited size of the group, this could be a point of observation due to the risk of losing focus.

The UoA has been part of the Department of forest biomaterials and technology, since 1.1.2018. The main part of the department, as well as most of their activities are mainly in Umeå. From the UoA:s point of view, this did not change their strategy, but it may become a problem and not in accordance with the intended synergies.

### Score for Scientific Quality

### 5

### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The multicultural, international UoA seems to be driven by curiosity and the possibilities provided when combining fundamental research with developing new industrial solutions and applications. The philosophy "working with, not for the industry" seems also to provide flexibility and keep many doors open to new constellations.

Scientific leadership has been excellent in the present constellation, and the present two professors seem to make an excellent working pair (fundamental and applied research) and the forthcoming retirement of one of them and recruiting a new one may affect group dynamics.

The degree of external influence through international recruitment does not seem to be any problem but the lack of domestic researchers in the group might however be a factor affecting the commitment to and positioning within SLU. Gender balance could be better.

The placement of the UoA within SLU has recently as well as some years ago been changing (2007, merged with Forest products & Markets), and the uncertainty seems to have affected both activities (eg teaching) and human resources (eg recruiting PhD students). The group is presently having very poor collaboration with Master and PhD students, compared with earlier years.

The panel is somewhat uncertain about if the present organization structure provides the most fruitful environment for the UoA, or if it might fit even better under or together with another faculty (NJ?).

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

As the UoA is very small with few PhD students and post docs, there is a limited playground for researchers to develop into independent researchers. Within the UoA there seems however to exist a supporting environment for this.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA has a clear international scope with a multicultural work environment and coping with research and industrial issues of global importance. Their impact is more based on the Scandinavian forest industry's world leading position than on a clear strategy.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

Based on research approach and available equipment the UoA is well suited for interdisciplinary collaboration The UoA may point out several examples of where cooperation within SLU has been fruitful (eg with chemistry, plant biology) while some dimensions of cooperation that the panel would have expected, based on the interviews, seems to be less developed or missing (e.g. between microbiology and aging of wood). The small size of the group might be one of the reasons behind this.

The panel noted the lack of strategy to use the unique possibility offered by SLU:s position as partner of MaxIV.

### Score for Scientific Environment

### 5

### 1.3 Strategy for Scientific Development

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The strategy for increasing scientific quality and ensure a proper level of renewal is rather general but lifts up areas that has to be developed. As the UoA has developed a very strong research profile throughout decades, the lacking description of scientific renewal surprise us. The panel senses an uncertainty for future, probably due to the coming change in professorship and the recent change in organisation, which probably affects this part of the assessment. The description of promising future directions where UoA plan to contribute, however, on a general level, gives indication of in what areas some renewal might be needed.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The panel got the impression from the oral presentation and the interview that there is no present planning of developing the research of the UoA. This is can have two explanations: the upcoming retirement of one of the professors and the uncertainty that has been existing due to changes in organization structure.

The written description of promising future research directions on the other hand lift up important areas where the UoA can – and probably will – make significant contributions.

The panel encourages the UoA to be proactive developing a strategy that help to develop collaboration also within the new faculty.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The panel consider that there are the UoA faces challenges that may have a negative impact on future successful scientific development:

• The recruitment of a new professor with an appropriate background and skills that fit into the present profile and ongoing research of the UoA. The early recruitment of a new professor is important for continuity and to boost recruitment of new PhD's.

• The adequacy of the new internal organizational structure should be reviewed again and adjusted if necessary, in order to give the excellent researchers of this UoA the working conditions that allow them to concentrate on their key research activities and develop long term intra- and interdisciplinary collaborations.

### Score for Strategy for Scientific Development

2

### **1.4 Additional comments**

### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

A recommendation from the panel is that SLU would become a member of TreeSearch. From the UoA:s coordinating work done in the former centre of excellence WURC, the panel foresee that the UoA will both contribute and benefit from that membership.

The supply of excellent PhD students from first to third cycle within Swedish University system does not in practice exist, so students have been recruited from abroad (e.g. in cooperation with foreign master programs). This requires long term planning and international cooperation that SLU might be able to support in some way.

### Panel - Section 2 Societal Impact of Research

### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The group takes the leading role in projects, which shows an ambition to take and uphold a world leading position. The access to a cutting edge infrastructure and use of state of the art methods, such as modelling, ensures a platform for high output. The sizable collaborations with industry and other partners and stakeholders result in a high productivity and visibility. This also indicates a high relevance to the stakeholders.

### Score for Activities and Outputs

#### 3

### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The relevance of the application of the UoA within areas such as wood degradation and preservation and wood preparation for energy optimized destructuring processes, is high and the output of these activities are taken up by the industry and other stakeholders. From the panels point of view we judge these outcomes as excellent.

#### Score for Outcomes

#### 3

### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The panel got the impression that the UoA has not been very active in developing goals for societal impact. From a societal point of view they are active within areas relevant to sustainability and circular bioeconomy goals, but approach these activities from an intrascientific standpoint. This also has an influence on the UoA:s collaboration with other groups within SLU.

The panel would welcome a more open strategy for optimizing the potential synergies emerging from more closely collaborating with the Forest biomaterials group, with which it has recently merged.

#### Score for Impact Strategy

#### 1.5

### Panel - Section 3 Capacity for Collaboration with Society

### 3.1 Collaboration

# 3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The panel identifies a number of strong collaborations that the UoA upholds, which seem to be with mainly industrial partners. With forestry, timber and wood products quality being of such great importance to the Scandinavian economy you would expect the UoA having more collaboration with agencies, NGO's and policy makers.

The panel position is that this is a loss on both parts, since the UoA has shown very good skills in both collaboration and leading and coordinating research and excellence centres.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

At the time of this evaluation, the UoA showed a strong leadership and a diverse composition of it's scientific staff. The two professors seemed to complete each other both in science and operation.

With this in mind, the panel will express some concern about the future development of the UoA when the leading professor retires. Given his apparent dominance and the multinationality of the group, there is an obvious risk that the UoA will split up if the succession is not taken care of in an appropriate way.

Panel/ ResearchMolecular Sciences, Biomaterials, and Technologyfield

### UoA Chemistry

### Introduction

#### General assessment of the Unit of Assessment

The 425\_1 UoA has a strong position in its scientific field, very high international collaboration and welldeveloped industrial collaboration. Some scientific developments are very original and impactful, and the industrial collaboration is clearly on a strategic level for the industry.

The UoA has achieved a strong scientific environment and high quality in its research. This opens up for even more proactive development of projects where they take the initiative to collaborations.

However, the panel lack a perspective where human and environmental safety aspects are taken more into account, especially considering the well established external collaborations.

### Panel - Section 1 Quality of Research

### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA have a very high scientific quality and seems to know how to handle collaborations that gives results in good international papers. They show a high ambition on seeking journals that have a high ranking. Some projects are very innovative and pioneering.

### Score for Scientific Quality

#### 5

### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The UoA seems to be working in a structured way and with a clear strategy in the area. They are working actively with mobility and exchange in order to create a wide interface for future collaborations.

External requests for collaboration with the UoA seems to be managed well and with a well functioning internal dialogue. The UoA may be more active in developing more their own scientific ideas / hypotheses and drive them internationally.

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA have a strategy for developing young faculty members and helping them with a carrier plan, and could maybe be even more structured in planning for development and could learn from the Biotechnology UoA. The UoA may very well be continuing its work within the current activities, but this did not come through in a structured way.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA possess strong international co-operation and networks.

Important assets for the unit are their access to infrastructure and the skills to develop their methods and techniques for analysis and for working with collaboration.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The UoA collaborates with several parts of SLU. With their instruments and knowledge they are an attractive partner in many collaborations.

The panel concludes that these collaborations could be develop even further with other groups within the university.

### Score for Scientific Environment

5

### 1.3 Strategy for Scientific Development

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA have a clear strategy for scientific developments. The plans seem to be realistically based on their quality of research and history.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The UoA has a clear plan for future direction of its research and described in concordance the dialogue in the group behind the plan. They seem to have a good knowledge on the research front in their respective areas and have a plan for how to implement it.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

Chemistry is a high performance UoA at the university, and the board can have high expectations on its future achievements.

The panel makes the reflection that the UoA may face a challenge in generating more own ideas and hypothesis, and driving them in international collaboration where they take the leadership. The panel would like to see more articles where the UoA have the first / last name on the paper.

### Score for Strategy for Scientific Development

4.5

### 1.4 Additional comments

### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The UoA has access to an advanced and important infrastructure for its research. This in turn requires a deep knowledge and understanding of the equipment and methods used, and time to maintain and run them.

The panel suggests SLU to consider supporting the group with Senior Technicians to maintain and handle the instruments in order to help the UoA to become even more efficient.

The UoA have a good position in collaboration with national infrastructure such as the MAX IV laboratory. It can be important for SLU to have a proactive plan to support that and have a clear idea for their preferred position in collaboration with national infrastructure.

### Panel - Section 2 Societal Impact of Research

### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA performs very well in their activities and outputs.

### Score for Activities and Outputs

3

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#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

With such a strong position in their research the, the panel suggest the UoA to develop its ability to achieve higher societal impact. In order to reach more collaborations within the university, the panel suggests the UoA as part of its impact strategy to develop an action plan for communicating its ability to the other parts of SLU better.

The UoA have strong industrial collaborations, which could be developed even further. The panel suggests the UoA to draw an action plan for international dream companies to collaborate with.

### **Score for Outcomes**

#### 2

### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The panel suggests that the UoA develops a more structured action plan for impact strategy. With the units scientific position and output, it has a potential for greater impact on the international arena than it has shown within the framework of this evaluation.

### Score for Impact Strategy

1.5

### Panel - Section 3 Capacity for Collaboration with Society

### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA shows a developed way of working together as a group on its plans for future research directions and internal collaboration based on mutuality and dialogue.

The panel makes the reflection that the UoA may develop a broader dialogue with more units in SLU on potential collaborations, e.g. with units within food science.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The case of the Vasa ship is an excellent way of collaboration with society and perform fundamental research in the same time. However the committee is surprised that the wood science has not be more associated to this development. There is a potential to do more with this kind of collaboration.

### Quality and Impact 2018 Kvalitet och Nytta 2018 (KoN2018)

Report Template for Review Panels – Overview of Research Field

Research field/Panel (no. and name): 16 / Nature and Society

**General Overview of the Research Field** 

### **Quality of research**

We were generally impressed by the research of the UoAs in the Nature and Society panel. The research spans a wide range of theories and approaches, with an emphasis of qualitative research methods. We have for many units given a score of "Internationally recognised" but noted that the units are in several cases on their way to "High international" with individual papers already in this category. By paying greater attention to publication channels and active dissemination of their scientific outputs the UoAs would be able to increase their scientific impact.

The research in the Nature and Society Panel is essential for the SLU's "ambition to contribute the knowledge that society needs to use natural resources in a way that is sustainable in all respects – ecologically, economically, socially and ethically." The strategy states, correctly in the Panel's view, that to achieve "a better understanding of the interaction between human and natural resources in the broad sense, a greater element of humanities and social sciences is needed." We therefore strongly endorse the stated strategic goal that "SLU therefore strives to increase the integration between the humanities, social sciences and natural sciences, i.e. to promote multidisciplinary and interdisciplinary science."

In examining the material and interviewing the UoAs the Panel has had two critical questions in mind. First: Does the strategy match reality and b) How could the research covered by the UoAs in the panel be strengthened in order to be both strong in its own right <u>and</u> fulfil the wider strategic goals of SLU.

Our answer to the first questions is that SLU is still very much on a learning curve. Many social scientists feel that they are expected to play a 'service' role in tasks that are determined by other sciences. This is clearly not a route to successful and path creating inter- and transdisciplinary science. It generates frustration and may mean that SLU fails to attract and keep high level social scientists. We noted considerable turnover and difficulties in keeping senior leadership among several of the UoAs we evaluated. This may be related to our concerns about treating the social science units as appendages to the hard science units rather than equal partners. In UoAs that have a tradition of interdisciplinary work within the unit the problem is less severe than in units where the main focus and theoretical frame is in social sciences and humanities. The Panel also note that the recruitment processes for senior staff were in many cases unacceptably long. Especially small UoAs suffer from this.

To correct for the problems experienced by UoAs representing the social sciences and humanities SLU needs to walk the talk and show in recruitment policies, incentive structures and infrastructure maintenance and development that integration means bringing together research areas in mutual respect and balance. Strategic actions within SLU are needed to ensure that UoAs with a social science profile have sufficient resources in order to contribute to interdisciplinary work. Only then can the really interesting interdisciplinary questions be formulated. Developing the Futures platforms is one route. They should be further developed to include possibilities for joint grant writing, seed money for innovative interdisciplinary projects and 'dating services' for researchers and data. Good examples exist in other Universities that have struggled with the same challenges. (see for example, DePaul University Innovation through Collaboration Initiative: <a href="https://offices.depaul.edu/academic-244">https://offices.depaul.edu/academic-244</a> affairs/initiatives/innovation/Pages/default.aspx )

One systematic problem that arose repeatedly was social science units being invited to dialogue with their hard science brethren late in the process, often after proposal writing or intervention deliveries in the field. We believe a high priority for SLU is to self examine the processes by which the social science UoAs are incorporated into the scientific and outreach programs in the agricultural, biological, and veterinary sciences. This should lead to an active move away from project planning in which social science sciences and humanities become 'add ons' to formally meet demands for multidisciplinarity.

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The second question obviously has many answers that are unit and context dependent, and they are elaborated in the reports on the individual units. Recurring issues include the following:

- Ensure critical mass several UoA have, due to imminent retirement or other staff changes already lost or are about to lose key personnel. Replacing those, and in some cases considering strategic additional recruitments that is research oriented, is essential to maintain the UoA.
- Many UoAs have a very heavy teaching burden relative to their size. Recruiting researcher-teachers and lecturer-researchers is likely to increase the research and teaching potential of many Units. This change is in line with SLU's strategy, but we think it should be accelerated as much as possible. A better balance intraperson would lead to better teaching and research because of their cross fertilization and enhance a sense of fairness and inclusion within units.
- Stronger research strategies that UoAs develop themselves and implement to truly reflect and deepen the SLU & Faculty strategies – this strategy work should encourage all staff how to formulate <u>their own steps towards the goal of improved research</u>. We have one excellent example. Urban Vegetation, Governance and Management has achieved encouraging concrete results with this approach.
- Bridging the gap between research and teaching, i.e. developing research that interacts with teaching through courses, thesis work and developing teaching that supports research in e.g. experimental studies.
- Ensuring proper monitoring, not relying exclusively on web of science, but truly thinking through how the different elements of the work in SLU can be measured in a way that provides correct incentives for development as opposed to focusing on partly arbitrarily chosen measurable variables.
- For units engaging predominantly in qualitative work, an important part of the publications may occur outside of scholarly journals falling in book chapters and monographs. This affects citation analyses.
- Similarly qualitative work by its very nature tends to take much longer to conduct, analyse, and publish than quantitative work. We recognize this is not true in all cases but as a general trend is
- it describes accurately the conditions. As a consequence publication rates may be lower than in areas relying largely on quantitative methods.
- Some units are spending in ordinate amounts of time raising funds to support core research facilities. As but one example, the therapeutic garden in the environmental psychology UoA. Because social science units do not have the capability to charge for various clinical services (e.g. veterinary medicine), we recommend consideration of how funding should be organised for some core facilities.
- There are both disciplinary gaps and redundancies across the units Panel 16 evaluated. Now is an opportune time to bring the social science units together to carefully examine where there are potential synergies across units and where gaps then remain. Such an analysis would assist several impending new faculty hires.

### Societal impact

The UoAs in the panel all have good to excellent societal impact because their research is almost by definition oriented towards societal impact.

There is variation: some solve local issues whereas others also influence policy making at national or European level.

Fine impristure and second second by:

Panel 16 - Nature and Society

- Truly interdisciplinary research as suggested above.
- Stronger support for digital communication and strengthening SLU's digital presence. By enhancing SLU's capabilities to translate research into practice both in Sweden and around the globe, the possibilities for positive societal impacts would be enhanced. The UoAs need to learn how to show a collective digital presence, not just PR, but they will need technical support from SLU to create platforms that provide digital tools etc. for stakeholders to use, not just web-pages that illustrate individual activities. For example, access to open data, tools for practical applications, educational material for wider use in MOOCs etc. could be developed with central support from the SLU as most of the UoAs are too small to develop their own technical and editorial skills for these kind of activities.
- Learning of good practices across UoAs. There are a number of innovative examples such as alumni networks maintained through social media, outreach activities, extension services, collaborative development and co-creation of research question and studies that could be taken into greater use.

### **Capacity for collaboration with Society**

Overall the UoAs of the Panel have excellent capacities for collaboration with society. The range of stakeholders is very broad, and the demonstrated actions convincing. Some units may have so much collaboration that it has reduced resources of their scientific work. Part of the educational activities also link to collaboration activities. Strategic discussions on how much collaboration, which routes and methods of collaboration (and co-creation) are suitable and what kind of services the UoAs and SLU is providing relative to other entities collaborating with Society are likely to benefit bot UoAs and SLU as a whole.

The work on developing a reward and monitoring system for these activities is strongly encouraged. It should engage the UoAs in a creative effort. A top-down ruling without participation and buy in from the UoAs is not likely to be very helpful.

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Panel/ Research field	Nature and Society
UoA	Landscape Architecture

### Introduction

### General assessment of the Unit of Assessment

A few individual researchers in this UoA have contributed to research which is recognized internationally in the field of landscape architecture/ landscape/sustainability research. There are also important contributions for the subject field in books and reports, which get less attention in the university's scholarly impact monitoring system. The UoA lacks however, breadth and they have a limited numbers of publications in high ranked peer reviewed Journals. The UoA needs to strengthen the scientific leadership and develop goals for the research field including strategies to achieve these goals.

The case studies show that the UoA collaborates with international, national and local stakeholders both on a policymaking level and on a more practical level. Most stakeholders are in the same discipline area as the group. The group has good societal impact but could have even better if collaboration gets wider and if the group can reach out to other disciplines working with outdoor space in urban areas. Similar to environmental psychology, we would encourage some strategic thinking about building linkages between LA and public health and medicine given the importance of experiences in natural settings for health and wellbeing.

### Panel - Section 1 Quality of Research

### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

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Input from: 1 a, 1 b. and 1 c.

Since 2014, research within the UoA has been conducted in four thematic groups:

- Design Theory (11 employees)
- Landscape Planning and Governance (19 employees)
- Landscape Design (14 employees, mainly teachers)
- Landscape Management (2 employees)

The group has had a positive development in recent years and attracted internationally recognized and experienced researchers from various parts of the field. The economy is good and in recent years, the group has received a number of research projects that are central to the challenges we face today linked to sustainability and urban development.

The group has in total produced 19 peer reviewed articles that belong to the top 50 % cited category according to InCites (Clarivate Analytics during the years 2009-2015. None of them falls within the top 5% cited. The 4 research groups gives an impression of a broad field of research, however in reality the scope is more narrow and mainly covers activities in the Landscape Planning and Governance group. Major scientific publications fall into three main tracks. 1) landscape values and landscape characterization/ participation, 2) environmental policy/ governance and 3) lawns as a cultural and ecological phenomenon. Within these fields, there are several interesting contributions useful for the field of landscape architecture. Some of the peer-reviewed articles are published in wellreputed journals like Landscape Research, Geoforum and Global Environmental Change. We have also found several interesting books, books chapters, reports and popular scientific publications produced by members of the group.

Members of the UoA stated in the interview, that the university needs to understand the nature of research and development within landscape architecture discipline. This does not happen only through articles, but just as much through other channels not included in the scholarlymonitoring system. They therefore called for alternative ways of evaluating quality. We agree on their concerns, which we consider is a particular issue within the design field. We therefore support the creation of alternative ways to evaluate quality. However, we believe that it is possible to publish more in this field. The problem here is that there are not so many publishing channels for instance compared to the fields of landscape research / landscape planning. Another issue here is the lack of researchers in the design field with capacity to publish. We return to this point later.

Given the number of people in the group there are not so many published articles in this UoA, even if there also are some books, reports etc. published as stated above. Landscape Planning and Governance group is the most productive, while Landscape design, Design Theory and Landscape management have fewer publications. Publishing distributes unevenly among individual researchers and more effort should be made to publish some of the work in higher impact, scholarly journals. One reason for the low scientific production within the Landscape design group is that most of the people are teachers with little/ no time for research. To increase productivity in the UoA it is important to rethink the divide between researchers and teachers in connection with new appointments. In addition, there is a need for stronger leadership to help people to publish. See below.

We have noticed that the UoA has had some important and impressive projects that are recognized in Sweden and internationally. The lawn study is for example an interesting example of how an experimental study of establishing a lawn also is recognized as a well-managed park. Through the research of Ignatieva Ultuna Campus got The Green Flag Award, which is a scheme that recognizes and rewards well-managed parks and green spaces, setting the benchmark standard for the management of recreational outdoor spaces across the United Kingdom and around the world. This demonstrates the distinctive character of the landscape architecture and how development in the design field can contribute to new knowledge. Two of the PhD students within the UoA got prizes from important international landscape architect associations (ECLAS and Landscape research Group) within the period of assessment. Members of the UoA have also been invited to conferences and have had national and international commissions during the period.

### Score for Scientific Quality

### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

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Several of the established senior researchers within this UoA have retired in recent years. The UoA has therefore made a great effort in recruiting new senior academic staff, which also includes internationally recognized scientists. This is particularly important since this UoA also has recruited new PhD students. 'SLU landscape' has proven to be an important platform for the UoA to overcome the division between Alnarp and Ultuna. A very good example of the collaboration with Alnarp is the international conference 'Beyond ism: the landscape of landscape urbanism' in 2016. This was an important conference that made the Swedish landscape architecture environments visible and thus SLU internationally. In parallel, the initiative contributes to a vibrant professional environment internally. In addition, minor measures are arranged like career mentoring, support academic and application writing, writing retreats, seminars, design lab etc. 'Beyond ism: the landscape of landscape internally. In addition, minor measures are arranged like career mentoring, support academic and application writing, writing retreats, seminars, design lab etc. 'Beyond ism: the landscape of landscape urbanism'.

The UoA has an extensive load of teaching and some of the groups have few active researchers, especially in the landscape design group. Landscape design is a core area of the landscape architecture field. We therefore consider it particularly important that this group has good conditions for further development, for example support to common study trips for the group, time for selfdevelopment, etc. It also appears that some of the researchers do not publish much. If that is the case, this is a challenge that UoA must take seriously. The UoA should consider many of the measures proposed to support young faculty also to help teachers and inactive researchers. UoA should focus on analyzing how teachers and researchers that do not publish can contribute more within the topics they are concerned. How is, for example, the UoA organized to give employees opportunities to participate in some way. Another question is how teachers get opportunities to participate in the research groups. The university should consider whether the balance between teaching loads and research is distributed appropriately throughout this unit. Some faculty appear to primarily teach and others primarily research. The Panel believes that a better balance of teaching and research across all professional staff is not only more equitable but also leads to better research and teaching.

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA mention several interesting measures to support young faculty and encourage their development. Examples are engaging junior researchers in PhD supervision, workshops on academic writing and writing retreats, presentations concerning career progression, workshop on developing a publication, department-wide system for supporting the writing of quality research applications, mentoring provisions (in some research groups). The unit also uses a system of target and goal setting, to give young researchers greater direction and to help identify and reward good research performance.

Altogether, the UoA has 8 PhD students of which 5 come from Tanzania This can be a challenge. We suggest better articulation of strategies to optimize the integration of international students into the academic community.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA states that trans-/interdisciplinarity is central to their field of research and research activities cover a wide geographical area. They also state that they have strong links internationally and intimate relationships with policy and practice in Sweden. The bibliometric overview does not show that this is the case when it comes to research. The group seems to be part of only a few networks internationally. The UoA itself recognizes this in their report.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

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Joint work within SLU is more developed than international collaboration. The group particularly emphasizes the importance of cooperation within Department of Urban and Rural Development to which they belong. Cooperation with the landscape architects in Alnarp has improved, not least due to the platforms established by the university. We strongly urge UoA to further develop networks within SLU to collaborate on research related to major challenges, such as climate change. Landscape architecture can be a link in this area, and SLU has great potential to become a leading university in Sweden and internationally in addressing climate change given its long tradition of excellent work in agriculture and animal husbandry: two activities facing unprecedented challenges because of climate change.

### Score for Scientific Environment

### 3

### **1.3 Strategy for Scientific Development**

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The strategy includes several initiatives to support the research environment from a practical / administrative point of view, The description of goals and strategies is however mainly about new positions and administrative measures etc. with little connection to what they want to achieve in the society and for landscape architecture education.

The unit has worked to provide the basis for developing an enhanced research profile through the recruitment of a new generation of leading scholars. These positive measures have contributed to the strengthening of the unit. However, it is difficult to see the overall research strategy the Department of Landscape Architecture (Avdelningen för landskapsarkitektur) has. The field of landscape architecture is broad and research needs to cover several aspects, from theory/ history in the field through planning governance, landscape design and landscape management (the four research groups). The submitted report does however not reflect this breadth. We therefore recommend that the unit clarifies its goals. This applies to all four research groups, but is particularly important for landscape design (that has little research) and landscape management (that has recently started and has only two members).

Included in the research strategy is also recruitment of PhD students. As shown above, 5 of 8 PhD students are from Tanzania. How is their work included in the goals of the unit's work? Is it right in a build-up phase of research to invest so much on PhD-student networks from Global South? The management of the department must be given a stronger opportunity to coordinate research needs. This is particularly important for the education at Ultuna, which has many foreign new employees.

Their goal of building a world class, interdisciplinary research environment in the period 2018 – 2022 is highly demanding and requires a very dedicated effort. It is preferable to set such a goal for all landscape oriented work in SLU and not just for one UoA.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

Plans for future research includes Food planning, Urban transformation, Landscape politics and landscape theory. This clearly reveals fields where the unit has strong research expertise that it can build on. However, we are asking how the proposed futures directions reinforce the research in all of the research groups. What about the prominent research related to design with nature? What about Ultuna's important work with children's outdoor environments? Leveraging collaboration with landscape architecture colleages at Alnarp?

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

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The UoA mentions retaining talent, increasing the number of applications, reducing administrative work for researchers and reducing the divide between teachers and researcher and to recognize other academic outputs in landscape field. All of these are important but we also see a need for a more elaborated research strategy and stronger leadership.

To strengthen the theoretical profile in landscape architecture is important but there is a danger that the professional approach is lost and the divide between the research field and the education will increase. The work done by people in the department for instance connected to children is almost invisible. That may be the case for other issues too. We miss a deeper understanding of what landscape architecture is a about and what kind of research is needed for that purpose and what it means at Ultuna. Landscape architecture at Ultuna also needs to be more visible at the university.

### Score for Strategy for Scientific Development

### 2.5

### 1.4 Additional comments

### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The most important messages to SLU are:

-Professional knowledge is crucial for landscape architecture educations. Nevertheless, the university must ensure that teachers who come from the profession also have time for self-development and reflection -In general, it appears that the researchers are overloaded with teaching. This should be mapped and measures taken if this is the case. As a professional education, it requires more time to teach landscape architects because much of the education is studio-based with 1 to 1 supervision. Too much time for teaching reduces time for research.

-The monitoring system has to recognize other kinds of knowledge production than peer reviewed articles -SLU should to a much greater extent than now utilize the field of landscape architecture to show how their inter-/ transdisciplinary approach can be a way to make the whole university more visible and attractive in the future.

### Panel - Section 2 Societal Impact of Research

### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The group is working on an international and national level with policymaking and they are also working with operative small projects such as creating play landscapes. This wide spread of activities produces a diverse set of outputs. The difficulty is to communicate the results to society. According to the interview Movium is an important partner in this area. It would also be good if SLU could be more digitally visible.

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The group has listed relevant stakeholders at all levels. It is very good that the UoA sees the public at large and especially children as important stakeholders. This makes the research more useful for practitioners. It could be good for the group to use other knowledge in SLU even more that they already do, for example environmental communication. The internal collaboration in SLU could be better and we recommend a stronger infrastructure for this in our overall recommendations to SLU. The future platforms can be developed and play a stronger role in supporting collaboration.

The case study of alternative lawns is important to cities in Sweden as lawns covers big areas in the cities. The manual is very good for getting a societal impact and it would be good to communicate this even more.

Environmental policy integration for sustainable development is a very important subject that can have significant impact on many different strategic projects both on the national level and the local level. architects.

With the case study "Livable and sustainable cityscapes" SLU addresses one of the most important topics to society, densification. SLU faces the challenge of spreading the knowledge to many cities and to city planners and housing architects.

### Score for Activities and Outputs

### 3

### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The outcomes that the UoA has achieved are relevant and impressive. The case studies show that the UoA has had or can have substantial impact on the society in the future. The hard part is to reach the practitioners and policymakers at various levels. It is important to be able to combine big social impact and high-ranking research and in some areas the UoA has managed to do this well.

#### **Score for Outcomes**

#### 3

### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?
The question is what the next step is and what to focus on in the future? The texts in the UoA and the answers in the interview didn't describe the themes and topics that the UoA is aiming for in the future to be able to maximize societal impact. The Panel did not see a clear description of the most important strategic themes and topics for society in the field of landscape architecture nor an outline of a strategic plan to meet those needs with the help of the research in the UoA. Relevant questions include: What topics are highest most priority in the field of Landscape architecture? What knowledge are landscape architects lacking when they work with planning, building, managing and sustainable outdoor spaces? How well are landscape architects trained to work effectively with relevant government agencies in Sweden?

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#### Score for Impact Strategy

2

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA shows that the UoA has a profound understanding of working with people representing the "green" area on different levels in society. Other groups appear to be harder to reach. The 'not so good case study' shows that the UoA can continuously learn from collaboration from society and that shows that it understands that collaboration is a two way communication. The UoA has shown how to use collaboration in solving complex problems and thus it could also act as a mentor for other groups at SLU in this area.

The UoA mentioned that they think of doing a georeferenced map that shows the width of collaboration and the case studies that they are working with. The Panel supports this idea and notes that it could also be useful for other groups at SLU.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

As the UoA has written in section 4.4 there is plenty of knowledge that they can use in SLU to get better at collaboration with Society. One key area is environmental communication. The Panel suggests one way to achieve improve collaboration is to strengthen the internal networks in SLU. Through a good networking infrastructure supports learning processes across SLU. Good examples exist in other Universities and the Futures Platforms may provide a starting point.

When it comes to stakeholders the UoA is very good at working at all levels from policymakers to practitioners. The UoA also has international, national and local stakeholders. Most of the stakeholders appear to represent landscape architects and related fields. The Panel suggests that the UoA, in co-operation with other related UoAs, reflect on how to reach a wider range of stakeholders such as housing architects, city planners and transport planners that all have a decisive impact on Collaboration with medicine and public health also would be worth exploration. outdoor environments in cities. The UoA, could, in co-operation with other UoAs, also develop closer relationships with other universities such as KTH, CTH and the school for planners in Karlskrona.

Developing ways to maintain active contacts with alumni is a very simple and probably successful method that was discussed during the interview. This could make SLU a meeting point for all landscape architects and use this as a base for increasing its societal impact.

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Panel/ Research Nature and Society field

UoA

Rural Development – Sweden and Europe

#### Introduction

#### General assessment of the Unit of Assessment

The UoA focuses on rural development in Sweden/Europe with a good profile, putting emphasis on social organizing, politics and cultures of environmental governance and rural transformations, of conflicts over resources, energy needs, migration flows, food security and agrarian transitions. In recent years it has significantly increased is publication record in high profile journals.

The finding of research on topics that the UoA focuses on can potentially contribute significantly to policy development and public debates on conditions for regional development in Europe and especially nationally in Sweden. The UoA has a good strategy and capacity for collaboration with society. It is, however, clearly constrained by the imminent loss of staff. A challenge is to ensure an adequate place and adequate work conditions for the social sciences research that this unit represents at SLU.

### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The width of the UoA's interest is broad in addressing a number of different features that affect rural development in Sweden/northern Europe. The approach to link the studies of the global north with studies in the global south is original and provides novel perspectives on what affects rural development. It provides an excellent perspective on how topics of global change, including profound social changes associated with migration in and out of rural areas and the structuring effect of EU as well as domestic policies affect longer term sustainability.

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The analysis of gender and class aspects is a research area where the UoA has been particularly prominent. The strong relations with the South rural development has provided important synergies, especially vis a vis the questions and forms and conflicts over governance.

The research of the UoA provides essential perspectives on the larger agronomic/rural concerns of SLU. The social science contribution that the UoA provides, helps SLU to ensure that it has a solid research base for the strategic ambition of the strategy of SLU 2017-2020 to "contribute the knowledge that society needs to use natural resources in a way that is sustainable in all respects – ecologically, economically, socially and ethically." Without this kind of research the ambition to "to promote multidisciplinary and interdisciplinary science" cannot be accomplished. The UoA's profile is such that it provides obvious links to natural science based research. The methods of enquiry appropriately combine social science and natural science and can engage many UoAs.

The UoA has a strong tradition in evaluating regional development, which has driven some of the research into a more practical area that has not resulted in high scientific visibility.

The research is helping push some boundaries especially in gender (climate migration, environmental practices and governance) forward in novel ways; the scientific impact could be higher, but the UoA's research is well respected. It is one of few groups that carry out this kind of research agenda in Europe.

The UoA has and is developing good national, European and international networks. In the process it should increase the width of researchers aiming for high profile international journals. This is not a problem with the quality of the research, but perhaps more with the confidence of the scholars. At the same time there is a need to reflect at the SLU level on appropriate monitoring of the publication records. The Web of Science is biased against the publications that the UoA delivers.

There is substantial potential in the unit's work. Local management of natural resources in a European contexts, including local actors' organizing, networking and engagement in environmental governance, environmental citizenship, conflicts over commons, as well as rural policies and everyday citizenship in rural areas are important topics that will continue to be of scientific and practical interest. The UoA needs, however, to increase efforts in making the work known. In the recommended recruitments that will replace the retiring staff, the capacity for international publishing should be an important criterion. This would also help in attracting high level social science scholars to SLU. The unit has had high level guest professors and this practice should be continued.

#### Score for Scientific Quality

4

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc The material provided and the interviews with the UoA showed that there is a strong vision and a clear idea about where the efforts should be made within a broad framing construction of socio-environmentalism and political ecology. The perspective on gender, power, forces of climate change and globalization shaping rural development provide a base for stimulating and creative research. Issues of how local governance and engagement can modify and create different kinds of thinking about what rural development might look like and be supported in a novel ways provides both topics for research and practical applications. The approach of the UoA is attractive for scholars in the field and offers several important future trajectories.

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The invitation of three guest professors has been an excellent way of complementing the units own research and the invitations should continue.

The gender balance is good. The UoA is, however, facing a serious problem with the loss of three staff members and replacements are urgently needed to maintain critical mass. Without replacement the UoA would have to limit its scope and its possibilities to co-operate with other UoAs to achieve SLU's strategic goals would be severely limited .

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

There have been active mentoring efforts and collaboration with many different UoAs within SLU and beyond. The UoA has provided support for young women scholars though workshops, mentoring and collaboration of papers and grants. The regular presentation of research results and writing support shows a great deal of attention to supporting young scholars. The exposure of the researcher and students to high profile visiting professors has also provided 'role models' for young faculty.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The collaboration is broad for a small UoA. The links and collaborative efforts between the studies of rural development in the global south and global north are particularly interesting. The unit has made a visible impact in the scientific debates dealing with rural development by bringing in, for example, gender perspective and by examining power structures. The work has contributed to a wider European and international research interest in the context of development studies.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

Practically all the work of the UoA is highly interdisciplinary: publications engage more than one discipline, and they are published in interdisciplinary journals. The UoA interacts across disciplines in SLU, and there are strong links to stakeholders. The synergies with other UoAs in SLU are limited by the number of staff, not by the ambitions and visions of the scholars. Thus resources invested in this UoA directly enhances the overall capacity and practice of interdisciplinary research in SLU.

One of the challenges is the relative lack of social science peer support within the SLU. Synergies between UoAs have increased the relative strength of the social sciences orientation, but further possibilities could be explored. However, if the UoA is reduced to a very small size it is obvious that it is obvious that also many potentially important opportunities for developing interdisciplinarity will be missed.

#### Score for Scientific Environment

4.5

#### 1.3 Strategy for Scientific Development

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The strategic goal of the UoA: "To carry out cutting edge research that theorizes and provides policy openings to deal with future challenges in relation to environmental degradation/climate change, food security and agriculture, the abandoning of rural areas despite their being generators of wealth and the increasing conflicts over the governance of natural resources in European rural areas" fits very well with SLU's overall strategy and the ambition to contribute the knowledge that society needs to use natural resources in a way that is sustainable.

The UoA is forced to renew itself through the retirement of a significant proportion of the staff. The UoA and the research it represents is resource starved and the demand to replace retiring staff is highly justified. It would allow the UoA to fulfil its renewal and contribute more strongly to the SLU interdisciplinary work in connecting large scale societal processes with local impacts and responses. To support recruiting within the limited resources the UoA has, the strategy is realistic, but at the same time aspirational.

The possibilities to implement the strategy will depend heavily on the staffing in the coming years. The strategy lists four major topics and it is clear that it cannot excel in all of those topics. The UoA is therefore advised to further reflect strategically on its topical priorities both from the perspective of its own skills possible recruitment and from the perspective of linking with other UoAs to create a strong SLU contribution to the chosen areas. In particular, joint strategy work with the global south UoA can be highly beneficial.

The UoA has identified that the tradition of publication with PhD monographs, at times in Swedish, is a weakness. The Panel agrees with this and encourages the UoA to make the shift in publication practice a clear strategic goal. It would not only enhance the visibility of the UoA but also strengthen directly the possibilities to publish interdisciplinary pieces with other UoAs.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The general research direction is fairly clear, but as noted above it is relevant to develop a specific profile to support significant contributions in the field. This additional strategic reflection is likely to support appropriate recruitments that benefit SLU as a whole and also the teaching of the unit.

Migration – the overall topic is relevant and provides possibilities for a large programme. It will important to formulate themes that engage other units at the SLU and also other Universities in Sweden and beyond.
Critical research on rural policies, local governance and everyday practice: This has the potential to contribute to policies, but the field is vast and thus specific angles and approaches should be thought through strategically, including the links to other UoAs.

- Genetically modified crops in Europe. The topic is certainly 'hot', but it is also a research field that is very widely studied from many angles in Sweden and internationally. The UoA should reflect on its potential contribution to a very widely researched. None of the reported publications for KoN appear to address this topic and thus it is not clear how the UoA can make a significant contribution.

- Research in agricultural change and food production in relation to security risks research on and the role of agriculture and farmers in defense policy – the overviews are very interesting and research can link with many other UoA across the SLU, but the formulation of a strategic research agenda would be appropriate.

- Establishment of short food supply chains – the topic of transition is interesting, but how is it related to all the other themes the UoA wishes to cover?

- "Climate change and resource extraction from the perspective of the local communities and analyses of the movement of capital, of policy-making and activist across geographical scales" - this is a wide frame that could generate concrete topics for all the other areas listed by the UoA. It is worth making the links explicit as the topics can lead to highly interesting studies on rural policies and rural life, governance and social capital.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The ability to replace the retiring staff will certainly affect the UoA's ability to perform. The recruitments will be critical in creating a base for more ambitious publication activities. The UoA is doing well on research funding etc, but the UoA is stretched in covering research and significant teaching with little personnel. The combined role with teaching and research is, however, generally a positive aspect as it allows for research based teaching and engagement of students in research activities.

#### Score for Strategy for Scientific Development

#### 4

#### **1.4 Additional comments**

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

Bringing the social science units closer in order to increase visibility and critical mass needs to be reflected upon. The following point raised by the UoA merits serious consideration within SLU

"To be able to work over disciplinary boundaries we need to have in-depth knowledge and be at the cutting edge of our own research fields in order to be able to our work with other scientists at SLU. We aim to further strengthen our collaboration with biophysical research at SLU. Being social scientists at SLU, we have potential opportunities for multidisciplinary collaboration that are not fully realised yet. Support for collaboration, and recognition of the disciplines' differences, is important on all levels at SLU (from the department, faculty and university leadership)."

Similar observations were made by all of the UoAs that have a social science orientation. This issue needs to be taken seriously not only for the research profile of the SLU but also for ensuring that students at SLU get diverse and deep insights from the social sciences. If SLU fails to provide adequate conditions for social science research it will also face difficulties in recruiting top researchers.

### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The unit has actively brought its knowledge to use, even risking some scientific output. The UoA stressed the need for strategic planning at the level of SLU to ensure that time can be allocated for outreach activities and the Panel agreed that strategic thinking on outreach is important for SLU as a whole.

The unit is well connected to the Swedish society on many different levels and to relevant organisations and networks on a European and international level. The panel acknowledged the UoA's strong emphasis on the importance of reaching out to a wide range of stakeholders in the Swedish countryside. The unit identifies immigrants and rural youth as groups of special interest to work with. It stresses the importance of giving feedback also on research to its stakeholders and strives to be active in public debates and research communication.

The unit has been commissioned as experts in processes on a national and EU-level. Stakeholders include the Nordic council of Ministers (the Living Local Economy Conference) and the Swedish Board of Agriculture (evaluation of Rural Develoment Polices on EU-level). Representatives of the unit have also been called in by the World Bank as experts on sustainability and gender – a research field where the panel conceives Rural development Sweden and Europe as especially strong.

Furthermore the unit makes efforts to benefit in a more structured way from their students work with stakeholders from mainly the civil rural society. In order to work more organized and strategical they have created a database in order to keep track on student projects.

Given its small size, the activities and outputs of the UoA are excellent

#### Score for Activities and Outputs

3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The changes in the rural debate that the UoA has contributed to are important. It is difficult to prove that these outcomes would solely be the result of the UoA's activity, but the UoA has certainly been part of and contributed to the 'Zeitgeist' of change.

Another important contribution to policy making is recognition of the interconnected rurality which can be local but never isolated. In the same way as in urban areas, the countryside is constantly influenced by global flows where economy, gender, migration and climate change affects the everyday life. The UoAs work to influence how narratives on rurality are constructed supports policy making and further studies of rural realities.

The introduction of gender and power in debates on forestry, environmental sustainability and agriculture within both SLU and various international organisations has been an important contribution in bringing reflections from development work in the global south to development work in the global north. This shows how outcomes of the UoAs of SLU can benefit from cross unit cooperation and the UoA has been active in delivering such outcomes.

In relation to its small size the UoA has achieved excellent outcomes in terms of influencing rural development discourses and policy

#### **Score for Outcomes**

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#### 2.3 Impact strategy

3

# 2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The description of the UoA's strategy for societal impact is well formulated. As a strategy for influencing society it may, however, be partly too academic. The UoA should identify specific entry points and windows of opportunity that the UoA may have or strive to exploit.

The strategy recognises that the impact strategy boils down to publishing and active interaction with stakeholder. The difficult task of finding a good balance between the two will benefit from further strategic reflection in the UoA. The small size of the UoA means that it cannot engage in direct interaction with a wide range of stakeholders, but needs to find different way to accomplish outreach, including the handing over of specific outreach tasks. The connection to and continued co-operation with alumni is an excellent example of a way to increase impact. Strategic thinking on how to best increase impact is also likely to contribute to SLU wide reflections on and suggestions for the recognition of stakeholder collaboration in the university career system.

The substance areas that the UoA has identified are well justified by the skills and orientation of the UoA. As some of the areas may be very sensitive to staff changes in the small UoA here is a need for strategic reflection on how the unit can maintain its contribution, possibly in co-operation with other UoA. The panel notes that the unit works with very many questions, and that it would benefit from focusing especially its ambition to influence society.

#### Score for Impact Strategy

2

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA has a good track record of collaboration with societal stakeholders and demonstrates awareness of the opportunities and challenges of such collaboration. The network of alumni that the UoA has established and encouraged means that they have a continuous feedback and 'reality check'. Dialogue is strong in the UoA.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

As the UoA notes there will in any case be a generation shift in the UoA in the near future. This means that the UoA will have to 'reinvent' itself also when it comes to the capacity for collaboration. The collaboration cannot any longer build on the same kind of long experience – even if senior persons are recruited. The real challenge lies in strengthening the academic competence and to use it as a platform for developing collaborative capacity further, in combination with a 'co-creation' process that starts from collaboration that helps identify scientific topics in the areas where the UoA has specific strengths, in co-operation with other relevant units at SLU. This can be achieved if the units resources are maintained and if a strategic discussion on the role of SLU in collaboration is carried out to identify the specific role of the university (in relation to, for example, extension services or consultants).

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Panel/ Research field	Nature and Society	
UoA	Environmental communication	

#### Introduction

#### General assessment of the Unit of Assessment

The committee was impressed with the Environmental Communication faculty's robust and meaningful academic program. They have a productive faculty doing applied research in this very broad, interdisciplinary field. The International Environmental Communication Association defines environmental communication as "communication about environmental affairs. This UoA includes studies on participation, collaboration, conflict and resistance in environmental decision making, implementation and change processes from a communicative perspective. Their research sites span both the global north and south, including work in Nordic and European countries, Mozambique, Ethiopia, Columbia, Nicaragua, Chile, India, Australia, USA and Canada.

There are few institutions of higher education that have this size faculty focusing on environmental communication in one unit and consequently they have an international reputation for the quality and impact of their contributions to the scholarly field of environmental communication. We found they could strengthen the quality of their research by expanding their use of methods into quantitative research, which would require adding this methodological skill to their faculty. Because of the applied nature of their research, it has direct societal impact and takes advantage of its ability for collaboration with society to create change in environmental contexts.

### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

Environmental Communication (EC) has had a productive research agenda and output over the last five years (2013 – 2017). By hosting the 2013 Conference on Communication and the Environment (COCE) conference that had always been held in the United States, SLU was successful in putting itself on the world map in environmental communication and internationalizing COCE. This UoA's scholarship is unique by combining applied scholarship with critical and theoretical questions. In other words, its applied scholarship is used to develop critical theory in environmental communication, thus contributing not only to EC theory but also offering sociopolitical critiques in the process. The faculty created strategic research teams around the following key interrelated areas of societal change, environment, and communication. They do this on three communicative levels: micro (interpersonal communication between social actors), meso - the process design by which actors communicate (how they communicate), macro – the societal structures that shape communication and influence outcomes (informal and formal power dynamics). Quantitatively they had a healthy output with the unit reporting 62 journal articles, 14 book chapters, and three edited books. It should be noted that the bibliometrics data reported differing results with between the time period of 2012 and 2016 44 journal articles, 16 book chapters, and no books. 9% of the articles published between 2009 and 2016 had a citation percentile profile in the top 5%, 19% were in the top 10%, 34% were in the top 25%, and 69% were in the top 50%. Additionally, one research project, "The role of learning in transdisciplinary research: moving from a normative concept to an analytical tool through a practice-based approach," published in Sustainability Science, 11 (3) was selected by the journal for its Outstanding article in 2016. With 10.6 FTE we conclude that this research output is a healthy number but believe the faculty could

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work on increasing their citation numbers and research impact in the field. Of the ten major scientific publications during

2013-2017 they posted, the highest number of citations the top article received was 29 The average citation number for the ten articles was 9, relatively low compared to other units of assessment in this panel.

The research of this EC unit is primarily in the area of human communication and its impact on environmental problems, as opposed to the analysis of environmental texts. They explore topics such as sustainable development and social change, game management and illegal hunting, agricultural extension, impacts of bio-economy, on forest policy and practice, climate change adaptation, sustainable urban planning, and indigenous rights in mining.

#### Score for Scientific Quality

4

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The Environmental Communication unit emphasizes a transdisciplinary approach to research, which attracts researchers from a variety of intellectual backgrounds. While the unit is searching for a new academic head, they were able to attract three prominent researchers to the university for guest professorships. These guest faculty have assisted with strategy development, proposal writing, mentoring younger faculty, teaching, and supervision. These guest faculty are from the United States, United Kingdom, and New Zealand which exhibits the unit's degree of external influence through international recruitment.

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The research team receives support, encouragement, and creative motivation through a variety of leadership initiatives including:

1) All staff except post docs have permanent positions, which not only contributes to employee satisfaction but also to longevity within the unit and the capacity for longplanning;

2) They encourage a collaborative research application process

3) They offer "reality checks" for writing projects that help improve manuscripts and research that is in progress;

4) They offer three-year projected teaching plans that help organize adequate time allocation between teaching and research.

The faculty is primarily made up of women, with eleven of the fifteen staff comprised of females. The current leadership of the unit is shared between two females, associate professors, as they complete their search for a new academic leader. The faculty distribution is skewed toward Researchers and could use a better between senior and junior faculty. There are 9 Researchers (of 15 total faculty), 1 Senior Lecturer, 3 Post-docs, and 2 "other research support staff." They are in great need, in particular, of senior faculty who can be a strong representative of the UoA in the Faculty and more broadly the SLU.

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

Environmental Communication has an impressive mentoring program that supports young faculty. This program includes the excellent initiatives listed above but in addition;

1) Mid-career and senior staff co-author papers with younger staff.

- 2) Faculty are encouraged to take courses in pedagogy to improve teaching and supervision (this is required for associate professorship).
- 3) Researchers are given the opportunity to teach and/or supervise students as well as given time for research only.
- 4) Younger staff can influence the UoA research strategy and connect their own projects to the goals of the larger unit.
- 5) Writing weeks are spread out over the year where administrative duties and committee meetings are reduced to allow time for uninterrupted writing.

Few of the units of assessment had this level of mentoring for their research team, which provided sufficient leadership to guide young faculty and "encourage their development into independent researchers."

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

Environmental communication as a discipline is inherently interdisciplinary and this unit is no different. This unit draws from a breadth of disciplines that inform its research including: agronomy, political science, sociology, anthropology, human geography, urban planning, social psychology, environmental politics, and conflict studies. Because of their interdisciplinary nature, they work with a number of SLU units and centers including Society and Landscape Research, Centre for Nature Interpretation, and the Future Food, Sustainable Cities, and Water Platforms. Furthermore, the unit covers a wide geographical scope with their research projects spanning the globe from Nordic and European countries, Mozambique, Ethiopia, Columbia, Nicaragua, Chile, India, Australia, USA and Canada (as mentioned above). Because they often work with engaged methodology, which draws upon local and indigenous knowledge and participant observation, their work is necessarily collaborative and therefore, has a richness and depth.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

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As a highly interdisciplinary unit by nature, it would be unusual for Environmental Communication to not have collaborative projects with other UoAs at SLU. As indicated above, they are living up to their potential. In fact, it would be easy for them to spread themselves to thin across SLU and as a result, lose the focus they now have on current research projects. When we were conducting our interviews with the other UoAs many of them either mentioned their collaboration with Environmental Communication or described how they would benefit from such a collaboration. We suggest they continue to choose their partnerships carefully and focus on areas that will highlight their own research strengths and draw on existing expertise.

#### Score for Scientific Environment

#### 5

#### **1.3 Strategy for Scientific Development**

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

Over the next five years Environmental Communication articulates a clear set of three goals that realistically map out a research trajectory that has the potential to position this SLU UoA in an international spotlight. These goals are as follows:

- Develop research projects in emerging areas in EC including the role of communication in a digital age, communication in relation to Global North-South issues, climate change communication, and gender/intersectional analysis of communicative processes for social change.
- Host an annual Environmental Communication Day for practitioners, Natural Resource Managers, and researchers to network, share best practices, and the most up-to-date research. Similarly, they will reprise their extension courses for public NRM/environmental authorities on dialogue competence and conflict management.
- Continue to promote critically engaged, interactive research methodology from an interdisciplinary standpoint. This research will continue to use the various intellectual resources around the university to strengthen disciplinary ties to other units and centers throughout SLU.

We find these strategic research directions to be practical based on the current faculty expertise and also for the goals of the unit.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

EC has a clear strategy for how their current staff can contribute to the current and future conversations around research questions concerning:

- "How can we develop agonistic modes of planning and decision making that recognize difference, address structural inequalities, and enable democratic social change?"
- Transdisciplinary Methodological questions "How can different ways of knowing, participating, and documenting be effectively integrated in NRM and environmental governance?"
- Digitalization of communication and its relationship to EC
- Climate justice and land grabbing

These topics and methodological issues are on the forefront of the discipline and given the expertise of this EC staff, they are poised to contribute meaningful research to the intellectual conversation.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

Currently there is a search for a new professor and with the successful completion of that position hire, the UoA's senior staff will be strengthened. The process should advance as fast as possible as it will influence the UoA's capacity for engagement both within and outside the SLU. As with other UoAs in social sciences SLU will need to strengthen them in order to live up to its goal of interdisciplinarity. The focus should be on hiring more senior faculty positions and hire those who have the capacity to have a career path towards senior positions at SLU. The Panel suggest that future staffing focus on hiring those with tenure track lines, which will attract competitive candidates because of prospects of promotion and greater job security.

The unit needs to recruit promising, young scholars to their faculty and place them on a career trajectory that develops the research agenda in a creative way. At the same time, the unit also needs PhD students and postdocs who, by definition, would not remain, but cross- fertilize the UoA's research agenda and then move on in their careers. In this manner, the unit will gain a stronger reputation internationally.

#### Score for Strategy for Scientific Development

#### 5

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The unit has made an impressive impact with the breadth and depth of its research, ability to recruit highprofile faculty to its program, and make contributions to UoAs throughout SLU due to the expertise they can provide. However, the unit needs human resources to meet the demand for this expertise. For the past two years the unit has been without a full-time professor and has had only one associate professor. Concurrently, the teaching load increased significantly to meet the growing demands at SLU. While mid-career researchers have made efforts to compensate for this lack of senior faculty, they are feeling the lack of necessary staff to maintain the work load. Despite this challenge, the unit has been successful as evidenced by receiving high levels of external funding for research, increasing PhDs, achieving associate professorships, and publishing a number of studies in key international journals. Given further resources, they could easily become a world leading academic program in environmental communication.

### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

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Knowledge about how to deal with climate change and loss of biodiversity from improper natural resource management are complex problems, often loaded with strong emotions, conflicting goals and established systems. Environmental Communication is well positioned to take up the challenge of providing research-based answers to these complex problems and help contribute solutions. The EC unit exhibits a wide range of societal outputs and activities based on their research ranging from forest policies to urban planning, wildlife management, and indigenous peoples' rights.

The following few examples represent the breadth of societal outcomes of the research and activities of EC:

- Meetings with Rosendal Fastigheter regarding strategies for energy reductions in housing indigenous rights and natural resources management
- Three workshops with 12 public agencies, 13 Sami reindeer herding communities, and 5 mining companies on indigenous rights and competing land uses
- EPA-commissioned evaluation of multi-stakeholder dialogue process on the right of public access
- Action research project on national park management in Zapatera, Nicaragua improving communication between local communities and park authorities
- Collaboration with Swedish authorities of Local Authorities and Regions to facilitate 5 dialogue meetings in spatial planning

We find that Environmental Communication's full potential for societal impact is being met given the size of its staff, their research profile, and activities and outputs. However, its societal impact could be even greater if the staff were enlarged because there is the demand for their expertise.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

Panel 16 - Nature and Society

The EC prioritizes external stakeholders that have a directly affected by the equitable and ecological resolution of environmental issues. Based on this priority, some of their most important stakeholders include indigenous organizations such as Sami reindeer herding communities, NGOs such as Rural Economy and Agricultural Societies, and government agencies such as the Swedish Environmental Protection Agency (SEPA).

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The SLU EC UoA has been notable for its practical and significant outcomes that address pressing environmental problems. Their research does not remain within the confines of academia but rather, has a meaningful presence in society, making change where it is needed. For example, they have established "communication capacity" as a "competence" recognized by various agencies. Their research project in Zapatera, Nicaragua helped shape Sweden's global development concerning democratization through participation. Their research project on democracy and conflict in nature interpretation resulting in knowledge development and revised planning for "Naturum."

A more specific example of their exemplary outcomes can be found in the project on Cumulative effects and indigenous rights: Re-designing impact assessment and land use planning in Sapmi. Working with the Stockholm Environment Institute, the UoA brought together researchers, representatives of indigenous Sami people, and civil servants from Swedish permitting authorities in collaborative problem solving analysis; development of concrete administrative practices; and identification of regulatory reforms. The end goal was to improve barriers to effective cumulative effects assessment (CEA) (determining past, present, and future impacts on the land). This has been a point of contention for indigenous groups like the Sami, whose land rights and livelihoods are often affected by competing demands on the land. Ultimately the project resulted in relevant and practical outcomes for all involved, including empowerment of Sami actors to participate in assessments.

This type of collaborative effort is an ideal example of how research in Environmental Communication has had a societal impact. The project involved multiple stakeholders, one group with a considerable disadvantage due to a history of injustice (Sami people) and found a practical outcome for a significant societal issue and contributes to scholarly research.

#### **Score for Outcomes**

3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

#### This UoA's specific goals are as follows:

- Develop methods for facilitating democratic processes for promoting sustainability
- including Natural Resource Management, with attention to marginalized populations

• Collaboration with stakeholders during research projects to ensure relevance and impact – focus on building research project together with social actors from the inception of the project.

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• Strengthen the role of the UoA as a national platform for EC practitioners continuing their program on courses for "Dialogue for Nature Conservation" and development of other necessary training based on research and stakeholder needs.

The demand for EC expertise exists; however, it is not clear to the reviewers that there is a well-defined and expressed strategy to meet this demand. On the contrary, it appears that the growing needs within the society and the resulting increase of requests for support cannot be met by the unit. We don't see this as a fault of the staff within the unit but rather, a fault of the university regarding into slow recruitment of senior leadership in the unit. In order to develop and implement an impact strategy that meets the demands of society, EC must have strong leadership that can focus on developing and accomplishing unit capacity. Furthermore, the EC need more staff to implement their collaboration efforts, training seminars and workshops, and outreach with the public. The unit also needs a stronger digital presence that will allow them to more readily disseminate their research findings, publish training videos, and position them as a premier international source for environmental communication. Their research and societal impact is impressive but is partly hidden because SLU hasn't invested in a mechanism whereby they can broadcast these outcomes. For instance, a digital presence like the Yale Program on Climate Change Communication would help realize this, see: http://climatecommunication.yale.edu/. Such an investment would not only have significant societal impact but also increase SLU capacity for collaboration with society.

#### Score for Impact Strategy

2

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

Given the complex and serious environmental problems society faces and how effective environmental communication plays a central role in the solutions, it has not been a challenge for the unit to find interested stakeholders. As a result, a significant amount of collaboration with society has developed in this unit. The unit understands that they must build stakeholder capacity in underlying communication processes; emergent processes of social change; social interactions such as conflict, learning and negotiation concerning natural resource management; and collective action in the context of environmental issues. To do this, they must collaborate. In other words, they must reach out to those they seek to help and gather information, suggestions, knowledge, and guidance to improve their research and outputs.

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The unit's primary collaborative efforts have centered around the need for dialogue in environmental controversy, especially over land use, indigenous land rights, and competing demands over resources. One project that exemplifies their ability to collaborate with society was their "Dialogue about the right of public access." The unit has had a long-standing collaboration with SEPA through the education program "Dialogue for nature conservation." Given the success of this collaboration, the unit was contacted by SEPA to work use the dialogue process to manage strong and differing opinions on the right of public access. The UoA brought together representatives from SEPA and about 20 stakeholders representing a variety of interests in public access. The project resulted in two major findings: 1) the goals of the dialogue process itself were never agreed upon due to differing understandings; 2) there was no consensus among participants as to how public access could be developed in the future. While this might seem like an unsatisfactory outcome, the UoA found great benefit after the analysis of the process. They found that participants learned more about public access issues and increased their understanding of the views of other stakeholders. They also learned more about the dialogue process itself and continue to receive requests from SEPA to collaborate.

The type of research this unit does, engaged, participatory action research, is necessarily collaborative. It requires the input of the "subjects" whom they are studying. With time the growing demand from the society for support and help with environmental communication has developed to an incipient challenge for this unit. The UoA does not have the necessary staff to deal with the heightened situation. We recommend SLU to invest resources in the necessary personnel and infrastructure to support such an endeavor.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

To develop and implement an impact strategy and capacity for collaboration that meets the demands of society, EC must have a strong leadership that is not overburdened with their own research agenda so that they can focus on developing and accomplishing unit capacity. Furthermore, the EC needs more staff to implement their collaboration efforts, training seminars and workshops, and outreach with the public. The unit also needs a stronger digital presence that will allow them to more readily disseminate their research findings, publish training videos, and position them as a premier international source for environmental communication. Their research and societal impact is impressive but is hidden because SLU hasn't invested in a mechanism whereby they can broadcast these outcomes. A digital presence like the Yale Program on Climate Change Communication would fulfil this kind of demand. Such an investment would create not only a significant societal impact of research but also increase SLU's overall capacity for collaboration with society. Additionally, this will most likely result in an advancement of SLU EC's world presence, moving them from a rating of "internationally recognised" to "world leading."

We think that a strategy for collaboration and focused research, as sketched out above, is necessary to help the unit take the next step in its development.

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Panel/ Research field	Nature and Society
UoA	Swedish Biodiversity Centre

#### Introduction

#### General assessment of the Unit of Assessment

Turbulence has affected the UoA and it appears still to be in a phase of buildup. The quality of the research is acceptable, with a number of publications in good journals. The most cited publications of the CBM are still clearly natural science oriented. This reflects partly the bias of the WoS citations against social science publications, but it also indicates that the shift to studies focusing on the relationship of society and biodiversity are only emerging. The most recent journals, books and reports are more interdisciplinary oriented in line with the strategy of the center

The CBM plays an active role in making biodiversity issues known in society and contributes to this work in many areas of terrestrial biodiversity.

### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

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CBM states that its focus is mainly on terrestrial habitats and cultural landscapes (forests, agriculture, infrastructure etc) as well as the policy, planning and management related to biodiversity and societal development. This is not achievable within the CBM unless significant recruitment is carried out to attract a wider expertise of political and social sciences. There are some seeds for this with e.g. part time expertise on legal matters. The UoA and SLU (and UU as a partner in the UoA) should reflect further strategically on the orientation.

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If the true ambition is to make in depth contributions to the broad topic of "complex interactions between biodiversity and societal development" then there is a need to strengthen the social sciences in the centre. There are some possibilities for this as also other UoAs in the area of Nature and Society can potentially contribute to the works and also benefit from interactions with the CBM. A partial solution would be to mainly strengthen the historical analyses, but even these would likely benefit from the participation of a wider set of social scientists such as political scientist, economists, legal scholars etc. The claim that (4.4a) "CBM studies include a range of methods and approaches in ecology, humanities and social sciences" is true at a general level, but the staff profiles still show limitations.

The links that the UoA identifies with other institutes in Sweden are limited to institutes with a focus on biodiversity. Among these the UoA may have a relatively clear position, but it is somewhat surprising that the response to 1.1b does not at all reflect on links with, for example, the Stockholm Resilience Centre, whose research streams http://www.stockholmresilience.org/research.html to a large degree also deal with the "complex interactions between biodiversity and society". The claim that "Each researcher thus keeps track of the international research front in order to make a solid and new contribution in their field" is not fully convincing as it would suggest that there is no overall strategy that the UoA tries to pursue. This observation calls for an internal strategy process to increase internal synergies and identify common themes where the CBM could make contributions as a unit rather than a collection of individuals. There are also international groups and organisations devoted to the exploration of biodiversity and society, for example the German Centre for Integrative Biodiversity Research https://www.idiv.de/about\_idiv.html which raises the same overarching questions as the UoA.

The UoA has succeeded in obtaining external research grants, but the annual budget suggests that the sums are not particularly high. The main part is obtained from Swedish public authorities, with research council and foundations representing less than 15 % of the total. EU and other international funding has been a very small fraction. If the UoA has an ambition to become internationally leading then a more active approach to international research grants are likely to be in order.

#### Score for Scientific Quality

#### 4

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

Panel 16 - Nature and Society

The report of the UoA underlines the turbulence that the CBM has experienced and that the turbulence appears to be partly continue with insufficient serious commitment to the CBM from the UU's side.

The ambition to jointly formulate "a long term vision and three overarching goals to support the vision and mission for research, co-operation with the community outside academia [samverkan] and for CBM as a work place." is very good but it is not fully clear how this will be accomplished.

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The explicit effort to increase the amount of research and research-based publications is likely to create new contacts and can also boost other activities. Paying attention to how the expert services, monitoring and research can operate jointly is potentially a strong combination that the UoA can capitalize on. It introduces a 'transdisciplinary diversity' that can create an interesting base for the UoA, but also making the UoA attractive as a partner for other UoA and collaborators beyond the SLU and Academia.

## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The CBM covers topics that surely are of interest to young researchers. The lack of direct teaching responsibilities in terms of courses has been justified by the special role of the CBM, but the limited possibilities to supervise PhDs and the lack of tenure track positions unduly hampers the possibilities to develop staff and offer the staff possibilities for advancement. This suggests that the CBM can offer interesting tasks for young researchers, but at the same time researchers with an ambition to advance in the academic world should not stay too long. This appears to be an area where SLU should consider strategic decisions on the position and role of the centres such as the CBM.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA is interdisciplinary based on its mandate. It has developed an international network and has also had one international recruitment, four from other Swedish universities and four post doctoral positions. This has brought in new links in the academic field. The outcome in the form of an international book is a sign of international impact in the interesting field of historical ecology. The CBM participates in several international networks and thus has contacts to many different organisations. When one examines the number of co published articles one finds a very wide range if single articles are counted.

With a cut-off point of two joint publications the network is very much smaller. The panel suggests that strategic reflection on which academic networks the CBM wishes to contribute to would be very useful.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The CBM has connections with several other UoAs in SLU. The description (1.2d) does not elaborate on the type of projects, but there appears to be potential for even stronger links within the SLU, especially to strengthen the social science dimension that several UoAs have commented to have a relatively weak position in SLU. A conscious effort needs to be taken to build stronger links between UoAs. Otherwise there is a risk that a path dependent progress will prevail and the full potential of truly interdisciplinary projects will not be reached. As an example, it is somewhat surprising that the link to the UoA 595\_1\_NJ - Agrarian history is not explicitly mentioned, despite the successful initiative of CBM is historical ecology.

#### Score for Scientific Environment

#### 1.3 Strategy for Scientific Development

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

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The three goals on Research, Societal relevance and organisation and work place (1.3.a) reflect an ambition to combine academic work with applied (transdisciplinary) efforts.

The base of the strategy is sensible, given the current role and position of the CBM. The planned actions (1.3a) look meaningful, but appear to be in different states of development and are likely to require very different types of actions. For example maintaining existing strong fields such as historical ecology is probably a good base for making humanities research more visible and applying for large interdisciplinary projects, but the material provided suggests that this will also require stronger co-operation and possibly also recruitment(s). The foreseen recruitments are suggested to for infrastructure and alternative habitats, but it is not clear what aspects will be emphasised. It seems that the CBM and the SLU will need to reflect carefully on different possible routes since there are other UoAs that potentially can make major contributions to this particular area, notably 595\_5\_LTV - Landscape Architecture, 644\_1\_LTV - Urban Vegetation, Governance and Management 644\_2\_LTV - Design of Urban Landscapes and Landscape Planning. The particular role of the CBM needs to be thought through. With good strategic combinations significant research impact can be achieved.

The outlined strategy specifically identifies "Research in the role of indigenous and local people in the management of biodiversity" and its integration into the Policy and implementation strand at CBM. This is an important field globally, but again a case where co- operation with other UoAs is likely to be important, including 595\_2\_NJ - Rural Development – Global south and 595\_4\_NJ - Environmental communication.

What appears to be missing, or only exist implicitly, is the wider policy and political dimensions of biodiversity. Reference is made to e.g. large government organisations, but there are no reflections on the pathways and transitions that may be needed, or the obstacles they encounter in economic, political, legal or broader policy dimensions.

The description does not clarify how 'paradigm challenging papers' fit into this, but may be an option. However, the description doesn't provide any indication of their nature.

The panel's conclusion of the material and the interview is that there are many interesting elements, but the CBM still needs to go through its strategy, identify concrete steps ahead and especially links with other UoAs as well as units outside SLU. This is part of an identity building for the CBM that still needs to continue.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

Research on mainstreaming, historical ecology and research on infrastructure habitats all have a potential for strengthening the CBM's role. However, they are in very different positions. In historical ecology there is a track record as well as in infrastructure habitats. The infrastructure research has evidently focused largely on the natural science aspect of the opportunities (2.4a3) and not on the economic, political and regulatory aspect. The CBM should reflect on its focus and future direction in this area, especially since recruitments are imminent. The work on mainstreaming can, as reflected in case study 2.4c build on the transdisciplinary work that the CBM is engaged in and it gives the CBM a potentially unique position. The scientific work on this is still in an early phase and the CBM should reflect on how it will be able to build up a critical mass in this field.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The ambition to develop a strong research unit on the complex interaction between society and biodiversity requires internally a further strengthening of the social sciences in the UoA and ways to ensure the integration of natural and social sciences at the level of research as well as societal contributions. This should be considered in the recruitment and strategic reflection of the unit.

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Externally this also implies a further strengthening of the co-operation with national and international research communities with a similar orientation.

The UoA evidently sees its output mainly in the form of publications and reports. However, it would be useful to reflect and make a conscious decision on, for example, the creation and maintenance of either case descriptions or some other form of data base that allows for an accumulation of knowledge in a more systematic form than papers and reports.

#### Score for Strategy for Scientific Development

#### 3.5

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

- 1) The position and role of the unit in an academic sense: PhD supervision & tenure track positions. The pros and cons of having the CBM as a special unit without teaching vs integrating it more closely with the teaching and training should be explored.
- 2) The profile relative to other units especially with respect to the balance social sciences/natural science
- 3) The long-term accumulation of information form of a need for systematic data storage on the societal aspects of biodiversity, especially in relation to the other BD units in Sweden
- 4) A clarification on the role of UU and its commitment to the maintenance of the CBM. This relates to issue 1) above. The material and the interview suggests that th relationship with UU is an issue that should be addressed urgently so that the clearly detrimental unresolved matters can be cleared.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

CBM deals with "Biodiversity as a societal issue". CBM has examined biodiversity in relation to bioenergy, grazing (including reindeers), forestry, and historical land use. The unit focuses on how to measure and how to manage biodiversity. The CBM deals with biodiversity policies and legislations on a national and European level on EU-legislation and its effect/ impact on biodiversity in the landscape.

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CBM's activities aim at societal impact. One of the primary focal areas in terms of impact appears to be infrastructure development as suggested by Impact Case study 1 (2.4.a), but also other types of biodiversity impacts have been sought (2.1a). As suggested by both the funding and the list of stakeholders (2.1b) Swedish public bodies are particularly important for the CBM. NGOs are recognised but private sector actors appear to be minimally addressed. This partly reflects the profile of the CBM with a focus on sectors that have a strong presence of public bodies. The forest sector is not particularly strongly present in the CBM's work and this probably also partly explains the absence of private actors.

In the fields that the CBM operates it has a good/excellent track record. From the point of view of biodiversity in Sweden the absence of attention on forests is a partly blind spot. A reflection on the links to bodies/institutes engaged in forest biodiversity would be in order, especially since the ambition of CBM is to contribute in a comprehensive way to Sweden's role in the CBD. It may be rational to exclude forest biodiversity from the profile of the CBM but this could then be explicitly noted.

The panel identifies that a major challenge for the CBM is to convince its commisioners that there is a value also for them as governmental agencies that the outputs aiming at direct impact also lead to academic publications. CBM has in some cases managed to ensure this and this approach to activities aiming at societal impact should be strongly encouraged although it can be challenging.

In the project Supporting policy implementation through commisions of research, inquiry and expert advice, the unit was able to use an agency commisioned study to publish the results in scientific publications. To combine outcomes in this way is the future for CBM.

Despite of the hardship the unit has in most cases been able to combine public outreach with academic publications, the panel acknowledges the strong activities and outputs made by the unit.

#### Score for Activities and Outputs

2.5

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The CBM lists as one of the key outcomes that CBM's reports on the state of the implementation of the Convention of Biological Diversity in Sweden has been the base for the Swedish national reports to CBD, and hence contributed to the Global Biodiversity Outlook issued by CBD. This is confirmed by the fact that the first draft of Fifth national report to the CBD (2014) was compiled by the CBM. In addition the CBM's 4 members in the Scientific Council for Biodiversity and Ecosystem Services, hosted by EPA, contribute to outcomes. Here the CBM can clearly influence the framing of the biodiversity policy in Sweden. The description of the report shows, however, that also other institutes have contributed significantly. The CBM should reflect on its particular contribution and on the co-operation with others in achieving societal impact.

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The CBM has contributed to specific policy areas based on its expertise. It is difficult to judge if a greater impact could have been had, but the CBM should reflect on possibilities to accumulate and store the impact in a more systematic fashion that could build up outcomes over the years.

One of the long term collaborations is with the Swedich Transport Agency (STA) in the project Transport Infrastructure Ecology where CBM is a part. The study deals with how roads and railroads can be planned in order to support and develop biodiversity. The results have been implemented in STAs steering documents and in directives for planning.

Another long term cooperation project is the Historical Ecology and Biocultural Heritage project where The National Heritage Board (RAÄ) is the main stakeholder. Together with RAÄ the CBM tries to find ways and methods on how to understand historical land use and its connection to biodiversity.

The projects have a great potential for inter- and transdisciplinary work; ecology, biology, history, economics and studies of behavior are included in the research that also includes direct communication with stakeholders.

CBM has a documented impact on society, mainly through the strong collaboration with governmental agencies. Good contacts at a personal level have ensured access to key decision makers. The CBM is encouraged to reflect on how the good personal contacts can be 'institutionalised' so that they are no longer dependent (only) on good individual connections.

#### Score for Outcomes

2.5

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The CBM stresses that "More research is needed on the relationship between biodiversity and lifestyles, consumption and production, economics etc." The aim is to bring forth "relationships and dependences that are "invisible" today. This creates possibilities for planning, policy, legislation, societal norms and values to develop in relation to biodiversity.", i.e. transdisciplinary work.

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This strategic approach makes sense from the point of view of the CBM, but the aim is very broad. It would be useful to reflect on which particular areas of biodiversity/societal activities the CBM aims to focus on. In the current profile the focus appears to be on terrestrial biodiversity, largely excluding forestry. This may be a good choice given the overall profile of SLU, but a wider reflection is probably in order as the CBM is expected to contribute more generally to the implementation of the CBD in Sweden. Therefore it is not only about the activity of CBM alone that counts, but also the co-operation between CBM and other units and institutes exploring changes in biodiversity.

With the broad ambition of CBM it would also be justified to explore more explicitly the drivers behind biodiversity change. Thus scenario work that would include different societal pathways and also impacts of climate change as well. Reflections on the impacts of climate change mitigation and adaptation could be made more explicit, even if it is decided to leave this area of dedicated scientific work entirely to BECC – Biodiversity and Ecosystem services in a Changing Climate.

The CBM has a challenging position between societal/ governmental needs and the academia. This position is both its strength and its weakness. In its strategic work the CBM should explore this position and find ways of making use of its potential. The transdisciplinarity that the CBM aims for can be interpreted taking the role of a science based think tank to government agencies in the field of biodiversity, but it can also be seen much more operational.

By examining its strengths new possibilities for outreach work can be found also in co- operation with other actors (consultants, other universities etc.). But the CBM should also reflect on the risks inherent in transdisciplinary work vis'a'vis academic credibility or some stakeholders. If CBM can clarify its position and use it to maintain an independent and 'honest broker' in relation to its stakeholders it may be able to both serve society and to gather material for traditional academic publishing.

The panel encourages the CBM to further develop its impact strategy in a systematic way so that it makes the most of the transdisciplinary position, also acknowledging the 'pitfalls and the steps needed to make progress.

#### Score for Impact Strategy

2

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The CBM has considerable experience in working with society and societal stakeholders. The overall description 3.1a and the interview confirmed a strong awareness of the conditions for good collaboration. The two collaboration cases illustrate this very well and show that CBM is well aware of both the opportunities and pitfalls that are involved in such collaboration. As case #2 shows this does not guarantee friction free work.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

For a UoA in the position of the CBM it would make sense to make an effort to carry out systematic debfriefings of major efforts of collaboration and in this way build up an institutional memory on how to improve collaboration and also on how to act in an agile way, when problems emerge.

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A further clarification of the profile of the CBM is also likely to help as this will contribute to 'expectations management' vis'a'vis external stakeholders.

It would also be useful for the CBM to develop its digital presence. The CBM has identified a "need to increase overall communication capacity" but in this it should more systematically reflect on whom should be reached with what means and how, in particular, digital platforms can be used. The current www-pages of the CBM are 'standard' pages and do currently not offer any particular services. Reflecting on how the CBM could provide more in depth information given its mandate would probably pay off in terms of visibility and deeper collaboration.

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Panel/ Research Nature and Society field

UoA

Environmental Psychology

#### Introduction

#### General assessment of the Unit of Assessment

The quality of the research is internationally recognized with 20 % of the publications 20092015 reaching the top 10 % threshold in citations. The UoA has a unique facility that it has been able to maintain and use successfully in its scientific work. It clearly has potential with better institutional core support to deliver even greater, high impact research and publications. The societal impact is excellent. The UoA provides novel approaches to solve societal problems and has been able to contribute to both societal planning and also practical implementation of actions.

The problem based approach of the UoA is a very efficient way of maintain and developing collaboration with society. The UoA has demonstrated a very good capacity for collaboration.

### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The environmental psychology UoA is an interdisciplinary, social science group focused on the impact of welldesigned and managed outdoor settings to promote health and wellbeing. They have a unique perspective within environmental psychology because of their intellectual ties to landscape architecture. This group has moved the field beyond the notion that nature is therapeutic to a more nuanced and creative analysis of the characteristics of settings that people prefer and find salugenic. They also utilize an impressive array of social science methods along with physiological indicators of human impact. They also are the originators of the world's first theoretically based, healing garden. This group has developed productive relations with healthcare organizations and schools both to conduct research but also to disseminate their work. They have done a good job, extraordinary within landscape architecture, and been able to attract external funding.

#### Score for Scientific Quality

4.5

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The unit has a good balance of gender and ages but suffers from too small a cohort of PhD students. The UoA has also established interesting international collaborations in Asia, particularly Japan. An extremely valuable asset is the healing garden and related facilities. A weakness is the current dearth of contemporary ambulatory physiological equipment that would enable them to better leverage the healing garden facilities. This facility should have core institutional funding so that the faculty can focus more of their grant activity on knowledge creation and extension. Right now the UoA must do this and also raise funds to operate the garden facilities. The group helps young researchers through collaborative projects.

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## 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA has recognised the need for supporting the qualification of younger scholars and has also developed ways of ensuring such support through e.g. the research collegium. Also younger staff has been engaged in education and offered opportunities to engage in active exchange with society and other universities. The UoA is quite successful in integrating research and practice that enables teaching staff to conduct research and have more research faculty engaged in teaching than in many other groups. These partnerships have also offered opportunities to recruit younger staff. Engagement in the LTV-research school, SLU Landscape and the department supports the development of younger faculty.

The Panel supports the approach of intraperson integration of teaching and research. More integration of other social science and health sciences would strengthen the interdisciplinary composition of the group and also support the development of young faculty to independent and qualified researchers.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA is active in collaborative projects primarily in the region because of the garden research facility. The UoAs has intellectual influence beyond the region, however, because of their unique approach studying how landscaped environments can impact people. This is an emerging field where the UoA can make further important contributions.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

More integration of other social science and health sciences would strengthen their interdisciplinary perspective and potentially enable greater opportunities for collaborative research projects in other fields, especially mental health, medicine and public health, and education.

#### Score for Scientific Environment

4.5

#### **1.3 Strategy for Scientific Development**

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA stresses its holistic approach but also notes that all researchers work quite independently and sees a challenge in upholding a common vision and common actions. The UoA stresses the need for strategic thinking on how to channel the efforts of researchers, advanced students and partners in society into knowledge production. The Panel considers this is an important starting point, and observes that a common vision that bridges the work of independent researchers is needed. By initiating a more systematic strategic discourse in the UoA the conditions are ripe for creating a stronger joint scientific strategy. As indicated above a more strategic analysis on how to integrate other disciplines (particularly health sciences) into the UoA's activities could increase the capacity to enrich and expand efforts, potentially increasing funding opportunities

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## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

Better articulation of common goals and uniqueness is needed. The Global SDG goals can be a useful reference, but the specific interpretation from the point of view of the UoA is necessary. Also more detailed reflection on how the UoA can combine its strength to achieve specific scientific contributions in its field is needed. This is especially important as the group considers building upon their current personnel. The UoA has identified new domains for application of theory to shed light on new phenomena in society, but it is not clear to the Panel if all of these should be in the main focus of the UoA. The UoA has projects on green food choices, horse assisted therapy, the conversion of farms for rehabilitation, outdoor offices, and urban agriculture, but these are linked to the therapeutic garden to varying degrees. It is likely this UoA has a coherent vision and understanding of how these various activities are integrated conceptually and perhaps in terms of policy/practice impact. However they need to do a better job to articulate a more coherent framework to persons external to the UoA.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

A clearer strategy for the UoA on where it wishes to go and which topics it wishes to stress is likely to help in PhD recruitment and in identifying avenues of potentially successful scientific contributions. This would also include ways of achieving better integration with other disciplines, particularly mental and physical health. Finding stable funding for the therapeutic garden facility will strengthen continued scientific development and excellence

#### Score for Strategy for Scientific Development

#### 3

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The issue of key infrastructure needs strategic consideration at the SLU/faculty level. For this UoA the therapeutic garden in a special facility where the use can be extended beyond the use of the UoA. SLU should therefore consider how core funding for the therapeutic garden facility can be organised.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

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The range and relevance of the described stakeholders is wide. There are international, national as well as local stakeholders. Many of the stakeholders are important policymakers and it seems that even though the area of environmental psychology is small, the impact on society is big and impressive. The Panel considers the Alnarp rehabilitation garden to be a unique testing arena, that serves both as an important door opener to wide societal collaboration and societal impact.

One of the important issues with the rehabilitation garden is that it has been there for quite a long time and is therefore is well known. It is crucial to maintain and develop the utility of this facility to foster research that underpins the high quality societal impact of this UoA.

The methods used in collaborating with stakeholders to find the right strategic topics for future case studies have strengthened the social impact of the UoA.

#### Score for Activities and Outputs

3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The UoA has had great impact on important issues for society. The UoA has addressed relevant topics for practitioners in different areas and provided interesting results. The UoA's interdisciplinary profile makes it possible to provide results that can be used by a wide range of professions.

#### **Score for Outcomes**

#### 3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The chosen strategy is to be problem-based and work closely with stakeholders. This seems to have been very successful. The UoA has access to many fields with a broad range of contact areas with society and many different stakeholders. The UoA works hard with challenges linked to the width of their area of work that reaches from social and human sciences to natural sciences. The UoA has spent considerable effort to secure economic support for the rehabilitation garden, which takes time away from scholarly endeavors. The provision of core funding for the facility operation is important in order to achieve this group's full potential for societal and scientific impact. Developing a long term funding strategy in cooperation with the SLU management is vital. Several possible 'business models' should be explored with a view to maintain the unique infrastructure and to possibly broaden its use.

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#### Score for Impact Strategy

2

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The most important thing in collaborating with society is to understand that collaboration is an interactive twoway process. It should benefit both parties. The group describes their problem based method that seems to have been very efficient. The UoA emphasizes thatUN's sustainability goals are a central starting point. Practitioners all over the world need help with these goals. The choice of this topic shows a general understanding of current and emerging challenges in society, and such understanding is the core in developing good collaboration. However, the UoA needs to elaborate and operationalize the SDGs from the point of the work that the UoA is conducting to make the collaboration fruitful.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The UoA has a very good strategy for transdisciplinary projects across many scientific areas. The strategy includes cooperation with several research departments and universities to fill the knowledge needs that users have. Active maintenance of contacts to alumni, who have become practitioners outside academia, is an approach that can provide opportunities for deeper collaboration. It is also a way to develop awareness on emerging knowledge needs of practitioners. The UoA clearly has the potential to be a meeting point for former students and to use this interaction to increase its visibility and societal impact. The approaches can range from the use of social media to practitioner conferences.

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Panel/ Research field	Nature and Society
UoA	Agrarian history

#### Introduction

#### General assessment of the Unit of Assessment

The committee found the Agrarian History faculty's research agenda and productivity to be good for a unit of their size. They are undergoing a transitional period having had a professor and a senior lecturer who just retired and a new professor coming on board. Despite this transition, they have a productive faculty doing interesting, interdisciplinary research in this historical field. As they describe it, their UoA emphasizes "a historical discipline that studies the development from the oldest to the present time. The subject deals with agricultural production and technological change, social and economic conditions, people in the agrarian society and their relation to nature, the landscape and to society at large." They are the only agrarian history unit in Sweden, and thus, are recognized throughout Europe and the world in this area. Their primary geographical focus is on northern European agrarian history, including Sweden, but they also have interest in agrarian history topics around the world. They are uniquely positioned because they are at an institution dominated by the natural sciences and can therefore engage in historical research based in natural science, producing highly innovative findings. Many of their research projects are enhanced by outreach with other units at SLU or other university programs. Their faculty's research provides insights to "issues relating to the interaction between people and landscape, and to provide insight into the complex processes that arise between social and economic conditions and the utilization of natural resources."

### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

Agrarian History has had a productive research agenda and output over the last five years (2013 – 2017) given their relatively small faculty. It should be noted that coming from the Humanities, they are less likely to focus on publishing in peer-reviewed journals and instead emphasize publications in books. Because SLU is a scientific institution with a particular understanding of what counts as scholarly publication, they should make themselves aware of the typical Humanities (not Social Sciences but Humanities) publication path, which is often in books by reputable university press publishers. If SLU privileges scholarly output by citations in peer-reviewed journals, this unit might not fare well by comparison.

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Their scholarship is strong on the international stage in that it combines historical and natural science methods. Faculty in Agrarian History have developed important contributions to the field through combining theories, methods and source material from a variety of perspectives. Over the years, examples of theoretical concepts and methodological approaches launched by SLU include source pluralism, historical map overlays, experimental agrarian history (Karlsson 2015), retrogressive methodology (Karsvall 2016) and retrospective veterinary diagnosis (Widenberg 2015; 2017). These projects are published and are referenced in their selfassessment document. They have four prioritized themes:

- History of animal husbandry studies on early-modern, modern and today's animal husbandry encompassing animal health, animal care, state policies versus farmers' actions, and the role of animal husbandry in the general agricultural and societal development using new and innovative methods.
- 2) Garden history a project on Garden History in Sweden is in its final stage and in 2019 a multi-volume work will be published that will be useful for experts and the public alike. Research in the unit has demonstrated the importance of gardening by peasants during the eighteenth century, examined horticultural produce in Sweden and particularly on small market gardens, has studied hops using historical map overlay as an important methodological tool to identify older clones of hops.
- 3) Older Historical Research Strengthen their profile as a leading unit for older historical research. They completed a study on medieval animal husbandry, which together with an earlier study on medieval arable production generated a comprehensive knowledge on Sweden's agricultural development during this period, unique also in an international perspective (Myrdal 2012).
- 4) Scientific Breakthroughs Two areas of research have been integrated providing major scientific breakthroughs but also pointing the way forward:
- a. Common-pool resources understanding commonly shared property and historical conflicts around property rights
- b. growth and inequality using a historical, micro-level approach to understand the relationship between growth and the creation of inequality

Quantitatively they had a healthy output with the unit reporting 14 peer-reviewed journal articles, 30 additional articles (scientific, reports and popular science), 25 book chapters, and seven books (or edited monographs). It should be noted that the bibliometrics data reported differing results between the time period of 2012 and 2016 with 20 journal articles, 10 book chapters, one book, and one report. SLU leadership might wish to investigate the reason for this discrepancy in numbers. The top ten articles they reported in their self-assessment were quite reputable in the academic field. 22% of the articles published had a citation percentile profile in the top 5%. With 4.5 FTE we conclude that this research output is a healthy number but believe the faculty could work on increasing their citation numbers and research impact in the field. Of the ten major scientific publications during 2013-2017 they posted, the highest number of citations the top article received was 12 (and this was a climate change article with apparently no historical relevance). The average citation number for the ten articles was 3.3, relatively low compared to other units of assessment in this panel. As mentioned earlier, this could be because of the research outlets for the field, books. Although, it should be noted that the faculty are not publishing frequently in agrarian history-type journals.

#### Score for Scientific Quality

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

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In the last year, Agrarian History experienced a major transition in leadership and moved to a new department; this created opportunities for their scientific environment and leadership. In order to create an attractive, diverse, intellectually stimulating and creative research environment Agrarian History has taken a number of steps:

They have provided new opportunities for cross-unit cooperation in research, teaching and PhD-education;
 They have increased internationalization in research networks and outreach such as: participation in international conferences, increasing the number of exchanges with universities abroad, and increasing participation in international book projects. Furthermore, they are currently planning two international workshops in 2019 and will host a major international conference in Rural History in 2021;
 They have supplemented their research profile by adding a professor with a quantitative, micro-level methodological approach. Together with the recruitment of a post-doc with a PhD in veterinary medicine this has increased the possibilities of forming new creative constellations in research;
 They are working on long-term career paths for successful researchers to increase incentives for younger researchers to thrive and produce. However, it should be noted that SLU does not have a long-term career path for the "research" faculty line so this committee assumes they mean they are hoping to promote more lecturers and professors. They currently only have two tenured positions. In order to provide more long-term

stability to the faculty and help develop a long-term research strategy, SLU should provide more opportunities for tenured positions, perhaps turning research lines into tenure lines is possible.

The faculty consists of 9 employees (a professor recruited in May 2017), a tenured senior lecturer, an associate senior lecturer, a post-doc employed for two years from May 2017, three PhD students, a researcher and an assistant professor with fixed-term employment, and three researchers funded through external collaboration and/or part-financed through external funds. Agrarian History reports that the staff within the department currently provides both an administrative infrastructure and possibilities for cooperation in teaching, research and in educating PhDs within their own and other units.

The faculty is a mix of male and female. The currently leadership is male but there is a balance between male and female senior faculty.

1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The unit is working on mentoring young scholars on their career path, even though few exist for them at SLU. They do this by encouraging young scholars to apply for external funding and giving them time for making applications. Senior scholars also support younger colleagues by reading and commenting on these applications. Senior scholars encourage young scholars to generate their own research interests and develop theories and methods that will aid their progress. Younger members are assigned teaching and encouraged to take pedagogical courses. These are all helpful measures, but the unit could do more. They could take similar measures that, for example, environmental communication has taken, which can include:

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- collaborative research opportunities with senior researchers on staff,
- three-year projected teaching plans that helps with time allocation for research projects,
- senior researchers act as internal reviewers of papers of younger faculty and/or provide younger scholar opportunities for co-authoring papers,
- there are writing weeks spread out over the year and
- "reality checks" take place for their writing projects.

Suggestions for improvement:

As noted above, the unit needs a more robust mentoring program. Additionally, the unit needs possibilities for career growth in order to develop their research trajectory and maintain a strong research base. They currently have an adequate number of faculty but not enough tenured faculty.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

As mentioned above, the unit focuses its research on Northern Europe, with a strong emphasis on research in agrarian history in Sweden. Their networks and collaboration reflect this research emphasis. The faculty have several collaborative research projects with universities and centres around Europe and the U.S. including Indiana University (USA), Centre National de la Recherche Scientifique (Paris), and University of Santiago de Compostela. They have been presenting at conferences throughout Europe and the U.S. Their faculty hold various assignments in organizations throughout the world such as The Royal Swedish Academy of Agriculture and Forestry and the International Council on Monuments and Sites (ICOMOS).

The unit has been most influential in impacting scientific study in the field in two areas: 1) Common pool resources - examining rules in form and rules in use. Examining court protocols researchers explore common pool resource conflicts and study the rules in use, as opposed to rules in form (or official rules). This makes a significant contribution to see how colonization of land occurs, not only in Sweden but elsewhere in the world.

2) Growth and inequality – faculty have developed ways to measure how growth contributes to inequality in society, especially its impact on land use and agricultural land, by looking at historical data.

1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.
Agrarian history has developed unique synergies throughout SLU that build bridges across the humanities and natural sciences. This has enhanced the academic richness of not only their own UoA but other academic units throughout the institution. Their current post-doc working with the unit, Kristina Nordeus, is a good example of this synergy, combining natural sciences with a historical use of antibiotics.

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Furthermore, the unit was instrumental in helping develop a project within one of SLU's interdisciplinary platforms, Future Agriculture leading to several publications and an understanding of how agriculture was restructured in Sweden.

Additionally, co-operation with SLU's Swedish Biodiversity Center on a historical ecology project resulted in a book, The Past and Future of Landscapes and Regions – Cambridge University Press, 2018.

Future research projects further their collaborative efforts with units at SLU including an interdisciplinary project in Sweden based on a study conducted on the U.S. Great Plains that examines the relationship between population and the environment. They will work with the Swedish Biodiversity Center at SLU on this project. Also, they will start a cooperative project with Physical Geography and Ecosystem Science at Lund University, examining agricultural change and economic growth through spatial analysis and exposure models.

There is potential for further joint work, for example with the landscape architecture UoAs.

#### Score for Scientific Environment

#### 4

#### 1.3 Strategy for Scientific Development

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The unit's primary goal is to become a national leading research node in agrarian history. As the only agrarian history unit in the country this should be an attainable goal. It should be noted, however, that there are scholars of agrarian history in other universities but there aren't any academic units solely dedicated to this field. So, it would be ideal for SLU to become the center of agrarian history scholarship for Sweden. The UoA wishes to increase its national and international profile through several means including: creating a national organization of agrarian history, hosting international and national workshops and conferences, and increased emphasis on external research funding. They also desire to increase their collaboration with a variety of academic units in SLU to increase their interdisciplinary focus, which sets them apart from a number of other agrarian history programs worldwide. They also value their collaborative research efforts outside of the academy, finding their strength in "qualitatively high-level historical research on natural and cultural resources."

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The most significant research contributions and potential contributions for the unit can be found in the following areas:

1) Common pool resources (see description above) – while the unit conducts historical research, the implications of their research are contemporary. For instance, by examining the historical evolution of property rights , scholars can document parallels to current day development of property rights. This UoA has a proven track record of publication in CPR and there is every indication that their future research directions in this area will continue to make contributions to the field of agrarian history.

2) Growth and inequality (also described above) – the unit's current research contributes a long-term, microlevel historical perspective to the relations between growth and inequality. The unit will add to their current body of research a project that quantifies "growth for a presupposed stagnant area of eastern Sweden and focus on regional differences in both growth and inequality."

3) The unit will also embark on an interdisciplinary project in a region in Sweden, examining the relationship between population and the environment. They will work

with the Swedish Biodiversity Center at SLU on this project.

4) In a cooperative project with Physical Geography and Ecosystem Science in the Lund campus of SLU, the unit will engage in an explanatory framework for agricultural change and economic growth through spatial analysis and exposure models.

Because these projects are either extending current projects or are building on the expertise of current faculty, there is every reason to believe that the unit has the potential to make significant contributions to scientific research.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The unit needs to recruit promising, young scholars to their faculty and place them on a career trajectory at SLU where they will remain and establish their research agenda. In this manner, the unit will gain a stronger reputation internationally. The unit has put emphasis on increased external funding and if a continuous flow of 'revenue' can be ensured it will also help in retaining faculty. The unit also would benefit from a lectorate in collaboration to increase their collaboration with external actors.

#### Score for Strategy for Scientific Development

#### 4

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The unit is going through a transition period right now and would benefit from stability among its faculty. This requires attracting faculty to a stable career path, which is difficult in positions that are fully externally funded. SLU should find internal funding for faculty positions to attract and maintain quality faculty, especially in light of the teaching load for which Agrarian History is responsible.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

Agrarian history, as a historical discipline, focused on the dissemination of research primarily in academic venues. Nevertheless, this UoA aims to contribute to society by translating the implications of their research to the general public, organizations in the agricultural and rural sectors, and in natural and cultural heritage. Given the size of the UoA and the relatively narrow scope of their research, they are reaching a broad audience with their activities and outputs that are relevant to specific stakeholders. Their primary stakeholders include governmental organizations, the cultural sector (museums), NGOs, and private actors. Some of their most significant stakeholders include County Administration Boards, the National Archives of Sweden, and the Royal Swedish Academy of Agriculture and Forestry (with whom they are working on a multi-volume Garden History publication that will be useful for both experts and the general public). The faculty in agrarian history share their expertise in external consultancy for landscape management and conservation of natural and cultural heritage. For example, they acted as consultants for the cultural reserve of Linnés Hammarby and previously at the SLU-managed land of the Krusenberg manor. The unit also shares its research with the general public through open-access databases that includes information on farm production, farmers and geographical and demographic data. From traditional agrarian history projects, to landscape management consultancy, to dissemination of agricultural data through open-access databases, the UoA is coming close to reaching its full potential for societal impacts. However, given the lack of stability in the unit during this time of transition, the unit will need to have a more stable research staff in order to fully reach their potential.

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#### Score for Activities and Outputs

#### 2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

Given the unit's highly academic focus, it might seem as if it would be difficult to have societal impact based on their research. However, that is not the case with this UoA. In fact, we found the societal impact of their research outcomes to be excellent especially insofar as they are relevant to communities and provide useful information for contemporary issues in agriculture. The UoA's report provides many examples of their relevance to contemporary society, including an EU funded project, survey of the Royal National Park in Stockholm, advice on management of historical sites, and a project on integrating demographic and geographic data through a new method, converting snapshot geographic data into longitudinal data. This has resulted in open access data stored at Nature: Scientific Data. The results of this last project have also been presented at the International Cartographic Society's (ICA) commission on the UN Global Goals for Sustainable Development.

The unit's research on animal husbandry and veterinary practices, common pool resources, and growth and inequality all have had substantial societal impacts. A new research method to diagnose historical outbreaks of disease, award winning historical analyses of common pool resources (CPR) and agricultural systems and research on growth and inequality during major societal transformations has resulted in the collection of large databases. The publication of the database on the web in January 2017 as an open-access resource shows that the UoA is strongly oriented to delivering output for society at large.

#### **Score for Outcomes**

#### 2.3 Impact strategy

# 2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

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The unit's main goal is to be the primary source that society turns to for knowledge of agrarian history and its relevance to contemporary agricultural and rural issues. Their sustained focus on agrarian historical topics such as common pool resources and animal husbandry, and now with a more recent research agenda in growth and inequality in rural and agrarian societies, has positioned this UoA to provide a relevant contribution to Swedish society. Their goal is to engage in research with relevant stakeholders that is mutually beneficial and is informed both by academic data as well as the experiences of societal actors. They also wish to work closely with those engaged in practical aspects of landscape management, especially insofar as they can inform them of the value of historical and cultural remains.

The unit's strategy for impact is realistic because it builds on work they have already been doing and the expertise of their faculty. While it doesn't expand their societal impact beyond the areas it has already been impacting, it is realistic given the size of their faculty. It is better that they focus on what they do best as opposed to branching out into areas, allowing for less time and resources to focus.

#### Score for Impact Strategy

3

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

# 3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

Agrarian History has a well-developed understanding of mutually beneficial collaboration and a strong will to collaborate with society. This is visible in their goals that include improving and extending the theoretical and empirical knowledge regarding agrarian history and its relevance for today's agricultural practices and the way in which history can inform contemporary problems. The unit defines its strength in connection with long term societal changes in complex processes and how history is a tool to understand these changes and how they affect contemporary and future structures.

Their emphasis is on mechanisms for change, to ensure that landscape values are preserved and protected, to contribute to our understanding of today's society from a historical perspective, and to participate in facing the challenges of tomorrow. They disseminate their research findings in a variety of ways including books and popular science articles that reach the public, presentations (scientific and popular), and teaching societal actors.

The unit aims at forming an interactive two-way process for mutual benefit with their stakeholders. With its collaboration philosophy, the unit has developed close relationships with governmental stakeholders and have worked with them successfully.

As with so many of the social science units in Nature and Society, the unit connects its weaknesses in collaboration to a lack of human resources and believes that an additional lecturer who emphasizes research based on collaboration with society could develop the interest that external stakeholders exhibit.

# 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

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The panel has only general recommendations to give when it comes to developing collaboration based on our discussion with the unit and two examples: historical cadastral maps in cooperation with the Swedish National Archive (SNA); and Cultural reserve Linnés Hammarby with the County Administration Board. The historical cadastral maps project has led to major outcomes for society at large and in research and teaching. The outcomes have been mutually beneficial for all parties. SNA has the public databases, scanned maps, and geocoded historical data. SLU's Agrarian History unit has been using the databases in research making new analysis possible, PhD students who have worked in the project have increased their knowledge about historical maps and their usefulness in historical research. Additionally, there have been other outcomes including several research studies and PhD theses based on the project's database. In the other major project, at Linnés Hammarby a long-term research plan will be formed together with the County administration Board in 2018. The possibilities of using the cultural reserve as a landscape laboratory for both research on historical landscapes and in education are strong.

In both projects the unit describes the factors of success as mutual interest and clear goals, continuity and recurrent meetings. The pitfalls are connected to resources and turnover in staff.

Given the limited staffing of the UoA, the panel advises them to establish a strategy plan for external collaboration that focus on the same topics as the research plan

- Animal Husbandry and welfare
- Common pool resources Property Rights
- Growth and inequality during transformation

This would help the unit to focus its scarce resources on fields where they can collaborate with and society while still making good internal use of their scholarly output.

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Panel/ Research Nature and Society field

UoA

Rural Development – Global south

#### Introduction

#### General assessment of the Unit of Assessment

The research of the UoA is internationally recognized and the UoA is a partner and collaborator with strong international centres. The number of international publications show a strong positive development since 2014 and the breadth of journals, which also include high profile ones, is good.

The societal impact is well documented. The UoA has contributed to societal debates on rural development and critical factors affecting it, also supporting local empowerment. Both in terms of research and societal impact the UoA could be better integrated within the SLU to ensure that a more effective interdisciplinary approach is taken to the integration of biological, agricultural, and health with the social sciences is achieved. In order to fully capitalize on the talents and insights of this UoA, better up front planning and integration of projects is needed.

The UoA's strength lies in societal collaboration and could therefore contribute also to an overall SLU approach on collaborative action. Joint collaboration is likely to provide synergies that extend beyond the remit of the UoA.

### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The global south unit is an interdisciplinary group devoted to using mixed methods to critically examine the interplay between rural development policies and trends as they affect human populations. Several unique and exemplary components of this UoA are noteworthy. Although largely populated by social scientists they have a long track record of active engagement with natural and physical scientists in various sectors linked to rural development including agriculture, veterinary science, forestry, and mining. Second, because of their long history of involvement with government agencies, ngo's, and other agencies and organizations working in the global south coupled with their own scholarly training, they are well informed scholars sensitive to sociocultural and political realities on the ground. Many staff have lived and worked in the locations where the unit conducts research.

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This experience informs their work in ways that can substantially improve the research of natural and physical scientific groups that typically lack the sociocultural understanding of the societies in which they are attempting to apply their work.

Of related importance many policy makers and scholars from these same regions of interest have spent time at SLU, including PhD students, visiting scientists, and various government and ngo professionals in workshops and short courses.

This UaO is clearly deeply committed to capacity building. Third this group has a track record of working on joint projects that address global, north-south interdependencies. This group's productivity is high, particularly in recent years. This is particularly impressive given the mixed method approaches that predominate which often include an extended period of careful and painstaking qualitative work grounded in the daily experiences of citizens of the global south. The breadth of the research portfolio is excellent addressing issues related to resource policies degree of congruence with local and regional culture; implications of climate change on land and water resources; market forces role in inequalities.

#### Score for Scientific Quality

4.5

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The UoA currently suffers from a severe lack of formal leadership having had a professor for a short time and who is now leaving without any clear successor. This seriously hampers the search for direction in the UoA, the development of strong links to other UoAs, and visibility at SLU level, although the current staff is competent in keeping projects running.

Despite the challenges precipitated by unstable senior leadership, the degree of camaraderie and mutual respect and knowledge of one another's work is admirable. Lack of more long term stability and support for permanent lecturers is hampering the efficient operation of this unit. The gender balance is acceptable but more senior leadership is needed. As noted above there is ongoing intellectual exchanges throughout areas of interest to this group.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The unit has an active mentoring program and practices participatory decision making that values all voices, including junior scholars. Several instances of collaborative publishing, grant writing and joint outreach and training are noted in the self-assessment.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA is engaged in extensive international outreach across all staff in research and teaching. The topics that the UoA has worked with, i.e. management of natural resources, the politics of the environment and rural transformations are all important for the field. Of the publications 2009-2015 13 % have reached the top 10 % cited and 43 % the top 25 %, suggesting a visible impact with the publications. The capacity building activities also contribute to a visible scientific impact.

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### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

A strength of this UoA is its experience working across disciplines and use of mixed methods. They have been active in multiple interdisciplinary research networks. Natural science units need to become better informed of the value of this unit to more fully capture their expertise, but the UoA will also need to reflect on how to demonstrate the importance of its profile.

#### Score for Scientific Environment

#### 3

#### 1.3 Strategy for Scientific Development

# 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The submitted strategy lists a number of important general topics, but the main focus is on the maintenance and expansion of staff with only a rather general strategic plan linking resources to the substance topics. More thinking about how to build up strong substance profiles for the UoA in the chosen areas would most likely also contribute to longer term funding and more focused proposal preparation.

# 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The topics identified for future focus are well chosen. Thus for example analyses of how rural development and local ecologies will be affected by climate change is important and can be linked with core competence of SLU. Another area of continued relevance is the unit's longstanding interest and expertise in the role of upstream forces that shape land use and in turn rural life. Expertise in developmental economics, planning, and political science would strengthen these endeavors.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

Instability in senior leadership and lack of sufficient core support for instruction hamper this unit. Their capacity to supervise PhD students is limited by staff shortages. There is a need to develop more effective ways to engage with SLU colleagues earlier in the process of research program developments. Most of the burden for the problem of underutilization of the expertise of this UoA appears to be structural within the SLU. Strategic decisions to strengthen the UoA would create additional capacity for novel interdisciplinary work in SLU and thereby also international visibility and impact.

#### Score for Strategy for Scientific Development

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

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The situation in this UoA reflects wider issues and challenges related to SLU's strategy of achieving true interdisciplinary problem based approaches. Strategic actions are needed to ensure that UoAs with a social science profile have sufficient resources in order to contribute to interdisciplinary work. Forums and mechanisms in which mutually interesting research plans and projects can be developed should be strengthened, for example as part of the Futures Platforms. This would constitute an active move away from project planning in which social sciences and humanities become 'add ons' to formally meet demands for multidisciplinarity.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA is active in an area where trends in society writ large such as urban and rural development and the relationship between developed and developing countries meet. In these juxtapostions many crucial environmental problems become visible thereby revealing important knowledge gaps and the need for possible novel solutions. The activities performed by the UoA explore several of these specific problem areas seeking possible solutions and dissecting conditions for optimum results. The approaches combining social and natural sciences within in situ studies in close cooperation with local societies are appropriate for societal impact. Strength is shown in studies regarding, for example, compensation (carbon purchase through forest plantation), smallholder farming, suitable cereals and water governance in a changing climate. These are important studies and activities resulting in useful outputs. There is potential for an even larger volume given the great interest, needs for knowledge and rapid changes in societies in the global south. The accessible potential and possibilities appears not to be fully taken advantage of at the level of SLU, in part due to unstable senior leadership. The activities and outputs of the UoA, which cover several very important problem areas and include useful methods and other work tools are good, but a stronger integration of the UoA's activities with other core activities of the SLU would further enhance the overall societal impacts of SLU. This should therefore be an issue of strategic reflection.

#### Score for Activities and Outputs

#### 2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The stakeholders concerned are mainly NGOs, institutes and Centres and the actual beneficiaries of the development co-operation activities. For funding the UoA is strongly dependent on the Swedish governmental organisation, SIDA. The outcomes of the activities and studies have been important for rural development and cases show how the long term effects materialise, for example in the production of cassava among female farming groups. The UoA has great ambitions for increasing societal impacts. Activities with impacts are primarily constrained by the capacity of the UoA to take on tasks. Although many of the core topics, such as understanding power, social inequalities and political dynamics, are universal, the UoA should still reflect on the geographical spread of its activities. It may be that by focusing more on particular regions the outcomes could be more deeply embedded in the cultural and political context where impacts are sought. This would enhance learning and facilitate duplication and upscaling of key outcomes. Such strategic planning of outcomes is obviously challenging given that the activities of the UoA depend crucially on what funds become available through the main funding source (SIDA). Identifying alternative and additional funding sources (including the EU) could potentially give the UoA greater control over its pursuit of a more focused and integrated research program. Also reflecting more deeply on how to achieve visibility and impact would be important. The idea of strengthening abilities to produce outcomes with a communication expert may be a useful step, but also for this strategic planning on what to communicate and how will be needed. Many of the solutions, methods and other tools developed by the UoA can also be expected to be of value not only in developing countries but also in developed countries as well. We applaud the track record of collaboration between the global south and north UoAs but encourage even more integration, particularly as new senior leadership comes on board. The Panel suggests that a joint strategy process for the global south and global north UoAs would be very beneficial once new senior leadership is in place. A joint strategy process would also facilitate joint discussions with other groups and the leadership in SLU on how the social sciences expertise in SLU can be more meaningfully integrated into multi- and interdisciplinary projects with natural, agricultural, forestry and veterinary sciences. As indicated above, the current modes of integration are less than optimal.

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#### Score for Outcomes

2

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The area itself where the UoA operates, the great experience among the researchers and the historically good connections with many important stakeholders offers very good possibilities of societal impact. As noted above under 2.2 the strategic goals and means of reaching them do not appear to be fully developed. The goals mainly concerns social media and visibility in media and arenas for discussions. An elaboration of how impacts can be achieved on one hand in the countries where activities take place and on the other hand in the policy development affecting Sweden's development policy is clearly needed in the UoA.

It appears that the UoA has been successful in responding to calls but that this has led to a very wide and at times rather thin spread of activities across geographic locations and topics.

The problem has been partly alleviated by teaming up with institutes that have strong local presence, but the UoA's own impact could probably be strengthened with a clearer profiling that would include, where appropriate, stronger links within SLU. It is rare that a relatively small UoA such as the one assessed would have great impacts on its own and thus strong collaboration is needed as stressed by the cases presented. The UoA would thus most likely benefit from strategic reflection on how to strengthen and focus its collaborative activities. There appear to be untapped possibilities for delivering societal impact that could be achieved with greater reflection on what the UoA's strengths and foci are and then advocating for appropriate projects as compared to a strategy of primarily identifying the need for additional resources to achieve greater impacts.

#### Score for Impact Strategy

#### 299

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

A long history of successful collaboration with many kinds of organizations on different levels within the local societies clearly shows a good understanding of collaborative processes. The experiences gained in the countries in center of the conducted research are particularly valuable. The UoA clearly has deep understanding of the conditions for working collaboratively with local and regional partners.. The UoA does not appear to be very well connected with development oriented stakeholders in Sweden which may partly limit the uptake of the research results in. Efforts in this regard might enrich policy formulation plus allow for better spread, use and impact of the results from the performed research.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The UoA needs a well-developed strategy that can further increase the ability to achieve societal impact. The UoA would, for example, benefit from reflection on how to widen the range of possible users of its work. This could also help in efforts to identify potential financers of research that can support the production of knowledge and solutions that the UoA chooses to focus on. The strategic reflections should also consider how the insights that the research has produced and will in the future can be incorporated into practical actions to help societies on different levels to meet severe and complex problems such as climate change, unequal use of resources, inequality, and biodiversity loss. The knowledge, methods and other tools developed to analyse and tackle challenges in developing countries can often also be useful in developed countries and vice versa. This insight speaks for further development of joint activities between the UoA working on rural development in the global south and the global north and a (partly) joint strategy for collaboration and research could strengthen both UoAs. See Section 2.2a for a suggested joint strategy process.

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644\_1\_LTV Urban Vegetation, Governance and Management 300

Panel/ Research Nature and Society field

UoA

Urban Vegetation, Governance and Management

#### Introduction

#### General assessment of the Unit of Assessment

The UoA studies "how governance, management, and urban vegetation can support the supply of ecosystem services, including social benefits. Central research questions concern how to develop applied ecological based vegetation design and plant selection, as well as governance and management that supports resilience and use of urban open spaces."

The focus is practical and the UoA has a large staff (relatively speaking) outside fully academic work. The academic work is also practice oriented, which is reflected in a relatively modest scientific output. However, strong international networks, including exchanges and international training, ensure connections also to academic worlds and raise the quality of the research. Overall the UoA has shifted from an applied enterprise focused on urban forestry into a more broad ranging set of activities thinking more about the implications of practices for environmental services and also about the meanings and sociologies of open spaces in a wide variety of contexts and also about the elements needed for a more constructed environment (green roofs and walls). The theoretical base of the research focus is evolving, also in response to strong stakeholder demands that can open very interesting directions. The UoA is evolving scientifically, and this is very necessary. It has developed excellent strategic thinking and a practice that ensures implementation and regular revision to the extent needed. It is using its Lab (The Landscape Laboratory) very creatively and actively thinking about how to expand its outreach.

The societal impact is concrete and rather immediate, which potentially could strengthen the research even more. The capacity for collaboration is well developed through skills and experiences gained in actual collaborative activities.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA has a broad approach spanning from research on functional performance of urban plants to local governance. It has a practical base with urban tree inventories, selection of urban vegetation construction and establishment and the promotion of plants delivering different ecosystem services. The Alnarp Landscape Laboratory is a very interesting facility. The expansion with theoretical insights of user experiences of green roof, perceived personal safety, green space management that supports child-friendliness and inclusion of children's perspectives in planning and management shows that the UoA is agile in picking up emerging scientific trends and topics and developing them with a combination of academic and practical orientation. The shift into more analyses of environmental services and a broader conception of governance and users has been quite salutary for the scientific development within the SLU. Because the results of the research have many applied implications the interaction with a broad spectrum of user communities is essential and this does seem to be occurring and expanding. The research on governance is emerging and developing. It is a significant arena of research that gives the UoA an area where to strengthen its research, as do the efforts on the periurban areas and forest edge dynamics.

The Live Learning and the Lab appears to provide an excellent context for outreach and training, and the engagement with many municipal, developer and private organizations makes the shift into practice seem relatively achievable. The idea of job rotations and internships/ scholarships for municipal workers engaged in the biotic management of the city is a good one, and also helps explain the kinds of research and its importance to the broader public and those who will be spearheading land use decisions.

The UoA has clearly worked a great deal on outreach, and its scholars publish in relatively high impact journals, with regional and international audiences. The strong education oriented share of the UoA means that its scientific productivity relative to staff size is relatively modest, but the UoA has a strategy for increasing output. The Faculty have also organized international conferences, and participate in international Fora and workshops and are part of broader regional collaborations, including the H2020 lead in an EU application, and its more general relation to the green surge and networks across Europe. The UoA has links with the urban and the UoA could probably do more to use the Urban Futures platform to its benefit. For its ambitions to deliver on governance, it could consider strengthening ethnographic or sociological approaches compared to the current scientific practices that frame the research.

#### Score for Scientific Quality

#### 4.5

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The UoA has a strong base in the intersection of practice and academia. The staff is large enough to provide diversity. It has delivered a decent amount of PhDs, but as the UoA notes there could probably be more PhD students (in 2017 statistics suggests only 1, but 1.2b mentions 5, which is already acceptable).

The effort towards a "holistic approach building on a strong group dynamic" with inter- and cross-disciplinary research is a good base for the area in which the UoA is working. The cross and multi disciplinary efforts make the UoA quite dynamics, its gender issues seem relatively well balanced among the younger scholars. The diversity of topic areas would be quite stimulating to young researchers, and there is certainly terrain for wide cooperation among other UoA in SLU, including the biodiversity centre .

The very concrete and participatory strategy that the UoA has developed is likely to give all staff a good sense of being part of a wider research effort instead of narrowly performing in a limited area.

The international influence shows an increasing trend as witnessed by the publications. The number of reported citations is still rather low for the publications listed. Partly this is an artefact caused by the Web of Science, but the UoA could wisely reflect on publication channels and also on ways to make the publications more visible and known. The joint production of a theoretical paper and books about the research arena are excellent ideas, and also help showcase the younger scholars. The Lab also provides a context for more interaction across hierarchies and a more informal setting.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

There is a conscious strategy that was very well presented in the interview session. The search for more PhD funding, and post docs, as well as the training in the Living Lab do help make this a more supportive environment for young scholars. There is significant sources of small funding which might be applied to help young faculty get to conferences and workshops, and to get some down time from teaching responsibilities so they can write and research. There seems to be enough institutional strength and resources for developing scholars and the links that conferences and engagement in international projects provide give a good base for scholarly development.

# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The unit has a wide network measured through co-published articles. This gives the unit a good platform for scientific contributions. By increasing the scientific output in high quality journals the UoA could strengthen its international impact further.

The UoA has already made real advances: It has a good international profile, is included in a multi-institutional international team on the EU Horizon2020, it forms part of the networks with green surges, and it has actively trained more than 250 researchers from 30 countries, and actively collaborates with regional and international scholars. This is both confirmed and supported by the conference and workshop organization and participation. The UoA has a well thought of and well thought out program.

The number of researchers is actually quite small, especially for senior researchers, so again, given the program size it "punches above its weight". The panel suggest that if resources become available it would make sense to explore a broader range of methods, (remote sensing/GIS) and also increase engagement with the sociologies and political ecologies of the urban setting. This could strengthen the international position and impact in the scientific field.

1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential. The UoA has a strong inter- and transdisciplinary profile. The Alnarp Landscape Lab gives the unit a special status and a unique facility. The published papers demonstrate that the UoA covers its topics both from a natural and social science perspective. The Landscape Lab, urban futures, nature based solutions and the Green Surge project all provide significant opportunities for cross campus collaborations for sustainability and environmental services.

There are many areas of potential impact, including green space governance in densification and urban transitions, urban agriculture and allotments in urban open space.

The UoA has excellent interaction with a variety of stakeholders for which there is obvious overlap with other units in both rural development, north and south, environmental psychology, and small size agronomy and temperate zone agroforestry.

#### Score for Scientific Environment

#### 6

#### 1.3 Strategy for Scientific Development

# 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA has developed an excellent approach for its strategic thinking that takes into account the full range of its activities, meaning that the strategy for scientific quality is embedded in a wider frame of reflection. In this the unit's approach is exemplary. Thus the presented strategy is well thought through and should provide a good base for further work. The governance aspect is of particular interest as it influences the actual possibilities for using ecosystem services, addressing urbanisation etc.

The expanding research networks will help push the academic quality forward. The challenge is still a relatively weaker social science framing, which could be strengthened through active collaboration with other UoAs that have stronger social science skills, or indeed collaboration also outside the SLU. The panel encourages a strategic reflection in all recruitments in order to see how the UoAs skill profile be developed for interdisciplinary studies.

The UoA has a potentially vast field of work considering the importance of urban biota in mediating heat island effects, providing better urban water management and rethinking the physical infrastructure of cities. The panel suggest that an active co-operation with all the UoA dealing with various aspects of urban landscapes would reinforce SLUs position in relation to urban sustainability. Also the dynamics of urban areas in the developing world gives the UoA together with other UoAs a global stage where the SLU can really make its mark.

The national and international networks can help, but also the diversity of stakeholders is likely to truly push the programs forward as well. The strong practice of international exchanges should also help to reinforce an expanding model of the UoA. The panel encourages further serious reflection on how the Urban Futures platform could be helpful in raising new kinds of questions from a multidisciplinary perspective. The panel considers that the overall strategic approach of the UoA is realistic. The strategy should also encourage the scholars to reflect on ways to become more ambitious in their choice of journals, and in distributing their findings so that the unit would speak to a broader scientific audience. This would increase its impact in the scientific world as well as in the world of stakeholders through popular press and blogs

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

Nature based solutions, governance arrangements and climate change provide a clear focus and a realistic frame for making an impact. The unit has specified concrete objectives and has an ability to live up to the expectations. The steps taken so far, including the ambition of being the coordinating unit for the "green innovation" and its army of stakeholders makes sense about doing a big rethink on urban nature.

Given that urban environments are critical in terms of generating GHG, GDP and are population centers, urban sustainability and the role of green space is an obvious focal area that the UoA can excel in. The panel notes that the UoA has made strides in shifting from a horticulture to an urban sustainability program and this direction should be supported and even expanded given the importance of the topic. The coordination of a H2020 application on Nature-based Solutions is a good example. The governance of urban open space management with participatory co- development is likely to be a fruitful avenue for research, including access to project funding. The topic is also likely to provide a strong base for research based teaching at the UoA.

The panel agrees with the UoA, that the research agenda related to climate change, including a focus on urban vegetation with new green approaches related to green roofs and green walls, is a promising specific direction. As argued earlier, by bringing in more governance scholars, the UoA could strengthen its ability to break new ground. This would also create a stronger knowledge base for analyzing conflicting objectives and interests with respect to urban green space. For example biodiversity conservation and the creation of recreational spaces do not necessarily go hand in hand and there is thus a need for tools that assist the analyses of such conflicts, and approaches that can help resolve them. Co-operation with, for example, the UoA on environmental communication can be highly fruitful.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The UoA has observed that in order to become more successful it should develop a stronger link between research and education, so that all staff is engaged in both research and educational activities. The panel agrees with this starting point, and notes that this should simultaneously be a way of encouraging staff to produce high quality scientific papers and making their papers better known. An additional aspect to reflect on is how to link the national urban tree data base and related inventory system to the research of the UoA.

#### Score for Strategy for Scientific Development

#### 5

#### **1.4 Additional comments**

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

SLU LANDSCAPE has provided a cross-departmental forum for collaboration and joint profiling of the landscape field within SLU, including the Urban Future platform. The SLU should reflect on how the Futures platform could provide greater incentives for joint activities across UoAs, including UoAs that could bring in additional perspectives such as environmental communication, economics etc.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

Global threats such as climate change and biodiversity loss have become a strong driving force for finding more sustainable solutions. The ongoing urbanisation underlines the insight that it is necessary to reduce the need for transportation. In theory more dense cities give opportunities for fewer and shorter journeys, more effective deliveries etc. This means that green spaces in cities are threatened by new buildings and infrastructure. At the same time their value increases due to their importance for health and well-being. The focus of the UoA, with activities and outputs originating from hands-on needs highlighted by different stakeholders involved in city planning, maintenance of parks and vegetation management is highly relevant. The actual needs of stakeholders act as a source for new studies, activities and outputs on all levels from the local to regional and international. It also involves a wide range of stakeholders ranging from very small private companies to big international organisations. The UoA makes use of the situation very well and the results, when it comes to activities and outputs, are excellent. For example, the maintenance of the Urban tree data base is highly important for practice and the Landscape Lab is a unique facility.

Since there is really no general monitoring of impact other than the case studies and lists of stakeholders, it's hard to say whether the resources and activities are 'optimally' focused from the point of view of societal impact. The impact is also harder to assess because the results are a combination of many factors, including research, education and outreach. However, the panel has concluded that the activities are directed to serve practical needs and it fills a clear demand. The focus of the units activities are based on strategic thinking that serves a correct emphasis of the activities in relation to a demand.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The case studies show a strong engagement and outcomes that have delivered societal impact. The most important keystones to achieve successful outcomes based on research, activities and outputs are all in place. First, a broad mix of stakeholders has been recognised and active interaction is maintained. Second, there is a well balanced mix of long term and short-term cooperation. And third, experience and historically good possibilities for applied research, triggered of by expresses needs and problems identified by stakeholders.

The outcomes are further reinforced by well-known and established show cases, for example the project BiodiverCity and the Landscape Laboratory. Although the urban vegetation sector represents a very big market, the needs and demands are often even greater. The result is an overall lack of money forcing stakeholders to economise and search for cost saving actions.

The successful outcomes of the UoA have built on an ability to supply stakeholders with knowledge and advice stretching over the entire lifecycle of the green spaces in cities and towns, covering planning, design, construction, maintenance, repairs, redevelopment and reconstruction. The outcomes delivered by the UoA help in streamlining all aspects of the urban green space and thereby enable stakeholders to lower their costs.

The Lab in Alnarp is part of an international landscape laboratory network in Europe including labs in Sweden, Denmark, Germany, France, Switzerland and England and thus outcomes are not limited to Swedish green spaces. It allows for specific studies that can be upscaled as shown by the implementation of findings from the Lab to more than 4000 km of woody vegetation along the Swedish railway. The UoA has also realised the need for diversity in communicating with stakeholders, including fact sheets, books, seminars, lectures and debate articles. Once specific outcome has been increased attention to child-friendliness of built environments.

#### **Score for Outcomes**

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The strategy builds on the concrete strengths of the UoA. The history of successful collaboration with a lot of different organisations at local as well as regional and international levels reveals a good understanding of collaborative processes.

Further attention to the digital tools and data bases for urban tree could be highly productive. The UoA would benefit from an analysis of how to strengthen its digital presence in offering concrete web based tools that could also be used in its extensive educational activities.

#### Score for Impact Strategy

3

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The long history in horticulture and urban forestry has given the UoA a good platform for further expanding their relation with society at large. The Urban Futures, playgrounds, practitioner funding, training and developing a "competence hub" for green space goals seems very promising. This UoA has had a long history of outreach and interaction so it is especially well situated to engage society at the local, national and international level.

The history of successful collaboration with many different organisations at local as well as regional and international levels reveals a good understanding of collaborative processes, including the need for a continuous dialogue.

3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

Most ingredients for a successful work are already in place. For example a closely united group that knows where they want to go, a big and growing demand among stakeholders and the society for their expertise, knowledge, advices and other outputs and not least they are in position of a well thought through strategy to help them achieve their vision and goals. The pieces are in place. The panel recommends a continuation of the current direction, but notes that for implementation a more active digital presence could enhance the collaboration with actors outside academia. For example, the standard that has allowed the development of the database for urban trees is a good starting point, but it can certainly be developed further in collaboration with other actors and probably be even more strongly linked to both teaching and research at the UoA. Developing, for example, the Urban Futures platform.

644\_2\_LTV Design of Urban Landscapes and Landscape Planning 308

Panel/ Research Nature and Society field

UoA

Design of Urban Landscapes and Landscape Planning

#### Introduction

#### General assessment of the Unit of Assessment

In general we find that the UoA Design of Urban Landscapes and Landscape Planning holds a high international standard due to the influence at Nordic level and to some extent also in Europe. The scientific leadership is good with potential to be developed further. The scientific strategies need to be more concrete and focused.

The UoA covers a broad area that stretches from architecture and design of outdoor urban settings to planning in general with a particular focus on sustainability and climate change. The stakeholders that the UoA collaborates with and the societal impact that it has covers a wide range of disciplines. The UoA reaches stakeholders from policymakers to practitioners at international, national, and local levels.

### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The UoA is divided in two subject areas:

- 'Landscape Planning' which includes Landscape planning, Landscape analysis, 'Cultural heritage and park-, garden- and landscape history'

- 'Design of Urban Landscapes' which includes Design Theory, Urban Design Strategies, Visual Arts, Material and Construction.

Members of the UoA are heavily engaged in the teaching within landscape architecture and landscape planning. More than 50 % of the staff is using 80% or more time for teaching and less than 18 % of the staff are spending 80% or more of their time only doing research. In our view this is problematic. There should be better balance, closer to 50:50 teaching and research for each faculty member.

The research has 3 major approaches; 1)planning and design; which includes theory and history of design and planning; 2) information and support to decision-making in planning and design; 3) Research Through Design (RTD);

Alnarp's landscape architecture environment has long and solid research traditions, and they have been important for the development of research in the field especially in the Nordic region but also to some extent in Europe. The academic community has attracted well-known researchers, recently through the Wallenberg professorship. The conference 'Beyond ism: the landscape of landscape urbanism' which was organized in cooperation with Landscape architecture in Ultuna 2016 is another example. The conference attracted an international audience and facilitated important debates within the field.

In total 138 peer reviewed journal articles are published. Twenty eight of these publications fall within the top

5% most cited. Most of the publications link to the subject area 'Landscape Planning' focusing on ecosystem services, landscape ecological issues, green structure, climate issues, urban development and the like. In addition, the main scientific publications within these fields and have very high citation impact. In addition, we also find other important contributions such a nature based solutions to promote to climate resilience in urban areas. Another direction of publications within the 'Landscape planning group', is the perception of landscape, identity in landscape and the like. The amount of articles here is less extensive compared to the topics mentioned above even though several on this topic have attracted international attention.

A guest professor has been involved with 20 of 28 most cited articles within the threshold of 5% and almost half of the articles published the last 5 years. The purpose of the engagement has been to strengthen and build up the academic community within the ecosystem services, urban green infrastructure, urban densification, etc., and to provide solid international network. These are key issues in the field of landscape architecture today. However, the UoA should also critically reflect on how useful the concept of ecosystem services is in landscape architecture.

Within the subject area 'Design of Urban Landscapes', we observe that there are relatively few peer- reviewed journal articles. The UoA also raised the lack of peer-reviewed articles as an issue for 'Design of urban landscapes'. There are limited opportunities to publish within landscape architecture because few scientific journals accept the format necessary to communicate (for instance by illustrations, drawings, maps etc). Journal of Landscape Architectureis one of the few journals butthe competition is fierce. In addition, the academic rewards system does not honor much of the R & D work undertaken by this group even when their scholarly research has important societal significance (reports, book chapters, guidelines for the government and the like). Nevertheless, important R& D work is taking place in this area. Examples are projects related to children's use and need for outdoor areas, research by design projects; involvement in the book series Landscape Architecture Europe. The Panel also wants to highlight the landscape laboratory, which is distinctive for the Alnarp environment, and has been an inspiration worldwide.

In addition, some UoA members are internationally recognized through international conferences as keynote presentations and as members of important organizations / institutions in the landscape architecture field.

FORMAS, VINNOVA and Mistra Urban Futures fund ongoing research, respectively. Some big FORMAS projects have moved to Landscape Architecture Ultuna together with the principal researcher. This may be a challenge to the UoA.

During the last five years, the UoA has awarded 5 PhD degrees and 2 licentiate degrees. Today there are only 4 PhD students and they seem to have very limited time for research (according to panel report: 3 PhD positions but only 1.9 full-time positions). The Panel thinks that there are too few PhD students in such a large academic environment. The UoA agrees with this and wishes to change the policy that was conducted a few years ago when priority was given to Post Doc positions.

As shown above, scientific productivity is good, but could be improved still. Similar to Landscape Architecture at Ultuna, there is the divide between teachers and researchers in the UoA. Teachers have very little time for research and self-development. We have noticed that the UoA is aware of the situation and that they are about to change. See below.

#### Score for Scientific Quality

5

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The UoA has some challenges both in terms of the need for new employees and in terms of workload. The Panel considers that the UoAs desire to recruit new staff is justified in securing necessary competencies, both now and in the longer term. The group has already lost two key researchers and during the next five years three more will be retiring. The report states that there are difficulties in keeping highly ranked researchers. This should be investigated more closely if it is a real problem

The submitted report notes international cooperation, internal funds for attending conferences, formal and informal meeting places, etc. The Panels considers these measures to be very positive. Particularly important measures and opportunities are the platforms that SLU has established: SLU landscape and SLU Urban future. The use of guest researchers can also be important since this is a way to extend networks. In the longer term, it becomes important that UoA itself is able to maintain the networks that guest professorship can provide access to.

The International Conference; "Beyond ism", which was arranged in 2016, is another example of measures that help to maintain a stimulating academic environment. The Panel encourages the UoA to conduct similar events that clearly make landscape architects at SLU visible both nationally and internationally. It is important that such efforts are well integrated with the research priorities of the unit so as not to dilute their focus.

In general, the teaching load is high.. As mentioned above, this UoA has an unfortunate distinction between researchers and teachers (Similar to Landscape architecture Ultuna), and part of the staff has a limited publication record. In order to create a vibrant research environment, which is the aim of SLU, there is clearly a need to give researchers more time for research and self-development. Moreover teaching offerings would be enhanced by greater involvement of primary research faculty in the classroom. SLU needs to carefully examine this issue not only in this particular UoA but across many of the social science units. This imbalance of teaching and research is hampering the ability of many units to optimize their scholarly and instructional contributions. In some units there is also evidence of malaise with teachers in particular feeling underappreciated and not well supported.

# 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The unit has 3 PhD students equivalent to 1.9 full-time positions. The UoA needs to ensure that the part-time work does not unduly prolong the PhD work and divert focus from dissertation studies. So far SLU appears to have been in the lucky situation that there is great interest for PhD studies among students at the Department's educational programs. Lack of external funding makes further PhD recruitments difficult. There is much competition for staff within the field of landscape architecture, including in Sweden. Thus it is important that the university is competitive if the goal is to get the best researchers.

The Panel supports the unit's prioritization to find ways of increasing PhD funding. The Panel notes that the main part of PhD positions is funded by either industry or scholarships. SLU should, at university or faculty level consider possibilities to enhance the academic environment with strategic funding for PhD work.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA has a long history of working with applied development and collaboration with practice, and very strong international, and national networks. They have close relationships

with the division of Landscape Architecture at the department of Urban and Rural Development at SLU Uppsala. The UoA cooperates with several institutions in the field. The most important are 1) some other Swedish universities (Uppsala, Linköping, Lund; Gävle and Gothenburg different fields)

2) EU H 2020, nature based solutions 3) The royal Swedish Academy (The Wallenberg professorship, a book project on cultural history of gardens in Sweden.) The UoA is also cooperating internationally with similar faculties in Sweden and Norway and universities throughout the world. The impact on scientific debate in the field is mentioned above (See 1.a). The unit has a potential to make even greater impact in the scientific debates and cooperate more widely in the Nordic region and beyond.

1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

Major societal problems related to climate change, increasing urbanization and changes in rural areas require more interdisciplinary analysis. With its traditions within applied research, SLU has an outstanding opportunity in this area. As stated in the submitted report landscape architecture is an applied field with a long history of transdisciplinarity research that is applied to real world challenges.. Thus Landscape Architecture is a field where the university has an opportunity to expand its attempts to apply world class, interdisciplinary scholarship to critical environmental and land use development issues confronting not only Swedish society but countries throughout the world.

The network chart and the submitted report reveal an extensive list of departments/ institutions with which they are collaborating in Sweden and at SLU. Despite the contribution in many networks, the UoA can utilize SLU's special position even better and more systematically demonstrate how interdisciplinary research can contribute to society in the future. This means that SLU may also help the landscape architecture profession.to be more visible. The landscape architecture field may help to show the outside world why many of the other subjects at SLU are important.

#### Score for Scientific Environment

#### 4

#### 1.3 Strategy for Scientific Development

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The overall aim of the UoA is to strengthen its research profile by inter- and trans disciplinary cooperation. The group want to achieve this by increasing the number of PhD positions in the unit; strengthening the integration between research and education; enhanding a stimulating and developing working environment for individuals and groups; expanding good communication internally and externally; and by becoming more pro-active in coordinating and actively contributing to research applications and projects.

The strategy of the UoA links to several of UN sustainability goals and to the overall goals of the university. The group also mentioned the importance of the Swedish government's architecture goals that were recently launched. This is very important to the whole architecture field and a reason to cooperate more with the architecture schools within research as well as in education. The new architecture policy will give this UoA and several others (e.g., landscape architecture, environmental psychology) expanded opportunities for further development plus provide increased funding opportunities.

The submitted report gives an overview of important themes that the two groups will pay attention to in the years to come. Each group mentions quite a few topics for further development and the UoA may need to prioritize. In addition, the Panel urges the UoA to concretize how they want to work with these topics. The Panel also calls for a clearer strategy for employees who are not involved with research. It is not enough to simply encourage them to publish. This issue is related to the general topic raised throughout about more in depth discussion and strategizing about the proper balance of teaching and research responsibilities across professional staff in not only this UoA but many of the units in the Panel Nature and Society.

# 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The panel report gives an overview of a whole range of future directions for the research field within the UoA. The overview is based on ESF-COST Science Policy Briefing 41 – Landscape in a Changing World –2010. The overview shows a number of key points for research in the field and looks more like a list of possible directions than a strategy. The Panel therefore suggests that the UoA to work out a more concrete plan for what are relevant and necessary themes within both of the directions design and landscape planning. One way to get even more societal impact is to do research that connects to new policies and guidelines, for example the new architecture goals from the government.

The submitted report also highlights the need for a wide and more generalist oriented teaching base, with high relevance for practice, which explains the disciplinary width of the UoA. Theory and methodology span the humanities and art, across social sciences to natural sciences and technology. The Panel finds this important for the UoA and suggest that specific plans should elaborate how research could be developed to fulfill these needs. Clearly this particular UoA cannot do this alone and needs to build better and more integrated teaching opportunities across different departments in SLU.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The UoA mentions several challenges for further successful scientific development, which the Panel supports. It is important to involve teaching staff more in research and design projects and offer an attractive working environment for well-established researchers. It is equally important that established researchers become more involved in instruction. Seen from outside enough time for research and development seems to be crucial here and need to be discussed also at the SLU level. It is also necessary to speed up recruitment of staff, researchers as well as senior lecturers. Another issue is to look forward to make plans for replacement of staff, which will retire during the next 5 years. Allocation of resources for international networking is also important. This is not always a question of money but an issue of time management. The UoA mentions that they want to encourage staff not involved in grant applications for smaller projects. While this may be a good starting point the Panel believes that there may be need for more active support and training.

An important challenge for the UoA is to show its importance for the university as a whole. The Uoa's inter-/ transdisciplinary work can be an inspiration for the whole university thereby making SLU more visible and attractive.

#### Score for Strategy for Scientific Development

#### 3

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The most important messages to SLU are:

- Professional knowledge is crucial for landscape architecture education. Nevertheless, the university must ensure that teachers who come from the profession also have time for self-development and reflection through research

- In general, it appears that part of the staff is overloaded with teaching and others have very light teaching loads. This should be mapped and action to achieve a better

balance between teaching and research should be taken. As a professional education, it requires more time to teach landscape architects because much of the education is studio-based with 1 to 1 supervision, but ways of combining research and teaching should be sought.

- The reward and monitoring system should recognize other kinds of knowledge production other than peer reviewed articles. Better ways need to be developed to

monitor and reward technical reports and other scholarly products (e.g., digital communications; blogs, etc) that influence professional practice and policy.

- SLU should utilize the field of landscape architecture to make its inter-/ transdisciplinary approaches more visible.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

This UoA does a lot of activities with various stakeholders such as public bodies, private actors, different organizations and NGOs on an international, national and local level. SLU should consider using this group as a model of collaborating both across academic disciplines and between the academy of professionals in practice. For the local society in all Sweden it is important to continue to work together with Ultuna landscape architecture and together have contact with cities all over Sweden. The UoA has a wide societal impact and reaches stakeholders all over Sweden. The Panel applauds the important activities that the UoA does together with the national board of housing, building and planning. The case study "small places and big cities" shows that the UoA understands big questions for society and that the work it does will have a societal impact for all Sweden as it has influenced the Planning and Building Act. This shows that the group has had highly effective scholarly outputs. The case study about nature-based solutions will also contribute to a change in society. It is also very good that the group covers the architectural and design field with case study three "Landscape architecture in Europe". Architecture is currently an important topic in the Swedish society as the government recently launched new political goals for Architecture.

The Panel stresses the importance of communicating research results and to have a better digital presence not only for this UoA but for SLU as a whole. It is also important to pay attention to collaboration inside SLU to spread knowledge between the separate UoAs. The knowledge of this UoA on societal outputs can valuable also for other groups in SLU.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The outcomes of the UoA are relevant and impressive. The case studies have had significant impacts on society. The hard part is transmitting knowledge to practitioners and policymakers at various levels and throughout the country. It is important to be able to combine big social impact and high-ranking research. In some areas this UoA has managed to do this well and these cases can be better leveraged by SLU as models of high quality and high impact translational research.

#### Score for Outcomes

#### 3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The Panel sees the need for more detailed description of the most important strategic themes and topics for society in the field of landscape architecture along with an outline of a strategic plan to meet those needs. What topics are the most prioritized in the whole area of Landscape architecture? What kind of knowledge are landscape architects lacking when they work with planning, building, managing and activating sustainable outdoor space in the cities? What kind of knowledge does the profession need when they try to implement the new governmental architecture goals in Sweden? The case studies suggest that the UoA clearly has experience in meeting such lofty goals. The UoA should now reflect on the key topics for the future and make a strategy that aims at optimizing societal impact with relevant research.

#### Score for Impact Strategy

#### 2

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA is very good at collaboration and that they already collaborate with international, national and local stakeholders as well as policymakers and practitioners. The UoA also collaborates with people in other sectors working with outdoor space in cities.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The UoA should reflect on possibilities to broaden collaborations and make it more transdisciplinary. A key issue is overcoming sectoral thinking The UoA has a proven capacity to address complex planning issues and therefore its knowledge in collaboration can be usefully expanded to deal with cross sector challenges. The new policy for architecture may provide excellent opportunities for the UoA and SLU to demonstrate its relevance.

Developing ways to maintain active contacts with alumni is a simple and probably successful method that was discussed during the interview. This could make SLU a meeting point for all landscape architects and use this as a base for increasing its societal impact.

Quality and Impact 2018 Kvalitet och Nytta 2018 (KoN2018) PANEL REPORT OVERVIEW

#### Report Template for Review Panels – Overview of Research Field

#### **Research field/Panel (no. and name): Panel 17 - Plant Protection**

#### **General Overview of the Research Field**

#### We identified some "generic problems"

- Insufficient core funding, with many researchers reliant on soft monies
- Lack of flexibility in moving monies and resources within and between groups in a UoA
- Some short-comings in technical facilities and technical expertise to run specific pieces of equipment
- Lack of focus in research due to the scattered funding system of short term grants
- Jeopardy in leadership with an aging cohort of male professors
- Lack of "home-grown" scholars

More specifically, we were privileged to hear from 2 exceptional groups, one moderate and one problematic group. We assessed the paperwork and presentations of the 4 groups and hereby present our overall findings as a SWOT analysis.

#### Strengths

There are pockets of real excellence in the groups 390\_1\_S - Forest Mycology and Pathology and 632\_1\_LTV Chemical Ecology, both with respect to huge international presence and outputs of high impact and with highly cited papers. These groups are exceptionally well-structured and organized and have strong leadership. These two groups had managed to create a stimulating environment and from this engendered much creativity.

SLU is spread geographically across Sweden with the benefits of access to an array of agricultural and forest systems.

#### Weaknesses

Two groups were deemed weaker, but each had different issues. Within the UoA 390\_2\_NJ Plant Pathology there are simply too many projects spread too thinly over the personnel within this grouping. As such, they are unable to capitalize on some of their very best work and need some advice as to how to raise the impact of their work to, for example by submitting a manuscript to Nature Plants (with the plant breeding story).

Within the UoA 632\_2\_LTV Resistance Biology and IPM there were more systemic issues and leadership problems – discussed in more detail on the submitted form

#### **Opportunities**

Within the pockets of excellence, there is a tremendous "attractivity" for the global scientific community that could be exploited either to attract a strong future leader or develop one from within their own team (s).

Large number of doctoral students are attracted to courses offered by these two excellent groups, which the university should capitalize on rather than turning them away. Admin help is needed here to progress such courses effectively.

More funding for Fellowships and perhaps a VC prize for excellence – not necessarily monetary but a recognition / celebration of true excellence would attract and retain talent.

The panel considered that SLU might benefit from a "rebranding" *ie* towards something more attractive to the younger generation – such as Life Sciences or Sustainability

SLU has a cohort of capable researchers – it must retain, promote and more effectively "grow its own".

#### Threats

There is no apparent strategy for the succession and succession planning. SLU must do this in a more timely manner and involve the current leaders and exploit their knowledge and expertise to recruit their successors. The threat imposed by a large cohort of aging Profs is a very real one. Recruitment of new incoming professors from abroad and who have no established stakeholder network inability will be somewhat problematic, at least initially.

Greater effort needs to be expended on attracting a greater number of "home" UGs to PhD positions and thence post-docs within SLU.

Risk assessments of projects needs to be more robust or, at least, detailed more obviously. The process suggests indicates insufficiency in:

-risk management (what are the risks, how to mitigate, when/how follow up on regular base)

-structured collection of stakeholder inputs

-routines for sharing and learning cross units/departments.

Panel/ Research field	Plant Protection

#### UoA

Introduction

### General assessment of the Unit of Assessment

Plant pathology

This UoA is composed of two research groups: Agricultural Plant Pathology and Epidemiology. The Agricultural Plant Pathology group has two focused long-term research lines: biological control using the fungus Clonostachys roseas and breeding for root rot resistance in pea. In both cases there is a strong background of basic research and the aim to apply this research in practice. The quality of the research is high and the potential is great. The epidemiology group works on a variety of topics and is much less focused. A clear strategy and vision is lacking. Our SWOT analysis indicates that the strength is that there is great research potential, for instance related to population biology of pathogenic fungi. The weaknesses are the seniority of the professors, the lack of a succession plan, the lack of leadership in the epidemiology group and the low number of PhD students. The opportunity is that there is great potential among the young researchers in the group to become future leaders and this should be encouraged. The threat us that there may unrealistic expectations that a new professor in epidemiology will be able to impose a clear focus to this group in a short time. The panel clearly saw a potential for exciting research in this group but may be lacking ambitions in terms of publication. During our interview we heard great stories that have the potential to be written in high impact papers. The panel saw the potential for capacity to collaborate for societal impact. Work on topics relevant to farmers and stakeholders are well described and some of it is based on solid basic research, but there is the threat to have too many projects that try to answer every need.

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#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

This UoA is composed of two research groups within the Department of Forest Mycology and Plant Pathology. The agricultural plant pathology group main focus is on biological control, while the epidemiology group works on a broad range of topics. The research productivity is average, with a total of 88 publications for 12.6 FTE for a total of 7 publication/FTE for the entire period. The impact is below average (13% top 10% vs 19% for the SLU).

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#### Strengths

The research in the biological control group is clearly focused and combines strong basic research with practical application. They have year-long research on the biocontrol fungus Clonostachys roseas. Their research is of high quality and comprises the analysis of the Clonostachys roseas genome, transcriptomics related to biocontrol, fungal transformation, and strategies to use this biocontrol agent to control major pathogens of wheat (Fusarium and Zymoseptoria) in an IPM strategy. Major findings are that C. roseas can distinguish between fungal prey species and that mycotoxin detoxification via ABC transporters is a biocontrol trait in this fungus. They are clearly leaders in the field of Clonostachys genomics and biocontrol and have published their work in very good journals. A second research line in this group is related to resistance breeding in pea against the root rot pathogen Aphanomyces. Also, in this case both basic and applied research is done with great potential that can have a possible impact beyond Sweden (e.g. seed production for export). This research line is less visible in the publication output.

#### Weaknesses

The epidemiology group works on a broad range of topics without a clear focus. During the interview, the group could not come up with a main theme. Research items include populations studies of plant pathogens such as Phytophthora infestans in potato, and Puccinia stem rust populations on wheat. Other topics, among others, include landscape-scale risk assessment in plant disease epidemiology, food security, and fungal barcoding. The work has been published in relatively good journals, but the number of citations is rather low. The impact of this work is not very high. The expectation is that this area will strengthen when the new professor joins the group.

In general the group has some papers in strong journals, but there is not much impact in terms of citations. The number of publications is not very high, given the number of senior scientists in the group. There is little investment in PhDs (only 2 in 5 years).

#### Opportunities

The group has a good science base on which they can develop really exciting questions. They could aim higher and be more ambitious in their publication strategy and have very good stories that could really lead to high level publications.

The panel recommends that the epidemiology group should focus on population biology with key questions such as: why are fungal populations so sexual in Sweden? There are also opportunities for joint stories between biocontrol and epidemiology, for instance population biology of pathogenic versus biocontrol fungi. The group also has a high quality of young and dynamic researchers.

#### Threat

There is a risk that the group will lose some of their best researchers because of lack of tenure, and the huge stress on researchers to secure their own funding.

#### Score for Scientific Quality

#### 4

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The leadership in this group is rather senior which leaves the unit exposed. The professor in plant disease epidemiology is already retired and the professor in agricultural plant pathology is 63 years old. It is clear that a leader is lacking in the disease epidemiology group. There is no obvious succession planning, which is surprising because there is considerable talent among the young researchers. The professor in disease epidemiology will be replaced by a new epidemiologist, Prof. Jiasui Zhan with expertise in Phytopthora and Zymoseptoria, who was recruited internationally. The drawback is that this person will require some time to establish a stakeholder network in Sweden and to assume authority and leadership within the group. A senior lecturer in plant epidemiology will retire in 2018. An associate lecturer, Dr Salim Bourras is recruited internationally in the plant pathology group with expertise in plant molecular biology and metagenomics and pathogen/pathogen interactions as part of this groups succession plan.

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The low number of PhD students does not help to create an intellectually vigorous and productive environment. The group currently has only 3 PhD students. Since researchers can hold only one grant, and this grant has to secure their own salary, there is little financial room to hire PhD students - who are perceived as being too expensive. There is also a massive absence in the group due to parental leave. The panel did not have the impression that there were opportunities for young researchers to contribute to leadership. The team seems to be in stasis until the arrival of the new Prof and there is currently no clear strategic vision. The strategic section provided in the document represents a long list of activities that do not represent a vision per se. The members of the research group indicated to the panel that they are happy about the research facilities, which are very good (recent building). There is also good access with SciLife. The bioinformatics heavily relies on a few persons, but workshops and trainings for other researchers are planned.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

There are very few young faculty members and very few PhD students. There is considerable talent among the young researchers and there should be an opportunity for them to become future leaders of the group ("grow your own").

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

A long list of collaborations within the department, within the university, internationally and with stakeholders and industry is mentioned in the document. There is a strong collaboration with the UoA Forest Mycology and Pathology, with 21 joint publications since 2008, which is facilitated by the fact that they are physically hosted together in the Uppsala Biocentre. The group is active in the SLU platform plant protection. There are good contacts with authorities.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The research unit works on a broad range of topics, but the panel felt like the research lacks depth, with a few exceptions. Synergies between different UoAs at SLU are not being developed to their full potential. It is not clear why this UoA does not collaborate with the Resistance breeding in the epidemiology group at Alnarp, given that there are several possible overlaps in interest and topics.

#### Score for Scientific Environment

3

#### 1.3 Strategy for Scientific Development

# 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

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There is no clear strategy in the written documentation. A variety of topics are mentioned without a unifying theme or vision. There is a huge expectation that everything will change with the arrival of the new Professor in Plant Disease Epidemiology. This person lacks stakeholder connections in Sweden and the expectations seem unrealistic.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The potential for significant contribution is certainly there, but it is not clearly reflected in the written document or during the interview.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The epidemiology group really needs to focus.

#### Score for Strategy for Scientific Development

3

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The research environment is excellent and the capacity of the young researchers is high, but there is a distinct lack of leadership.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The unit works on problems that are relevant to farmers. They interact with the right stakeholders, including farmer organisations, the industry and the authorities concerned. They also have activities in collaboration with international organisations.

Research conducted by the UoA is relevant for stakeholders and contains aspects such as risk assessments, and policy support. The interaction with the Swedish Board of Agriculture and their Plant protection centres also gives the opportunity to reach out to a lot of extension service officers and farmers and is an efficient way to spread the results and have impact on important issues.

The unit employs a field pathologist who acts as a bridge between academia and society and regularly interacts with stakeholders.

The first case study that was presented (breeding for root rot resistance in pea) involves the UoA and the plant breeding company Findus and has resulted in the development of new pea varieties with partial resistance against Aphanomyces root rot. The impact of the second case study presented resulted in a change in the growers' fungicide strategy to control Alternaria solani in potato after findings of resistance to strobilurin and SDHIs in the Swedish Alternaria population. Fungicide treatments in ware potatoes could even be avoided without reducing the yield.

In case study three it was shown that the biocontrol agent C. rosea could give significant control of Fusarium head blight and Zymoseptoria in wheat. This has led to a patent application for the use of C. rosea against Zymoseptoria in wheat, since this pathogen is currently controlled with several fungicide sprays. In addition, the biocontrol agent can be combined with fungicides in and IPM strategy to reduce fungicide use and avoid fungicide resistance.

#### Score for Activities and Outputs

3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

There are a lot of good examples of studies done the latest years. See also 2.1a and for some of them, for example the work done with fungicide resistance, there is a potential to make it a success story if communicated in the right way.

There is a clear vision of being in an internationally leading position in core disciplines of Plant Pathology based on top level research as well as research-based teaching and industrial innovation. However, there seem to be a distinct lack of focus.

#### **Score for Outcomes**

2

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The unit has identified a variety of societal needs and wants to make important contributions to the Food Strategy and work in line with the SUD (Sustainable use Directive). The goals are very broad and the department aims to have significant impact on objectives ranging from keeping up competence in Sweden within plant protection and contribute to minimizing problems in food and feed with mycotoxins. This broad range of needs will be very hard to achieve and the measures are not really in place. There are not enough resources to reach all of these goals.

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#### Score for Impact Strategy

2

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The unit has a good understanding of the collaborative process. They have communication with and take part in different networks in the agricultural society. They do also present their work as popular articles and for example web pages. This gives the unit a lot of input about issues that all same to be important. This makes it hard to concentrate and focus on some core activities and become the real world leaders in specific topics.

One example of good collaboration is the first case study about breeding for root rot resistance in pea. It is based on solid fundamental research, and involved a collaboration of people with complementing expertise ranging from plant pathology and molecular biology to practical plant breeding. The key to success was that all partners went in to the collaboration with a positive attitude and with a willingness to learn from the competences of the other partners.

From the case that went wrong they learnt that it is important to clearly define the role of everyone in an interdisciplinary project. The goal of the project from the perspectives of the different partners was never specifically discussed.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

There is no need to further develop the capacity for collaboration. It is important however to focus on a few important topics.

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Panel/ Research Plant Protection field

UoA

Forest Mycology and Pathology

#### Introduction

#### General assessment of the Unit of Assessment

The panel was impressed by all aspects of the evaluation of this UoA. The UoA is divided into two streams, Forest Pathology and Mycology that were relatively well integrated and form a nice continuum from symbiotic to pathogenic fungi and oomycetes. The quality of research is clearly at a level that showed internationally recognized contributions, including numerous scientific papers that were highly cited in high impact journals. The societal impact of the research was clear with an excellent network outside of the academic world and some clear demonstrations of benefits to society. This UoA clearly understands the nature and importance of collaboration, involvement of stakeholders and the general public to foster a general dialogue on their research topics and their benefits to society.

Our SWOT analysis reveals that the strength of this UoA is the excellence of the scientific team and the leaders, reflected in the outstanding scientific productivity. The only weakness that we can identify is the succession plan, given that both current leaders will retire within the next 5 years. The opportunity is that this UoA has a tremendous attractivity in the global scientific community and could either attract a strong future leader or develop their own from inside the team. The threat is that the succession will not involve the current leaders so that their vision and leadership strength will not be capitalized on. This is compounded by the uncertainty in the politics of the SLU board.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.
This UoA covers a wide range of topics in sufficient depth to generate important contributions that are clearly in the world-leading category. In spite of having two clearly different topics (Forest Pathology and Mycology), this UoA is remarkably well integrated. This unit comprises 23 members, representing 20.5 FTE. The productivity of this UoA is very impressive with a total of 260 scientific publications, for an average of 12.68 publication per FTE. Their papers are frequently highly cited (6.7% of their papers are in the top 1% cited) and is more than 3 times above the SLU average. Their selected top 10 papers include multiple highly cited contributions in top tier journals such as Nature, Science) and several in flagship journals such as New Phytologist. We found some research papers produced by this UoA that did not make it to the Top 10 list were in top tier journals and have the potential to also become impactful over time. The panel noted that the UoA leaders were quite modest about their scientific outputs in their self-assessment and encouraged them during the interview to elaborate on the significance of their contributions. This humility on the part of world-leading scientists was quite refreshing. The research leaders stated that their strategy is to apply existing technology and to be early adopters in their field of specialization, a strategy that allows them to focus on significant research questions that leads to groundbreaking work. It is clear to this panel that the research conducted by this UoA creates paradigm shifts, including being the first in the world to apply genome-wide association studies to pathogen virulence, leading the mapping of biogeographical determinants of forest pathogen invasions in Europe, sequencing the first conifer genome and discovering that roots and root-associated fungi are major contributors to carbon sequestration as well as producing a user's guide to fungal community analysis. These scientific achievements led to scientific publications that were cited an impressive total of nearly 1200 times in the last 5 years.

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In spite of the broad range of topics covered by this UoA the panel was impressed by the fact that this did not compromise depth. Indeed, the team leaders clearly put the emphasis on quality instead of quantity (although both aspects were impressive). The team leaders emphasized that they encourage the whole research spectrum, from a holistic approach that encompasses theory, technology development and close contact to practice (more on this in the impact section). The team is also opportunistic (in a positive way) to new and emerging issues. For example, they have developed an important research area in invasive forest pathogens such as ash dieback and on important processes such as weathering and carbon sequestration.

The panel believes that this UoA comprises members who are truly world leaders in their research areas and have a level of recognition that set up this group for continued success.

#### Score for Scientific Quality

#### 6

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

This UoA clearly fosters a very exciting research environment. They are active in keeping a strong scientific animation in the group and carry multiple activities that foster creativity, for example by maintaining weekly group meetings, journal clubs and seminars. The group is clearly well balanced with team members from 14 nationalities and a very favourable gender ratio overall and a relatively good balance between age groups (although the leadership is all in the older age-group, something that will be discussed below). We note that this UoA strongly encourages international exchanges, with a total of 43 visitors from abroad spending more than 1 month within this UoA and 15 UoA members visiting labs abroad for more than 1 month.

# 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The panel has the impression that the young faculty and trainees were strongly supported by the UoA leadership. This includes the encouragement and support to young investigators to write their own grants and the allocation of resources for trainees to become docent. In fact, they have allocated (we suppose via the department funds) some funds to support docents for support and salary support. They also encourage young investigators to serve on graduate student committees. The leaders were very forthcoming in their vision for the importance of involvement of the next generation of scientist in forest pathology and mycology. In 2018 they have 8 PhD students (2 Swedish and 6 from other countries) and in the last 5 years they have recruited 8 researchers, 5 post-doctoral fellow and one senior lecturer.

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As evidence of their success in training the next generation of specialists in Forest Pathology and Mycology, several of the trainees find employment and some even find faculty positions in academia.

# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA has established an impressive network of collaborators both nationally and internationally, that allows them to radiate outside of SLU and perform research that is internationally recognized. For example, they are partners in the Future Forests initiative working with stakeholders; they also collaborate with the American Joint Genome Institute in a project on microbial dark matter. This UoA also coordinates major initiatives such as Biodiversa (a network of national and regional organisations promoting pan-European research on biodiversity and ecosystem services), NEFOM (a network on fungal DNA barcoding), FRAXBACK (a network on ash dieback). This large network not only allows this UoA to raise the level of their research but also results in international exposure, reflected in multiple invited presentations as speakers in conferences and invitations to participate in national and international commissions.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

This UoA, likely because of its strength, plays an important role in the development of synergies with different UoA at SLU. Their strong involvement in Future Forest is an example where their leadership played an important role in the success of that multidisciplinary research initiative. The presence of previous UoA members as professors in other UoA ensures a close collaboration between this UoA and other departments such as soil science. This UoA is involved in co-direction of students from different departments such as Plant Biology, Molecular Sciences, Soil and Environment, and Plant Production Ecology. Their involvement in the UMBLA platform is one example of a single platform and resources can be made available to groups from different departments and even users from outside SLU. This type of synergies provides very strong potential for the development of interdisciplinarity and should be applauded, while maximizing the resource utilization within SLU.

#### Score for Scientific Environment

#### 6

#### 1.3 Strategy for Scientific Development

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA essentially wants to maintain the outstanding research they are conducting going forward. The panel agrees that this UoA has a winning formula and that maintaining this strategy is a good strategy for the next 4-5 years but is concerned about succession in the future (see below for further comments). The mycology team has some ambition to begin a new research front on biogeological aspects. The panel believes that this could be an interesting new opportunity but warns of the danger of spreading too thin in the future.

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For scientific excellence they have recently enrolled an assistant lecturer and are in the process of enrolling a second one. The UoA also wants to maintain and develop their competence. They propose in the next five years to recruit two new professors. They have already started this discussion with the faculty on renewal of the chairs. This panel strongly supports and encourages this initiative.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The team wants to move from genome comparison and metabarcoding toward functional aspects at the community level. This is potentially an extremely promising field as the databases as filling with sequences that allow the identification of taxa in the environment without any knowledge of their function. The mycology team will continue to study the role of carbon cycling in the context of forestry practices. This will likely prove to be important in the context of mitigation approaches to climate change.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The succession plan of this UoA is the most important challenge in the near future. We strongly encourage and recommend that this process begins soon and that the current leadership team be involved in the succession plan. The identification of strong leaders in the research areas in this UoA is not a trivial task and cannot be delayed. They also identified bioinformatics as an area where capacity building will be required.

#### Score for Strategy for Scientific Development

#### 5

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The panel acknowledges that the move to the new facilities has been both beneficial in terms of fostering synergies and challenging in terms of increasing rental costs, thereby taken resources away from the UoA. Overall, clearly this has not affected the scientific productivity and quality of this UoA but this could be considered in the future funding allocation.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

This UoA is involved in multiple activities to promote the maximum societal impact of their work. They use both traditional methods (mycology courses, workshops, training, meeting with stakeholders and end-users) and new methods (social media, internet, You Tube) to ensure as broad a dissemination as possible. Since 2015, the UoA systematically writes popular science pieces on their main research papers, approximately twice a month. These are regularly published on SLUs front page and has provided a nice data base of publicly available information. Most of them attract attention and get cited widely in newspapers and news sites, both in Sweden and abroad. The Face book page has more than 1000 active followers, and more than 22000 unique clicks were registered on popular science texts at their website in 2 years.

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The stakeholders represent a wide range of recipients of the scientific production from this UoA. The Swedish forest owners and the Swedish research community, e.g. Skogforsk, are stakeholders that benefit from the molecular marker work, the identification of forest threats, the description and protection of biodiversity which will contribute to a sound and sustainable governance and management of the forest resources.

The impact of the research on biodiversity can also be measured in Non-Governmental Organization (NGOs) such as the IUCN, the red species lists and the environmental protection agency etc. In additional the UoA contributes to forest policy and invasive phytosanitary issues which benefit the Swedish Forest Agency and the Board of Agriculture in Sweden and at EPPO and EFSA at the European level.

The general public is another important stakeholder group that to which this UoA does an excellent job of reaching.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

This UoA has a very good program for producing outcomes that have the potential for societal impact. They provided as example their leadership in the analysis of the increase in forest pathogens in Europe, and the identification of previously unknown new threats. Given that early interventions are at the core of prevention of invasive species establishment, this provides an excellent example of a research outcomes that impact the Swedish society. Their study directly led to The Swedish Forest Agency updating its policy on the management of the identified alien forest pathogens. Another important outcome that can lead to societal impact is the breeding of spruce resistance to root disease, via their discovery of a gene, PaLAR3, that can be used in tree breeding. This pathogen causes one of Sweden's most important diseases of conifers in plantations and second growth forests. Discovering markers for resistance to pathogens speeds up the resistance breeding represents an important and measurable societal impact.

One of the cases presented concerns the National monitoring and analyses of fungi in forest soil fertility. They have developed a bioinformatic program, SCATA, to analyse large fungal datasets derived from Next Generation Sequencing. In interaction with databases such as UNITE and FUNGUILD, they can compile knowledge and develop approaches to classify fungi into guilds, for interpretation of species communities. The Swedish Environmental Protection Agency (SEPA) is keen to use this data as part of their large-scale annual monitoring of soil fungi. The monitoring data is used by the Swedish Species Information Centre to underpin in their national fungal red-list assessment. Knowledge on the relationship between fungal community composition and soil fertility, carbon sequestration, tree growth and forest management is expected to have management implications and be of interest for different forest stakeholders.

#### **Score for Outcomes**

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

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We can identify three strategic goals for impacting the society. The first one is the development and support of diagnostics capacity for established and emerging forest diseases. A field mycologist is handling enquiries to identify causal agents on behalf of the end-users. The second goal is to help companies and forest owners fight against tree diseases by developing resistance breeding strategies. In order to accomplish this, they work with forest breeders on some of the most important diseases e.g. Heterobasidion root rot, ash dieback, resin top rust of pine, spruce cone rust, Diplodia dieback of pines. The third goal was to analyze the importance of forest soil microbial community for forest soil fertility. This can be used to develop inventories of the impact of forest practices on biodiversity e.g. whole tree harvesting. In addition, this can be used to provide knowledge and guidelines of how to manage for fungi of conservation interest.

Strength of this UoA to implement their strategic goals for societal impact include very good relationships with authorities e.g. the Forest Agency and the Board of Agriculture, with forest companies and forest breeders, authorities and consultants in conservation and with journalists active in the forest sector and popularizing science.

The weaknesses to implementation are that some of the scientific achievements can be difficult to explain, especially for projects of a more basic nature.

The panel believes that these strategic directions for societal impact are entirely realistic based on the past success of this UoA.

#### Score for Impact Strategy

3

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

This UoA clearly understand the nature and importance of collaboration, involvement of stakeholders and the general public to foster a general dialogue on their research topics and their benefits to society. See Section 2 for further details.

3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

This UoA already does an excellent job of outreach with stakeholders, the general public and the scientific community. Our only recommendation would be to also engage all levels of the political community to ensure visibility not only in the public and the stakeholders but also in the decision-maker community.

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Panel/ Research Plant Protection field

UoA

Chemical Ecology

#### Introduction

#### General assessment of the Unit of Assessment

The UoA conducts world-leading research, is well positioned for societal impact, and demonstrates very good capacity for future successful development of the unit. A major challenge is that chemical ecology is an exciting research field with a very large range of applications, and, at the same time the potential societal impacts are identified as being substantial. Therefore the project direction, priorities and resource management will become critical if their full impact on the society is to be realized.

### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The unit:

- shows depth in their research on chemical communication, olfactory physiology, and neuroscience, and breadth with regards to their work on different organisms.
- demonstrates unique expertise concerning interactions between plants, pests, and microorganisms.
- is broadly skilled in developing and applying advanced methods (eg ToF GCMS), and in demonstrating their innovative capacity.

Their scientific productivity, based on papers published (of which 16% are in the top 5% of publications in the area, and 39% are within top 10%) is high, with over 1.6 peer-reviewed papers published per year per scientistyear. The number of citations reported, together with the high quality / high impact factor of the scientific journals mentioned, also demonstrate their prominence in this field of science.

All critical elements needed for high-quality research (know-how, equipment, critical mass and good organisation) are present and proven in this UoA. They are well able to capture opportunities from basic science to applied research.

#### Score for Scientific Quality

6

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

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The unit has managed to maintain high productivity and research excellence over the past 9/10 years (since the last KoN, 2009).

Leadership continuity and successful recruitments, plus ability to attract funding have likely been key factors in maintaining this position and in generating stability.

Diversity / gender balance is not ideal at the leadership level (one female out of six professors), but overall (35% female researchers) is acceptable and comparable with the assessment of other units in SLU. However, this figure could and should be improved.

The leadership succession plan appears to be in order (internal recruitment plan said to be drafted and preliminarily agreed upon). The submitted documentation and submitted self-assessment do not give us sight of the full analyses, however.

The number of PhD students, post docs and researchers (on average about one of each per group) per Professor are well balanced.

The recruitment of PhD students and post docs is truly international.

# 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

This unit obviously fosters the development of young independent researchers in an environment that is conducive to growing the talent inside their unit. They mentor and train their young investigators in all aspects of career development. They provide ample opportunity for development and leadership via programs such as the Future Leader program and the Vaxa program developed in their department. The unit leaders believe in the importance of training in teaching and provide opportunities for their junior unit members to develop these skills at the undergraduate and graduate levels. Junior scientists even receive support for participation in the pedagogic training program of the Division of Educational Affairs. Finally, they encourage participation in international conferences and student workshops, in addition to involving them in active support with grant applications. Highly successful international PhD courses are organised by the unit, being very popular and significantly overbooked (this needs attention and admin help to better exploit). The panel was very impressed by the support that this unit provides to their young faculty.

# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

This unit represents an interdisciplinary network (a constellation in their own words) of researchers, providing opportunities for collaboration within and outside the department and faculty. This allows this unit to increase the scientific quality of their work and to bring their research to application. The very basis of their expertise makes them a strong partner in collaborations. In addition, the nature of some of their work, for example on insect control for plant protection or on the control of disease vectors is widely applicable around the world, enhancing their international collaborations. The research and its applications are truly global. The unit collaborates with several of the best research institutions and universities in this international arena. This international networking allows this unit to develop these strong links and to lead in their own research field with a significant global contribution. However, they also put a high priority of collaborations at home with other UoAs, platforms and centers at SLU, as well as with national partners and stakeholders.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

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The UoA demonstrates both depth and breadth in interdisciplinary and innovative research. The UoA is engaged in collaborations with an impressive 16 other UoAs at SLU. This includes joint grant applications as well as collaborative research projects and co-direction of PhD students. They maintain collaborations with SLU platforms and centers, including Future Food, Partnerskap Alnarp, PlantLink, Platform Plant Protection (the UoA is responsible for one focus group), SITES, SLU Global, SLU Global Bioinformatics Center, the Swedish Metabolomic Center and the SLU Max IV user group. A postdoctoral researcher has recently been recruited to the UoA to facilitate projects at the Max IV laboratory.

To foster even further interdisciplinarity the research unit has submitted an application for funding of research infrastructure for a GC-Q-TOF instrument that will not only promote leading-edge analytical chemistry research within the UoA, but will also facilitate cross-UoA cooperative research. The panel applauds this pro-active initiative and would suggest promoting more similar approaches to develop trans-disciplinarity at SLU.

#### Score for Scientific Environment

#### 5

#### **1.3 Strategy for Scientific Development**

# 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA has been clearly successful in attracting research funds and substantial core funding from SLU. Their overall goals to develop sustainable and secure food production and protect human and animal health is definitely a theme will be important for the future of human kind. Their research on the chemical ecology of pests and disease vectors and the development of practical solutions to pest problems that can derive from that research brings an important contribution to this goal. The document indicates that the promotion of scientific quality and renewal is important and they are devoting some time and resources to foster this renewal. In addition to investing in professional formation and curriculum development for their team members they continue to successfully fund the position of senior and junior scientists.

The proposed strategy that is highlighted in the document confirms that this unit will maintain the high level of scientific rigour and outputs that they have demonstrated in the past, and there are no signs that these standards will decline in the nearer future.

The unit's proposal to strengthen and update their infrastructure and to secure staff working with chemical analysis and microscopy should be important to maintain and advance their analytical capacity.

Overall, the panel believes that the strategy laid out in the document for scientific renewal is sound and realistic.

# 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The unit identifies several interesting future research directions that fit well within their identified goals and that also fit within their expertise. They propose to conduct transcriptomic and functional genomic studies on odour reception and to look at selection pressures on salient odour receptors. They want to conduct functional analyses using directed mutagenesis and CRISPR/Cas9 genome editing of odour reception to identify how single-point mutations determine ligand selectivity. Lastly, they plan to obtain stoichiometric and three-dimensional structure for these receptors. Understanding function and structure of odour reception could accelerate knowledge transfer and achieve novel applications. Overall, the panel believes that these future research directions have the potential to make significant contributions in the future.

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# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The panel acknowledges that the proposed scientific program is dependent upon a certain number of factors. The list presented in the self-assessment identified the following potential risks and obstacles, to with which we agree:

- Paucity of funding
- Recruitment issues and career development problems
- Infrastructural concerns (lab etc)
- International collaboration issues

We believe that this list is accurate but is not unique to this UoA and concerns issues that will have to be addressed at the higher SLU level. We strongly support this UoA in their attempts to secure more stable funding so that they can recruit and retain highly qualified team members and maintain highly competition infrastructures that have supported their national and international collaborations.

#### Score for Strategy for Scientific Development

#### 5

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

Suggestions for improvement:

- Structure the stakeholder inputs (initiating focus groups)
- Require risk assessment plans for critical work/projects.
- Secure routine / best preactice for sharing and project learning cross units / departments.
- Understand why "Plant Protection Platform" has not been included in the discussions. Analyse and manage the root causes of this fact.
- Understand why "The Centre for Biological Control" not been in scope of any discussion. Analyse and manage the root causes of this fact.
- Ensure that funding processes stimulates (or steer) cross unit/department collaboration.
- Evaluate the need for a joint infrastructure resources (cross departments), where concepts can be tested in field/green houses, with special focus on IPM.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

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The UoA is clearly active interacting with a broad range of societal stakeholders. The unit communicates with a diverse group of stakeholders including government and non-government public organizations, commercial companies, and grower's organizations. The panel appreciates their approach to build on mutual information exchange and joint field campaigns to foster such exchanges. They also engage in external consultancies with grower's associations and pest control companies. They are active in their communication to stakeholders via meetings, workshops websites as well as popular science articles and news media. Their research portfolio includes both economically important insects in the agriculture, horticulture and forestry sector as well endangered insects. They also perform commissioned research which allows companies to receive clearance for their products, including both attractants and repellents for mosquitoes.

The panel was happy to see that this unit also cares about the next generation of stakeholders by engaging in high school education to create and support interest in natural science and agriculture. This has the double advantage that it involves junior staff presenting their research and supervising high school project work (GA-arbeten). Although the panel realizes that this type of activities is not highly recognized in scientist evaluations, we think that it is a very important service to society.

The panel identifies a large potential to contribute much more to current and emerging problems in European agriculture (as in oilseed rape pest control for example) where the unit's expertise could be truly beneficial. In the presentation we observed the potential for extension into food applications and would strongly encourage engaging in the development in future food science.

#### Score for Activities and Outputs

#### 2.5

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The unit identifies their main outcomes as the development of methods for sustainable control or mitigation of insect pests and disease vectors. For example, they have worked with companies to develop novel attractants and repellents for biting insects and propose to initiate a joint company for which intellectual property rights and patents will lay the foundation. They also work, via commercial companies, in plant protection on the development of pheromones and other attractants as lures for insect monitoring and treatment. In addition, they work on insect control by mating disruption with chemical industries which led to registration of commercial products. The unit's project on biodiversity monitoring has lead to several action plans for threatened, red-listed species that could be used to define indicator species of biodiversity hotspots.

Overall the panel is impressed with these research outcomes and we agree that the outcomes provided as examples such as the bark beetles and mosquito stories target significant societal needs. The technologies developed have huge potential here and in many related arenas.

#### Score for Outcomes

2.5

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

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The unit's strategic goal to for societal impact is to ensure direct application of their basic research and contribute to long-term sustainability and productivity in agricultural production and forestry, public and animal health, and the conservation of biodiversity. They propose to increase practical applications through behavioural manipulation, for monitoring and for direct population control. Already, their research has led to the foundation of companies with the potential for commercialization. Part of their strategy is also to continue to transfer knowledge to stakeholders, the general public and students at all levels. The panel is very supportive of this unit's approach to contributing to society and believes that the strategy is realistic within the goals outlined above.

The future directions in the self-assessment are well described but we would have liked to see more how to advance this strategy to actionable levels. We agree on the overall direction and we put trust in the execution based on the group's past record of achievement, but it would help to assess if we understood the key actions for social impact that are to be taken for each "opportunity" over the next years.

The applied research is said to be of lower priority due to lower scientific interest and lessened career opportunities. We agree, but, at the same time, require a proper planning, resourcing and incentive structure to capture the opportunities described.

#### Score for Impact Strategy

2.5

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The cases presented all demonstrate good capacity to collaborate with society, and they represent significant application potential. They are geographically well dispersed, and the research counterparts represent various types of organizations.

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The capacity in terms of time is harder to evaluate - we have identified a potential risk that opportunities might get lost due lack of resources. Indeed, it may be that the limiting resource is senior staff time, and the balance of time apportioned to societal impact or to science should be discussed more overtly.

There is thus the identified a risk of over-stretching the current staff. If pulled in too many directions, the high quality fundamental research may be jeopardized.

The case example with a negative outcome, indicated that a feasibility assessment at an earlier phase in the process might have helped to mitigate this situation.

# 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

Manage the challenges mentioned above by creating a position for a researcher / administrator who specifically takes responsibility for the application stages of the various project opportunities. This person could also boost external communications by crafting articles for the popular press and so enhance awareness and increase interest for the unit's work.

Panel/ Research Plant Protection field

UoA

**Resistance Biology-Integrated Plant Protection** 

#### Introduction

#### General assessment of the Unit of Assessment

We have divided our evaluation into two sections to more accurately reflect the topics covered in this UoA. We considered that the mismatch between the documentation that the panel received and the presentation per se warrants the division into:-

1) Integrated Pest Management (IPM)

2) Resistance biology.

Our evaluation is dramatically different between these topics 1) and 2). Moreover, the panel is aware from the documentation that there is a third topic, on strawberry research, that was alluded to but not covered during the two presentations and subsequent interview.

It is clear to this panel that the UoA co-coordinator misjudged the seriousness of this evaluation. Indeed, the unit coordinator confessed that he had crafted much of the prose, considering that the documentation was only an "internal working document" etc (see prose page 24). This represents an opportunity unfortunately missed. The documentation was poorly prepared, had not been proof-read, some sentences do not make sense, whilst others are in Swedish. The presentations were sub-par, lacking a more holistic look at the groups' activities and one carried various typographical errors. The interview showed a lack of thought, consultation and coordinated preparation. Indeed, it appeared as though the other Principal Investigators (PIs) had had insufficient input into the whole process.

We make more specific and positive comments in the subsequent prose.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

\*Please read the general comments concerning the structure of our evaluation of this UoA.

There are 29 researchers in the UoA. They produced 136 papers over the 5 year assessment period. . The impact factor of the papers is variable and many of the higher impact papers come from collaborative research or from review articles. The UoA co-coordinator could not fully describe the "process" for choosing their top 10 papers listed and it is apparent to the panel that the choice of selected papers is a poor representation of the unit's capacity and ability. Indeed, some of the selected papers were not described in the scientific achievements (eg, the temperature sum model and the Saprolegnia work) and some work areas were described under scientific achievements but had no papers listed.

One of the major contributors of this unit (Johan A. Stenberg) was absent from the interview and had not

apparently inputted into the report. We are aware that this PI is a strong contributor to this UoA in IPM research.

It was apparent to the panel of the considerable internal strife within this UoA; a fact which seems to being eclipsing their ability to capture, conjoin and relate their more successful stories. They lack leadership. Thus, it is clear from the documentation and from the interview that there are different units operating within this UoA who simply do not function in a coordinated fashion.

On a more positive front, the first part of the documentation submitted in the self-assessment form is good. The brief description (1.1a) captures a good summary of the group's activities. However, the subsequent documentation seems to have been crafted in a hurry (as per earlier prose). We consider that the documentation undersells the research of this UoA, in particular the strength of the work in the IPM team.

The panel comments on IPM and Resistance breeding separately in the subsequent prose. The documentation and the presentation of the Resistance breeding portion were confusing and muddled and the panel had difficulty understanding the nature of this research programme. Whilst the IPM portion of the documentation and the presentation were better articulated, there was no coordination or synergy between the subunits.

We have therefore chosen to assign scores to the IPM consortium alone. After considerable debate and discussion, we have decided to assign a o score across for Resistance breeding, given that we cannot properly evaluate the work from the evidence presented in the document and the interview. The committee also felt that this was a kinder course of action and hopefully would open an avenue for re-evaluation, than awarding very low scores to this group.

#### IPM

The IPM programme is very much orientated towards applied research in horticulture (including potatoes) and practical implementation. Much of the research is demand-driven and is co-designed with stakeholders. Some aspects have led to patent filing, so demonstrating innovation leading to application. There is novelty in the research into interactions among pests and pollinators. Moreover, there are some conceptual advances in the area of evolutionary approaches to capture genetic variation in crop wild relatives. (Score = 3.5)

#### Resistance biology

The research in this group focusses mainly on potatoes and the late blight pathogen Phytophthora infestans (Pi), but invokes the use of tobacco as a model experimental system. The research ranges from basic molecular biology, through proteomics and field trials with the aim of to discover and translate new resistance and susceptibility mechanisms into potato, as well as to understand general plant immunity. It also encompasses some work on induced resistance. The aim is to generate better ways to control Pi in the field. The UoA coordinator did not present or articulate a convincing "pipeline" to the assessment panel – a compelling argument from "gene to green field" would and could have formed a nice adjunct to the IPM programme. The panel felt that this was a lost opportunity. However, as the interview came towards its close the panel asked one of the team members to comment. Laura Grenville-Briggs Didymus then articulated a clear vision for the Phytophthora spp work (in Sweden and more globally). Her short prose was informative, visionary and exciting. The panel again felt that this was a lost opportunity and that she should have been given the opportunity to present.

#### (Score = 0)

The resistance programme, as presented, is not particularly novel or cutting edge. There is huge international competition in effector discovery. The unique aspect at SLU would come from an integrated approach for IPM, but this was not articulated.

There is some evidence of strong international collaboration, by partnering but not leading research, but an absence of evidence for internal collaboration on similar research topics.

#### Score for Scientific Quality

#### (RB) o (IPM) 3.5

#### 1.2 Scientific Environment and Leadership

#### 1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

This UoA is clearly not functioning as a cohesive unit and appears to be in transition.

The document was poorly prepared; the UoA coordinator confessed that he wrote the document largely on his own without consulting the team; the document clearly was not ready for dissemination to the panel (as per earlier prose). The writer of the document appeared critical of the review process and was unaware that this document was to be read by an international panel of experts. We perceived tension between the PIs during the interview and of tension during the transition in team leadership.

In summary the panel felt that this UoA is dysfunctional and poorly led. However, the proposed new Prof has the potential to dramatically improve the health, wealth, well-being and productivity of this group. Indeed, after learning of the current succession plan for this unit the panel invited Laura G-B D to comment. The panel felt a transformation in the interview after hearing that she had a vision not only for this unit but for global science, with respect to the IPM of Oomycete diseases of potatoes and cacao. We strongly endorse the choice of Laura G-BD to lead and develop a true IPM vision for this unit.

Current leadership score = 0

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The leadership transition plan presented by the Dept during the interview is evidence of the promotion of an internal candidate who clearly has potential for leadership. We are not able to comment further than this as we did not specifically cover this issue during the interview process, given the serious issues we had to address.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

There is good evidence of networking, mostly in Sweden, by the IPM group. Indeed, the IPM researchers use networks of growers for collaborations. There is also evidence of international networking by the Resistance biology group (eg with The John Innes Institute, James Hutton Institute and with Wageningen University). However, it is not clear what the contributions of the members of the UoA to these collaborations are in the absence of obvious publications.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

There is a much breadth within this UoA but little depth. There are several disciplines that are covered, from proteomics to resistance biology from a plant perspective and modeling, but these are not integrated, even within this UoA. Thus, the panel identified clear potential for synergies that have not exploited by this unit within the UoA and between UoA at SLU.

#### Score for Scientific Environment

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(RB) o (IPM) 2
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#### **1.3 Strategy for Scientific Development**

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

It is difficult to assess this aspect given the documentation, the presentations and the outcome of the interviews. It is clear to the panel that under current leadership there is no well-articulated strategy for scientific renewal. Everything is now contingent on the new appointment to take leadership of this group.

1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

Same comment as the previous section.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The panel perceive that the challenges of this UoA are so great that we recommend that there is an additional internal review of the work packages and leadership needs. We recommend that full support is given to the incoming Professor so that the new leader can raise this team to greater success.

#### Score for Strategy for Scientific Development

(RB) 0 (IPM) 2

1.4 Additional comments

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

#### Panel - Section 2 Societal Impact of Research

2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

These sections were difficult to evaluate from the document since all we had was a list that comprised some activities and outcomes without description and some of it was in Swedish. The following is based on what we understood.

#### IPM program:

The IPM program is focussed on activities and outputs aimed at answering real-life questions. This is exactly the type of research that engenders societal impact. That impact of this part of the UoA's work was clearly articulated (reduction in pesticides, costs, etc) during the interview.

The impact of the Resistance biology part of this UoA is less clear and poorly articulated. However, an activity in plant breeding in collaboration with Wageningen was alluded to. There is clearly some potential for societal impact in particular if the IPM strategy for the Oomycete that was articulated during the interview by the junior Prof was implemented.

#### Score for Activities and Outputs

(RB) 0 (IPM) 2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

IPM: the team works effectively with the farmers who are benefitting from their research activities – eg pheromones have been tested in the field. Moreover, farmers are involved in the research and their outcomes and applications (score 2)

Resistance: the potential for IPM is present in the Phytophthora spp programme but it is not clear how the outcomes could benefit society in the current documentation. In discussion, a problem was identified within the phosphite project, as this chemistry is not registered for usage in Sweden.

Score for Outcomes

#### (RB) 0 (IPM) 2.0

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The strategy was not clearly laid out and it was difficult to see the societal impact being implemented.

#### Score for Impact Strategy

(RB) 0 (IPM) 1

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

IPM: This unit clearly understands the importance of collaborative processes and has involved networks of growers and industry, not only in the applications of their research but also in the design of their research. They have also helped commercialization by providing the IP free-of-charge to a company for a product that can impacts on growers and industry - for a small niche market.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

Adopt a strategy similar to that in Forest Mycology.

#### General overview - Panel 18 - Soil & Environment

The panel evaluated four UoAs. Three of them are from the Department of Soil and Environment and one from the Department of Aquatic Sciences and Assessment. All UoAs deals with different aspects of soil – water interactions and they are to different degrees involved in teaching, research and environmental monitoring and assessment following strategy of SLU. Our comments are organized by the three criteria of the assessment

#### Quality of research

#### General strength of UoAs:

- UoAs display a range of strength including some world-leading research based on new ideas, using traditional and modern methodology. Scientific metrics range from good to excellent.
- The most successful UoAs effectively combined EMA and research, using EMA to develop hypotheses and to open new lines of research.
- Interdisciplinary (mainly within the natural sciences) at department, faculty, and university level varies from good to excellent, but is recognized as important by all UoAs.
- UoAs all exhibit support for a creative scientific environment through seminars, knowledge exchange, friendly reviewing of proposals before submission.
- The strongest UoA has good career development support for young scientists and attracts many PhD students; their efforts should be emulated by the other units.

#### Weaknesses:

- Delays in appointing professors has impacted scientific productivity and planning future strategies
- Potential of EMA to contribute to research is not fully realized in some units; reductions in EMA funding threatens scientific exploitation.
- Reliance on external funding weakens ability to pursue coherent strategy in scientific topics and leads to broad range of subjects and goals;
- Multiple faculties within one department resulted in an artificially separated UoA; the panel is concerned about effect of resource allocation and planning although this does not seem to effect research
- There are a small number of young scientists and PhD students in some units.
- Lack of institutional support for advancing new centre on drinking water is concerning.

#### Societal impact

#### Strengths:

- Sharing long-term monitoring data and assessment results provides the basis for strong societal impact.
- UoAs exhibit ability to respond to a wide spectrum of stakeholders and respond to demands from private and public sector.
- Some units have developed ability to bridge the gap between societal needs and basic research.
- In general, there is strong collaboration with authorities and private companies.

#### Weaknesses:

- Not all units have or actively seek the support of external collaboration specialists.
- Collaboration/extension duties not well defined.
- Reductions in EMA funding reduces opportunities for flexibility in responding to societal needs.

EMA and related research provides a large potential **capacity for collaboration** with society; but realizing that potential requires sufficient human resources. Increasing impact of research on policy requires a more coherent and thoughtful communication strategy at the university level. In some UoAs, interaction with general public could be improved but requires additional resources to be accomplished.

#### General comments and recommendation to SLU management

- Assessment. While self-assessment is a good tool, the structure of the form was rather complicated and confusing. The interviews were critical to achieve a comprehensive view of the units.
- Faculty/Department Structure. The value added to scientific research of these overlapping and cross-cutting structures is unclear. How do these structures impact resource allocation and support for strategic investments in new initiatives? We recommend simplifying administrative structure.
- Urgently fill chair for 435\_3\_S. In general, delays in filling professorships have affected half of the units.
- **Creating new professorship for 280\_1\_NJ.** This most productive and innovative group should be considered for new professorship and new senior lecturer. This should be considered a strategic investment in the future.
- Improve institutional support for future platform and centre development. The panel sees great potential for SLU to initiate and support important new developments such as the drinking water center that assembles state-of-the-art science in response to societal needs.
- Share best practices. Problems encountered by some UoAs (e.g., in PhD student recruitment, collaboration) have been solved by other units.
- Include collaboration elements in performance reviews. Given the importance of collaboration to SLU mission, efforts should be recognized and rewarded.
- Continue to support EMA as a key element for research, innovation and response to societal needs.

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Panel/ Research field	Soil and Environmental Sciences
UoA	Biogeochemistry of Forest Soils

#### Introduction

#### General assessment of the Unit of Assessment

The group has a strong commitment to EMA and sees the potential of related research. The group members are active in collaborating on research topics in the field of forest soil science, in particular soil biology and biogeochemistry with other groups within the department and across department boundaries. In this respect, they contribute with sound long-term databases and with their expertise on forest ecosystem processes and forest management to fundamental and applied research. The collaboration in EMA-related topics might be utilized for stronger international research collaboration (e.g. make use of the 'Big Data' for hypothesis generation and testing). The full potential can however only be realized, when the vacant chair position is filled. Attracting new PhD students should also be prioritized.

The group is good in communicating their findings to authorities and thereby influence legislation and decision making on important fields related to conversion from fossil based to renewable energy (e.g. Impact of forest bioenergy on GHG). They contribute to sustainable forest management with their data and competence in information and DSS systems. Another achievement, contributing to the SDGs, is their engagement in human capacity building on sustainable soil management in Africa.

The ability for collaborating with government authorities is well developed. The understanding and availability of resources to interact with the public could be improved with the support of an extension collaboration specialists.

#### Concluding remark:

At present, the group is too small and has too many EMA commitments. Despite the vacancy of chair, the group should chart a plan for its own research within available resources and not continue to wait for a chair. To be viable, the number of staff in the unit has to be increased and the appointment of the chair is urgent.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The unit's research focus is closely linked to its EMA commitments, which are a) the Swedish Forest Soil Inventory and b) the LULUCF reporting. EMA activities cover 56 % of the funding and consume a high proportion of the unit's work capacity.

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The topic 'Management and Climate impact on carbon storage and greenhouse balance of forest soils' is a central field of research internationally and the findings have important economic and societal consequences. The group is working on carbon storage in boreal ecosystems and, partly based on EMA data, has identified important drivers (climate, site conditions and management) and has used simulation models to calculate scenarios of future development. Monitoring data is also used to support basic research, e.g. the hypothesis formulation on mechanisms and drivers of humus turnover in boreal forest soils.

The group members try to integrate research topics relevant for the forest sector via collaboration with other, more specialized groups (e.g. soil biology, and soil physics). The unit also has a strong focus on applied research in line with SLU and Faculty of Forest Science strategies (replacing fossil-based resources with biobased materials); the results may have important impact on decision making and legislation (national and international). Examples are LCA-based system analyses of forest bioenergy, experimental research on effects of harvesting on soil properties and C-storage, effects of nutrient removal on soil acidification. Research on BGC and hydrological processes in rewetted peatlands, based on long time series, is a further research focus.

In the past decade, the unit has published its research findings in leading journals in the field (e.g. Nature Communications, Scientific Reports, Ecological Modelling, Forest Ecology and Management, Soil Biology and Biochemistry, Agriculture, Ecosystems and the Environment) with a fair number of citations. In relation to the number of researchers the number of publications (44) in the assessment period is lower than that of units less involved in EMA, reflecting the imbalance of commissioned work and research. The group is strong in application-oriented research but has not reached its full potential in fundamental research.

Considering the present group size, the forest BGC group could improve their research quality by being focused on fewer key topics. In some contexts (forest floor accumulation – micronutrients – enzyme activities) there are new fundamental findings, but mostly there is a traditional focus on basic methodological aspects (C stock calculations etc.). At present the group gives the impression of being the provider of data (albeit of high quality) and infrastructure rather than leading the science. They should formulate more fundamental research questions and, by utilizing their international collaboration in EMA-related topics, make better use of the 'Big Data' from their EMA. We can see a potential for further development of research on C-turnover in forest soils. In the field of forest bioenergy research, they contribute to method development and provide data for LCA. The potential for related publications is high. The scientific impact of the group can be improved by communicating more of their results in peer-reviewed literature.

The group is well embedded in the department. Strong research can be developed in collaboration with other groups within the department if there are sufficient personnel. The chair professor, a position that has been vacant since 2014, urgently needs to be filled.

#### Score for Scientific Quality

#### 3

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The involvement in large research programs (IMPRESS, QWARTZ), ERA-Nets, both as lead and partner, as well as the active role in the international LULCF and bioenergy communities offer opportunities for national and international exchange of researchers and ideas and these are utilized. Unit members are involved as experts in UNFCCC, FAO and IPCC.

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In addition, hosting the graduate research school, intensifying the integration and setting up networks within the department are further ways of generating a lively scientific environment.

The number of graduated PhD students in the observation period (6) was high, and the involvement of international co-supervisors supported scientific exchange; however, at present there is only 1 PhD student.

Overall, age and gender structure appear to be fine when considering the number of people, but there is a strong imbalance in the distribution of FTEs. The recruitments in the observation period were all from SLU; the professor should be recruited internationally.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

Members of the unit initiated a number of supporting initiatives at the department level.

Friendly reviews enhance the success of research grant application by young researchers. Mentoring within the unit seems to work well as successful promotions (2 Assoc. Profs) show. The Graduate school 'Focus on Soils and Water' stimulates networking.

The annual performance review talk is assumed to be compulsory and seems to be used for career planning.

The involvement in EMA can provide additional funding sources for young researchers but at the same time limits the focus on and time for basic research.

# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

In the list of major national and international scientific collaboration, the unit only mentioned Nordic organisations. Their academic networks and the impact are however global in the LULUCF reporting part and could be used also for scientific exchange (see 1.2.a in the self assessment report).

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The research unit is small and it is wise to focus on its core activities, in particular when EMA is such an important task. The unit collaborates well in research projects with other important groups within the department and units within the Forest Ecology and Management and the Ecology department, resulting in well-acknowledged publications in SCI journals with good reputation.

Participatory research and human capacity building (focus Africa) contributes to the SDGs and methodological achievements have been published in an interdisciplinary context.

#### Score for Scientific Environment

#### 1.3 Strategy for Scientific Development

# 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

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The UoA aims at maintaining the focus on forest soil processes in relation to management questions (C storage, GHG, acidification, nutritional sustainability). However, given the size of the group, it may be better to focus on fewer topics and pursue basic research questions within this limited set.

This strategy has important implications. The potential for further integration within the department is high as shown in the group's presentation. The internationalization is already being undertaken but could be further developed by adding basic research. The intention of widening the scope of EMA activities should be developed further with an eye to increasing basic research. The inclusion of DNA analyses in the forest soil inventory is an example of improving EMA from basic research.

The panel commends the efforts of scientific capacity building in low-income countries and encourages continued efforts in this area.

The UoA is composed of few researchers with a large monitoring responsibility. To increase their scientific profile the group must be expanded.

It is clear that the unit will not make radical adjustments to the research strategy before the appointment of the new professor. Still the panel recommends the unit to develop a research strategy even before the appointment of the new professor.

The panel is concerned that the group being within a separate faculty may weaken its position to be advocated for increased funding and new positions. This is of extra concern before the new professor is in place.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The UoA has important competences that are needed to solve important scientific challenges. The group needs to make a greater effort to articulate their scientific added value for research within the department and the panel suggests, under the current circumstances, to focus on fewer topics and to strengthen the collaboration on fundamental basic research questions.

The identified future research directions aim at linking monitoring and empirical research to disentangle mechanisms of complex biogeochemical processes. Long-term experiments and monitoring are of high importance in this respect. The development of decision support systems will positively affect the societal impact of research.

The specific expertise on forest soil of the unit within the department, and the resulting added value for basic research, should be better communicated.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The UoA should keep and develop its profile and communicate the added value they provide. The location within the department offers several opportunities of collaboration. The new professor will play an important role in further strengthening the profile of the group. The size of the group and the number of PhD students need to increase. If the group size is sufficient, getting engaged stronger in education may attract master and potential PhD students. The opportunities for internationalization in the research sector should be pursued.

#### Score for Strategy for Scientific Development

3

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

In view of the lack of a chair for a major part of the evaluation period, the group is performing well. The panel strongly advises SLU to fill the vacant chair position as soon as possible and to increase the group size to secure both the EMA as well as to give the unit sufficient human resources for developing excellence in research.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The unit is highly efficient in transmitting monitoring and research results to end-users which are primarily government authorities: e.g. EPA, SFA. Both basic as well as applied research results of the group related to their EMA have been published in peer-reviewed journals and guarantee a high level of credibility – a prerequisite to enable stakeholders to trust in the data and the advice provided. The reports of commissioned work impact the formulation of regulations on national and international (EC negotiations on forest fuels for bioenergy) levels.

Web-based information Systems (e.g. Markinfo), DSS (e.g. StandUp) are good ways of delivering research and monitoring outcomes and are acknowledged by stakeholders. The unit was also involved in the development of the Heureka forest planning system which is used in Swedish forestry.

Workshops with stakeholders other than researchers have been organized.

Members of the unit collaborate with CGIAR institutes in development-oriented projects which aim for poverty alleviation and sustainable land use in low income countries.

A suggestion of the panel is to complement statistics with interpretations and visualizations to further promote the use of the results. This could be made possible through support from extension collaboration specialists, and with experts in visualization, etc.

#### Score for Activities and Outputs

2.5

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

Major outcomes of the EMA activities (Swedish Forest Soil Inventory) are used for environmental assessments by EPA. Research results, e.g., on the climate impact of forest bioenergy, are used by governmental delegations in European commission negotiations.

Work of the unit was a basis for the treatment of LULUCF in the climate policy framework including the climate and clean air strategy for Sweden and contributed to the development of the new national programme for Swedish forestry.

The knowledge base for the climate impact of bioenergy is a good example how research can contribute to decisions on phasing out fossil-based resource utilization (in line with SLU and Faculty strategy).

#### Score for Outcomes

2.5

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The panel acknowledges the strategy of the unit: they have a clear focus and define well crucial factors to reach the goals. They are conscious of their stakeholders. The two topic areas are highly relevant. The strategy would be improved by the formulation of concrete actions.

The topic area on sustainability of forest production using a system perspective is broad. With sustainability, also comprising social sustainability, this requires, beyond the core skills of this group, additional competence and resources dedicated for interdisciplinary research, as well as sufficient staff capacity. Currently the group is small and may not be able to accomplish these activities without getting more resources.

The panel recognizes the topic areas as important, and the support of the unit by an additional extension collaboration specialist is recommended.

#### Score for Impact Strategy

2

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

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Their approach to collaboration is clearly expressing the benefit for both society and the unit: they state the importance of delivering good quality results in time, of understanding the roles of the collaborators and knowing the institutional context. Their approach is based on long-term experience in working with institutions and the public sector.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

From an academic career perspective, an obstacle for further development of collaboration activities are limited incentives. Support by additional extension collaboration specialists would be beneficial for further developing this area.

The involvement of 'new' stakeholders in formulating research needs should be further developed.

Panel/ ResearchSoil and Environmental Sciencesfield

UoA

Soil and Environmental Physics, Agricultural Soil and Water Management (including water quality)

#### Introduction

#### General assessment of the Unit of Assessment

Overall the quality of the research is rated as very good and internationally much recognized, with several high quality publications being realized. The research covers a wide range of aspects related to soil, nutrient and water management, various approaches, different spatial scales and diverse soil functions but without losing its major focus, i.e. sustainable agriculture under a changing climate. The panel saw a clear research pathway starting with in depth fundamental research, that results in the development and further improvement of model-based decision support tools, that are widely applied by national and international scholars and end users.

Though the panel recognizes significant delays at the faculty level in re-appointing two chairs within the evaluation period, it noted that the research output (quantity) was, though still reasonable, significantly lower in comparison with other similar UoA's. The panel has a strong belief that the future directions the UoA is taken will remediate this. The UoA recently recruited two much renowned chairs that will give a boost to the UoA's research and further consolidate the UoA's excellent leadership. Additionally, the UoA (and the Department at a higher level) has taken several initiatives that might contribute to further improve its scientific quality. The panel would suggest to pay particular attention to scientific visits of at least one month.

The UoA presented a well-articulated vision on how to move forward and integrate their work on coupling soil structure and function with (micro)biological, ecological, and plant physiological aspects. This work will highly contribute to better understand system behaviour and further improve in-house developed computational tools, thus strengthening the connection between fundamental and applied research to address societal challenges in relation with several national and international sustainability goals. This will consolidate the UoA's position as an internationally well-recognized research unit within its domain.

The panel was impressed by the diversity of stakeholders the UoA is addressing and the diversity of activities and outputs the UoA is rolling out to realize societal impact. The panel highly values the efforts the UoA is making to realize societal impact through several of those activities and outputs. The panel noted that individuals of the UoA are very visible and influential in the agricultural and environmental sector. The panel would stimulate the UoA in maintaining its role as important societal actor. However, this might be at the expense of generating a very high number of scientific publications. The efforts the UoA is making in realizing societal impact, should therefore be recognized as well. The UoA outlined a clearly articulated strategy to consolidate and even enhance its societal impact. Overall, the panel sees that all activities made by the UoA can serve as an example of good practice to other UoAs.

The UoA has a perfect understanding on how to materialize successful collaboration with society and is participating in activities ensuring communication with stakeholders from the start. An important role is to be played by the External Collaboration Specialists, and the panel recommends a long-term commitment to provide at least two such mandates within the UoA.

To conclude, with a cumulative score of 15.5 for quality of research and 9 for societal impact, this UoA demonstrated that it is perfectly possible to match high scientific quality with excellent social impact, and vice versa. Though outstanding societal commitment might lead to some loss in scientific quality, the panel is convinced that by creating an excellent scientific environment and leadership in combination with an outstanding strategy for scientific development, as was shown by this UoA, scientific quality can further increase. The UoA can be considered as an example of one of SLU's success stories of bridging high quality research with societal impact.

### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The quality of the UoA's research is rated as high. The panel saw a very reasonable breadth of the research profile that covers many aspects of physical and soil hydrological research. This is also reflected in i) the diversity in approaches, ranging from fundamental to very applied work, from experimental to modelling, and from laboratory, lysimeter to field studies, ii) the various spatial scales the research is spanning, i.e. from single pores through profile, field, catchment and regional scales, and iii) the various soil functions that are covered. At the same time, the panel saw a deep vertical research profile with much research focusing on better understanding of processes and digging into the fundamentals of e.g. water and solute transport at the pore scale, stress propagation and soil structure recovery under different soil management practices, and nutrient uptake and release. This in depth research resulted in the development and further improvement of model-based decision support tools, and complements research at other units (e.g. pesticide leaching, forest soils).

Unique long-term field experiments and catchment monitoring programs are ongoing and highly valued by the panel. The UoA has a good strategy in using the generated data for better understanding the impact of environmental and management factors on soil properties. For example, state-of-the-art machine learning techniques have been applied to assess the importance of climate and land use factors on soil hydraulic properties. The UoA has been at the forefront in using X-ray scanners to better understand soil pore architecture for which they are clearly recognized internally (SLU) and externally. Other emerging methods such as geophysical methods and use of drones are further explored.

The UoA addresses pertinent questions to "advance the understanding of water, energy and mass transfer processes in soils, primarily in agricultural systems", and "elucidate the effects of land use, soil management and climate on soil physical quality and functions, crop production and environmental impacts". This generates the knowledge, tools and capacity that contributes to meet national (Swedish Food Strategy, Swedish Environmental Objectives - Sveriges Miljömål, and Swedish Climate Strategy) and international (EU Framework Directives, Agenda 2030, Paris Climate Agreement, UN SDG) objectives. The listed important scientific achievements/breakthroughs all contribute to better understand processes and system behavior, needed to further improve predictive tools that are developed in house.

The UoA published its articles generally in highly ranked WoS journals (primarily in top journals like Soil and Tillage Research and Agriculture, Ecosystems and Environment, and in mid-tier journals like Soil Use and Management). Within the period 2009-2015, 18% of the WoS publication belonged to the 10% most cited articles in their field, and 71% to the 50% most cited. The UoA rightly values quality of articles higher than quantity, but the panel can only note that the total number of publications is significantly lower in comparison with other UoAs with less professors and of similar size.

Evidence of the scientific impact and prominence in the field of the UoA can be seen from individual bibliometrics of its professors. For example, Nick Jarvis and Lars Bergström both have a WoS h-index of 35 (nearly 4000 citations, excluding self-citations, which is high within the soil science domain), while Thomas Keller has an h-index of 21 (almost 1000 citations). Most researchers, professors and (associate) senior lecturers had a good share in the 71% articles belonging to the 50% most cited in their field (in the period 2009-2015). Yet, the panel noted that not all groups within the UoA were that active in realizing high-quality research. The contribution of the post-doctoral fellows and PhD students to the UoA's 50% most cited publications (at least in the period 2009-2015) was minimal. This might be due to their recent appointment at the UoA: the narrative reports e.g. that 17% of the publications within the period 2012-2016 was first-authored by PhD students. Overall, most of the UoA professors and part of their team are renowned for their work on agricultural water management, water and solute transport in macropores or various aspects of soil structure including soil compaction. Several UoA members are taking eminent positions in national and international commissions or have given invited talks on international fora.

As shown during the interview, the UoA could finance its research by attracting on average >57 million SEK/year, with 59% from external sources. Of the total budget, 67% was from research and research education, 23% from environmental monitoring and 10% from education. Major granting agencies were FORMAS, SLF, SIDA and international (EU, NordForsk). These figures demonstrate the competence of the UoA in attracting external funding from diverse sources and their international recognition.

#### Score for Scientific Quality

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

New seminar series, internal (friendly) project application reviews, workshops and short-courses on methodological advances and the initiation of a Phosporus Platform are good initiatives and seem to work in practice. The department was successful in attracting a university grant (FGI) given to departments belonging to two faculties to fund these activities. This all illustrates the UoA's (and at a higher lever the department's) dedication and concern to create an attractive and stimulating environment..

Individual mentoring as suggested by the UoA may boost up the number of WoS articles.

The UoA has taken initiatives to reduce the administrative burden hence enabling more time to focus on research and teaching, by introducing a Head of Division with leadership and stewardship skills. Merging four existing research groups into one Division is acknowledged as a good practice for better integration and creating an enriching environment.

Overall, there is a good gender balance with 20 male and 18 female staff members (representing, 11.1 and 13.9 FTE, respectively). However, there is a discrepancy between professors (all male) and senior lecturers (all female). In 2017, a female professor was recruited (not taken up in the evaluation) which is a positive evolution. There is a relatively sound diversity in age groups, though the age group <30 years including PhD students is underrepresented.

A significant proportion of new staff (including post-doctoral students) is recruited from the SLU PhD degree pool. However, over 1/3 of them are recruited from abroad, which the panel considers as a positive trend.

No UoA members made a research visit of at least one month abroad. Such visits might result in new insights or give extra impetus to the research. The panel would therefore recommend to stimulate international mobility. Likewise, only five visiting researchers were hosted by the UoA. Such research visits might bring in new creative thinking to the UoA.

The teaching load seems low (~10%) providing ample time for research and outreach activities.

# 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

Support is provided by the NJ faculty by organising courses (on leadership and pedagogic skills).

The UoA stimulates young researchers to participate in conferences, to write grant applications and to publish their research findings. This seems however part of a (young) researcher's job. Yet, as said earlier, there is room to increase the number of WoS publications and all kind of stimulations thus need to be welcomed. Individual mentoring by senior researchers, as suggested by the UoA, seems a good initiative in that respect. The panel would further suggest motivating young researchers to take up a research stay abroad. In the past years, there were no (reported) visits (at least one month) abroad.

The panel suggests to organise workshops (at departmental or higher level) on how to write a successful project proposal (grant writing) if not done yet.

A research school Focus on Soils & Water, which arranges high-quality PhD courses and lunch seminars with invited researchers, is organised for PhD students. The panel highly appreciates the involvement and engagement of the UoA into/for such activities.

# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA has a strong international collaboration with several renowned national and international institutes, including Nordic/Baltic and other European, North-American and Oceanic countries. It is/was a partner in EU-funded projects like HOR2020, ERA-Net, FACCE and FP7.

The panel highly appreciates the engagement for international development cooperation in various countries, including Bolivia, Mozambique and Rwanda. Though these collaborations focus on capacity building, they add to the science development through, among others, PhD research.

The international collaboration is also reflected in 54% of the publications being co-authored by international colleagues. Most collaboration was with Aarhus University resulting in articles that shape the soil compaction research.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

There is already extensive collaboration with other UoAs within the same department and across departments and faculties. The panel evaluates the number of collaborations as very adequate and is delighted to see that the UoA considers this collaboration as crucial to further unravel system behavior in soil and water.

Collaboration within the department is stimulated through smaller inter-UoA activities (e.g. workshops, seminars, reviews and a Phosphorus Platform) across two faculties, as noted above.

There are several other well-established collaborations with at least eight other departments and centres at SLU, including departments on aquatic sciences, crop production ecology, chemistry, microbiology, economics, molecular sciences. The models/expertise being developed at the UoA are used in studies by other units and departments (e.g. pesticide/nutrient leaching, soil compaction, X-ray tomography). Vice versa, expertise present in other units and departments helps the UoA to better understand the development of soil structure (e.g. expertise on root development, (micro)biology) or in determining costs related to soil structural degradation and alleviation (economics). Evidence for this collaboration comes from ~1/3 of the articles being published with eight other SLU departments.

In a context of development cooperation, the UoA collaborates with departments of forestry, energy and engineering, ecology, rural and urban development.

#### Score for Scientific Environment

5

#### 1.3 Strategy for Scientific Development

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA presented a well-articulated strategy for scientific quality that is realistic and supported by the panel. The UoA will maintain and further develop its interdisciplinary focus in which soil play a central role. Collaboration between research groups at departmental level will be further encouraged through several of the activities noted above. These create an enabling environment for new ideas and out-of-the-box thinking and provide links between basis and applied research across different scales.

Research facilities and technical staff will increasingly be shared, which the panel considers as very important. This not only might to some extent compensate for possible reduced funding, but will further stimulate interaction between groups and can guarantee high-quality research for all groups involved. The UoA has a unique asset in the EMA database and intends to further capitalize it, while encouraging the staff to mix research with EMA. The panel also supports the suggestion to attract at least one system/big data analysts to unlock the potential of the substantial amount of data from the long-term experiments and EMA, within or across different related UoAs. Attracting such analyst could additionally facilitate interdisciplinary research.

During the interview, the UoA presented plans for a joint program on "Coupled dynamic modelling of soil structure and function" and an EU joint program for "Agricultural Soil Management". The panel believes that these could be excellent katalysts for scientific renewal.

The panel highly appreciates the UoA's intention to feed courses at Ba and Ma level with new research findings and to invite and host international/guest researchers making use of e.g. the SLU August T. Larsson fellowship. The latter might help in addressing some of the concerns the panel raised above. Likewise, the UoA explicitly intends to further develop internal mentoring and friendly reviews as to increase the number of articles being published in highly-ranked journals.

The panel is positive about the UoA's strategy to continue pursuing international collaboration with EU funding. The UoA will further encourage researchers to strategically attend international meetings or be present on international fora, and thus establish networks with international partners. This is also a good strategy to expand the currently rather low number of national and international PhD students (only 2.5 FTE in May 2017).

The UoA will invest in a new X-ray scanner enabling to increase the resolution of the scans to further its understanding of processes and impacts at the pore scale. Other emerging techniques such as use of drones and geophysical methods will be further explored, which is appropriate.

# 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

During the interview, the UoA presented a very clear vision on how to move forward and integrate their work on coupling soil structure and function with (micro)biological, ecological, plant physiological and to a lesser extent chemical aspects. A new joint initiative to formalize this will be shortly implemented. This work will highly contribute to better understand system behaviour and further improve in-house developed computational tools. Since the UoA has been at the forefront in developing those tools, it has a great potential for making a substantial contribution.

The recent (2017) recruitment of two much renowned professors will give the future research an important boost and will bring in a new dynamic. It will ensure to continue and further shape the work on soil structural degradation, alleviation and recovery (in particular on soil compaction and soil sealing). Very important is that it will also revitalize the research on irrigation and drainage, which has been a major expertise at SLU in the past. Expertise within this domain of agricultural water management will be really needed given the projected weather extremes, in and outside Sweden.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

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The number of incoming students at SLU is relatively low. As a result, relatively few students start studies in Soil and Water or related studies, resulting in a low number of Ma dissertation students. Such students also contribute to a unit's scientific quality as junior researchers and form a first pool from which potential PhD students might be recruited. In May 2017, the number of PhD students (7) but particularly the FTEs (2.5) was low. Increasing this number might be challenging. The panel recognised that attracting PhD students with international grants is not evident given their enrolment as SLU employees according to Swedish rules.

The UoA has unique long-term experiments and catchment monitoring programmes. The decrease in core funding needed for maintenance/continuation might jeopardize future research, not in the least because it takes e.g. tens of years for a soil to recover from damage made in a few seconds.

Consistent with other units at SLU, the panel recognizes the serious concerns about the current funding environment resulting in limited job security and lack of attractive research paths. This seems to hamper recruitment of and support to early career researchers, and thus hinders the UoA in implementing its research strategy.

#### Score for Strategy for Scientific Development

#### 6

#### **1.4 Additional comments**

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The panel advices SLU to maintain basic/core funding to guarantee long-term experiments. Such experiments are invaluable to better understand long-term impacts of soil, nutrient and water management and/or soil degradation. SLU has here a unique asset which is worldwide rather rare.

Soils are key toward sustainable agriculture: the panel encourages SLU to continue investing in research on soil physical and hydrological processes under a changing climate. Soil and water management is an entry-point activity to increase crop production in a sustainable way and thus to contribute to Swedish and international sustainability goals.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

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The panel considers the appointment of two External Collaboration Specialists combined with Associate Professor positions as an excellent strategy to bridge research with society and vice versa. The panel saw that such positions could really make a difference in realising significant societal impact.

The panel was impressed by the diversity of stakeholders the UoA is reaching, including regional, national and inter-governmental public authorities (in agriculture, water and environment), the farm sector (e.g. LRF and their members), private actors in the agricultural (consultancy/extension) and environmental sector (management/assessment), agro-industry (seeds, fertilizers, farm equipment) and the general public.

In the narrative and during the interview, the UoA listed a diversity of activities and outputs that are highly valued by the panel. Examples include:

• in-house developed computational models are 'transformed' to (web-based) decision support tools that are readily accessible and understandable by potential end users (from farmers to industry to public authorities to students), in and outside Sweden (e.g. SOILNDB, ICECREAMDB, MACRO, Terranimo);

• effective use of research-based knowledge within the Focus-on-Nutrients programme to give free advice on environmentally friendly nutrient management or on subsidies;

• research findings are used to estimate greenhouse gas emissions for the Swedish climate reporting;

• two coordinators (one assistant) contribute to developing strategies and methods for improved environmental monitoring and assessment; the collected data are made available to the public at the SLU webpage and the "Miljödata MVM" data platform;

• very active participation in e.g. Borgeby Field Days, where UoA staff gives demonstrations to farmers on how to avoid soil structural degradation or avoid leaching of nutrients and pesticides from arable land; it appears that the UoA is one of the very few SLU units present at such days;

• school contacts and materials, seminars, media, articles in popular media, fact sheets, courses, ... for the public and the agro-sector; the UoA holds contacts with journalists;

• improved scientific capacity of institutes/universities in Mozambique, Bolivia and Rwanda, which finally results in improving livelihoods of farmers by optimized soil and water management.

These are excellent examples of how research contributes to address demands of a diverse range of stakeholders.

#### Score for Activities and Outputs

3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The panel acknowledges the efforts the UoA is making to realize societal impact with several of the activities and outputs listed above. Some examples include:

- new legislation, guidelines and new agricultural practices based on the UoA's research-based knowledge;
- recommendations, advice, and decision-support tools reach a majority of Swedish farmers; through European awareness projects in which the UoA collaborated, farmers, their advisers, industry, policy makers and students outside Sweden are implementing some of their tools as well (e.g. Terranimo);
- calculations on nutrient leaching using in-house developed models is used in national and international reports on water quality (e.g EU Water Framework Directive, HELCOM periodical pollution load compilation (PLC), OSPAR, national environmental goal "Zero eutrophication") and for planning and implementing measures to reduce leaching by the local water management authorities;
- research outcomes are used in the Swedish Rural Development Programme (2007-2013) that is subsidized by EU.

The panel notes that individuals of the UoA are very visible and influential in the agricultural and environmental sector. They are well-known by various stakeholders and much consulted.

The panel would stimulate the UoA in maintaining their role as important societal actor. However, this might be at the expense of generating a very high number of scientific publications. The efforts the UoA is making in realizing societal impact should therefore be recognized as well.

#### Score for Outcomes

3

#### 2.3 Impact strategy

# 2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA outlined a clearly articulated strategy for societal impact. Its major objective is to support sustainable agriculture by contributing knowledge, tools and capacity thus addressing grand challenges. The UoA explicitely refers to Agenda 2030, the Paris climate agreement, EU Framework Directives, UN SDGs, as well as to National policy objectives: the Swedish Food Strategy, the Swedish Environmental Objectives (Sveriges Miljömål) and the Swedish Climate Strategy. The UoA's strategy builds on maintainance and development of broad multi-level partnership networks in national and international fora, the continued support of two senior scientists with dedicated outreach roles (50%, External Collaboration Specialists), training and capacity-building, web-based information, newsletters, seminars and securing communications platform (e.g. www.slu.se/goodla).

The panel appreciates the explicit reference made by the UoA to farm business profitability and that it not only tries to reconcile agriculture with better water quality or mitigation of greenhouse gas emissions at the expense of farmers' income or the need for higher subsidies. It also demonstrates the close ties between the UoA and farmers and their associations.

In 2017, the Department started a newsletter, with the aim to increase information about ongoing research and other activities, with stakeholders outside SLU as the main target group. This newsletter is coordinated from the UoA and will be distributed 3-4 times per year. The department has hired an external expert for keeping the external webpage up to date. The panel recommends the UoA to actively follow up the impact of this investment and evaluate its effectiveness over time. Important is to write the right articles for the right target audience. If not, this initiative might not reach its goals.
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#### Score for Impact Strategy

3

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA has a perfect understanding on how to materialize successful collaboration with society. It understands that most benefits can be realized when the process involves communication with stakeholders from the start so that research ideas and/or development work are based on issues introduced by the partners involved. The UoA's capacity in achieving this is very high, as they are already implementing these ideas, for example by participating in national and local conferences (e.g., Uddevalla konferensen), workshops and field days (e.g., Borgeby fältdagar). There, direct knowledge exchange with farmers, agricultural advisers, and relevant authorities can be made. The UoA also appeared on television, radio and podcasts.

As the UoA is active in projects that directly involve collaboration outside academia, continued vigilance and discussion about stakeholders demands and needs is guaranteed.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

An important role is to be played by the External Collaboration Specialists. The UoA has two of such specialists in place, who combine their outreach activities with an associate professorship. They focus on the two major outreach activities of the UoA, i.e., on nutrient management in agriculture and environmental impacts and on soil and water management. The panel recommends a long-term commitment to appoint two External Collaboration Specialists within the UoA.

Panel/ Research field	Soil and Environmental Sciences	
UoA	Chemistry and biology of soils, Plant nutrition, and Precision Agriculture	
Introduction		

#### General assessment of the Unit of Assessment

The UoA covers a broad research domain spanning soil chemistry, soil biology, plant nutrition and precision agriculture. With a very limited staff capacity of only 5 professors and a senior lecturer, the unit has realized a high international scientific quality, particularly in soil chemistry (e.g. P-speciation and dynamics and emerging contaminant binding and mobility) and soil biology (e.g. development and applications of gene transcription analysis in fungal community ecology). The plant nutrition and precision agriculture groups have provided more applied research outputs, while the unit as a whole has outlined a research strategy to strengthen the connection between its fundamental and applied research expertise, and to increase the use of data from their environmental analysis and monitoring, and long-term field experiments in joint research. In addition to these plans, the panel welcomes the UoA's intentions to extend its national and international collaboration over the full scope of its research domain.

The UoA has realized very good societal impact, e.g, on new policy developments in agriculture and forest management, webtools for the farming community and general public, important new toxicity data implemented in the REACH database, and spin-off activities. The panel highly values the UoA's research outcomes, yet sees even greater opportunities as further detailed below.

The UoA has also clearly demonstrated its sense and capacity for successful collaboration with societal stakeholders with different aims. It has shown how high-impact scientific research and publications can be successfully combined with outcomes that serve society at large. While the UoA has clearly demonstrated capacity for successful collaboration with society, the panel recommends all groups in the unit to more actively seek the support of the available external collaboration specialists, which would widen their societal collaboration capacity to their full expertise and domain.

### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

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The panel ranks the scientific quality of the UoA overall as high international, with some excellent papers that shape part of the unit's research domain. Given the limited research capacity, the quantity and particularly quality of publications is high, with 25% published in top-10 research journals.

The panel would like to draw distinction given the wide domain expertise of this unit that some topical areas, in particular plant nutrition and precision agriculture would benefit from close collaboration and development of their scientific depth and impact. There lies an opportunity to collectively identify the successor of the chair professor in plant nutrition to meet and exceed the scientific needs of the unit and to attract the best talent to strengthen internal and external scientific collaboration.

The panel feels that there also lies an opportunity for the precision agriculture (PA) group to further the science of quantitative assessment of soil and plant heterogeneity, given the history of the group's scientific contributions in PA.

#### Score for Scientific Quality

#### 5

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

Despite its limited staff capacity, the UoA actively contributes to creating and maintaining a stimulating research environment in the Department of Soil and Environment, with its active policy to stimulate scientific discussion, creativity and exchange across the Department's subject areas. Several members of the UoA have taken an active role with both intellectually stimulating and productive initiatives.

On the level of diversity, there is clearly gender inequality among the professors (4 male versus only 1 female). However, for the rest of the categories, (associate) senior lecturers, researchers, post-docs, doctoral students, and research support staff, there is well representation of gender diversity. The unit could benefit from strengthening the gender balance among the chaired professors at the earliest opportunities that arise, such as for plant nutrition.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

Supported by the Department (e.g. through "friendly reviews" of proposals) and Faculty (a.o. through tenure track support), the UoA has been successful to expand the number of post-doc researchers and to recruit an associate senior lecturer. The unit also promotes collaborative opportunities by organizing seminars on current topics for post-docs and graduate students.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

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The UoA does have international collaborations in place. Logically most are within Europe, while one extends to North America (McGill, Canada). These collaborations are also reflected in the unit's publications that include 50% of the co-authors from international institutions. Collaborative papers that are particularly shaping the research field include the highly-cited papers of Clemmensen et al. (2013) in Science, and Lindahl et al. (2013) in New Phytologist, and multiple novel analytical and modelling approaches on Phosphate and (emerging) contaminant/nanoparticle speciation and reactivity published by Gustafsson, Cornelis and colleagues. These impacts are also reflected by the invited presentations and chaired sessions at scientific conferences that are realised by these unit members, as well as by their involvement in international committees and editorial boards.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

This UoA is quite interdisciplinary in nature, given its broad focus area. As for the other UoA's reviewed by this panel, interdisciplinarity mainly spans the natural sciences. Research conducted in this UoA include soil geochemical processes; risk assessment of contaminants for quality of ground and surface water; chemistry of soil nutrients; meta-transcriptomics, simulation models for carbon and nitrogen transformations in soil-plant systems; digital field mapping/remote sensing across multiple geographic scales; sustainable intensification of crop production, etc.

Synergies with other UoA's exist, while the panel sees room for further expansion to develop them to their full potential (e.g. with 435\_3\_S; 280\_1\_NJ). Organisational solutions to overcome faculty barriers in collaboration can strengthen synergies between UoA's and wider-spanning interdisciplinary research.

#### Score for Scientific Environment

#### 5

#### 1.3 Strategy for Scientific Development

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA has outlined a clearly articulated research strategy that is reflected in its intention to further develop interdisciplinary focus and collaboration within the unit and the department, with soil as a common focus of research. Moreover, ideas have been formulated to strengthen the theoretical basis of the unit's applied research activities in crop production and environment and connections between its research at different scales. The strategy also includes new ideas to increase thorough scientific exploitation of the unique data resource from the unit's different environmental analysis, monitoring activities and long-term field experiments.

Specifically important developments that the UoA intends to take on in their scientific renewal and are acknowledged by the panel include the following:

- The UoA has identified new developments in nanoscale analytical techniques and (big) data acquisition and analysis that enable collection of novel information on the chemical and physical properties of engineered and natural nanoparticles.
- The application of gene transcription analysis enables assessment of activities and eco-physiological priorities of organisms within complex communities in natural environments. The UoA currently conducts pioneering work on adapting such meta-transcriptomic techniques on the ecosystem scale (ecotranscriptomics).
- Based on their unique data resources, plans are made to establish an interdisciplinary bioenergetics framework within the UoA to address some of the grand research challenges in food security, sustainable agriculture and forestry.
- A Laboratory for Smart Decision Support Systems is planned to combine information from crop and soil sensors with national data resources, to create new soil and crop models designed for reliable decision support (joint effort with society and industry).

The unit has formulated the explicit goal to ensure that the intended research outcomes, in addition to their publication in high-impact research journals, will be known and used in society. Strengthened national and international collaborations and an increased number of grants from research councils and other funding sources are sought to facilitate the realisation of the strategic goals. These actions are also particularly important for expansion of the currently limited number of PhD students that the panel has noted.

The panel recognizes the UoA's high scientific potential and strongly supports the formulated strategy that will strengthen the coherence of the unit and widen opportunities to attract funding and shape the scientific domain of all participating groups with high-impact research.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The panel appreciates the UoA's clearly articulated research strategy, with plans that include more detailed crop quality investigations, advance soil analysis and precise in-situ monitoring of soils and crop during growth in the field, further development and application of fungal gene transcription analysis and assessment of Phosphorus and emerging contaminant speciation and dynamics in soils. The development of statistical modelling methods enabling analysis of complex correlative patterns in large data sets and the creation of new soil and crop models designed for reliable decision support are seen as very good plans for future research directions that fit well with the competencies of the four contributing research groups and the mission of the SLU.

The panel recognizes the required fundamental and applied scientific capabilities of the contributing groups in this UoA, as well as their strategic plans to expand their capacity and strengthen their collaboration to successfully realize the unit's targeted scientific renewal and impact.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

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As indicated under 1.3b, expansion of the currently limited staff capacity of the UoA is a major challenge to realize the intended scientific developments to the unit's full potential that the panel recognizes. Facilitating staff and post-docs to maximize their available time for research would, in addition to tenure track support, strongly contribute to realize the unit's scientifically valuable strategic plans.

The panel strongly supports the unit's intended expansion of staff that would significantly contribute to develop the identified opportunities for scientific renewal to their full potential. This should include filling in the chair professor position in Plant Nutrition, while the panel also suggests SLU to consider establishment of a chaired professor position Precision Agriculture to adequately develop this growing field.

#### Score for Strategy for Scientific Development

#### 5

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

This is a very good UoA with significant fundamental and applied research potential, as well as important EMA involvements, to contribute towards grand challenges. The panel advises SLU to invest in both the capacity (additional faculty) and capability (additional resources) of this UoA that can make important contributions to the scientific quality and impact of the SLU.

The panel also advices SLU management to consider organisational solutions to overcome faculty barriers in collaboration, which would strengthen synergies between UoA's and wider-spanning interdisciplinary research.

### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA has realized a very impressive list of activities and impacts for both the research community in the domain of the UoA and for society. Examples include:

- Novel scientific discoveries in the speciation and dynamics of P and emerging contaminants in soils and fungal gene transcription analysis, with great fundamental and applied impact in this field of research;
- The laboratory for intelligent agricultural decision support systems (LADS)
- Modelling platforms and software for scientific peers as well as for less-specialized stakeholders (Decision Support Systems). The already widely used Visual MINTEQ platform, for example, will find its way to a wider research Community, including environmental toxicologists, with the intended implementation of (terrestrial) Biotic Ligand Models.

Most groups in the unit have contributed to a very good outreach to, and participation by, a wide range of stakeholders such as farming and forestry communities, state authorities, consultancies, and the private sector. The panel recommends the UoA, and particularly the Soil Biology group to make optimal use of the Department's External Collaboration Specialists in order to further expand their societal impact.

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#### Score for Activities and Outputs

#### 2.5

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

Based on both the UoA's scientific accomplishments and development and exploitation of its unique environmental monitoring data, important research outcomes of the unit have enabled substantial societal impact, such as:

- New policy developments (regarding agricultural sludge application and assessment of forest management on targets for reduction of acidification);
- New and societally-important toxicity data implemented in the EU REACH database;
- Webtools for the farming community ("Precisionsskolan" on precision agriculture; Calculation tools for improved nitrogen fertilization), as well as for the general public (MVM Miljödata with statistics from the Swedish Crop and Soil Inventory);
- Spin-off activities (Phosphorus recovery from sludge)

The panel thus highly values the UoA's research outcomes, yet sees even greater opportunities as indicated in 2.1a.

#### **Score for Outcomes**

2.5

#### 2.3 Impact strategy

# 2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The panel acknowledges the UoA's strategic view that soils are vital for a multitude of life-supporting ecosystem services such as nutrient cycling, food supply, biofuel production and climate regulation through carbon sequestration. From that point of departure, the unit's strategy is clearly directed at realizing both scientific and societal impact through focusing major research activities on actual societal challenges, many of which listed in the UN Sustainable Development Goals, e.g. Zero Hunger, Clean Water and Sanitation, Climate Action, and Life on Land.

The panel recommends the unit to direct its strategy also more explicitly at the Swedish environmental objectives. In addition, the unit should consider social dimensions to achieve their goals with regard to sustainable agricultural intensification through increased collaboration.

#### Score for Impact Strategy

2.5

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The presented example of the UoA's very successful collaborative study with different societal stakeholders on the environmental toxicity of Vanadium, with different interests, clearly reveals the unit's feel and capacity for collaboration with society. This approach can serve as a benchmark example of how high-impact scientific research and publications can be successfully combined with outcomes that serve society at large. The presented case study has convincingly demonstrated that industry as well as the general public both benefit from true risk-based toxicity criteria. This collaborative approach thus facilitates the safe handling and beneficial use of byproducts that contain trace elements of concern, particularly under increasing circular economic developments, and demonstrates the UoA's sense for important factors that influence collaborative success and impact with and for society.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The panel highly values the Department's actions to strengthen its outreach through the recruitment of external collaboration specialists. While the UoA has clearly demonstrated capacity for successful collaboration with society, as described in 3.1a, the panel recommend all groups in the unit to more actively seek the support of the Department's external collaboration specialists, which would widen their societal collaboration capacity to the full expertise and domain covered by this UoA.

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UoA

Geochemistry and organic environmental chemistry

#### Introduction

#### General assessment of the Unit of Assessment

The panel was impressed with the research productivity, excellence and industry of the group. The group, which is comprised of, effectively, 1 chair professor, 1 promoted professor, 1associate senior lecturer and 9.2 researchers, has published 353 papers of which 25% are among the top 10% of those cited within their peer group. Evidence of the achievements of the group is that its members have received 8 awards in recognition of research excellence. We see that this group enjoys an international reputation and contributes to defining research questions and approaches. These accomplishments have been achieved despite the limited size of the UoA.

The research of the UoA is guided by the overarching goals of protecting the environment and achieving sustainable development. Under these guiding principles, the UoA has defined four core research areas that include contributing to decision support grounded in strong scientific understanding, developing new analytical methods, and probing mechanisms responsible for surface water-related phenomena. The UoA also is also developing measures to promote the recovery of aquatic systems.

The committee noted that the UoA has a clear vision for their future endeavours that logically builds on past accomplishments, but that exploits state-of-the-art methods and knowledge (e.g., emerging organic chemicals of concern). The future goals are consistent with SLU's mission to provide value to society. The UoA has a strategy by which they plan to achieve their future goals.

The review panel noted that the UoA sought to develop opportunities to connect EMA within their overall research plan. The latter is an important point. The secure, long-term funding for EMA provides opportunities for junior researchers to develop their research programs without the need to bring in external funding, where the latter is time-consuming and difficult. Further, the UoA sees scientific opportunities presented by the unprecedented longevity of EMA programs. Clearly, this unit understands this opportunity and is able to avail itself of this opportunity.

The UoA has connected their core work to other units to contribute to multidisciplinary knowledge. Overall, the panel considered that the UoA was highly productive, creative and industrious despite challenges of having limited funding, a limited number of senior professors, and a lack of support for infrastructure.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

This UoA ranks highly for scientific quality. Evidence of excellence comes from number of awards received, invitations to speak, and well cited publications. It is noteworthy that most researchers within this UoA are

actively publishing, and being cited in the peer reviewed literature. Their ideas and methods used are at the forefront of the field of water quality.

The UoA is asking key questions with respect to the overall vision of expanding knowledge and tools to understand and predict the "human influence on water, primarily in a Nordic context". The review panel recognize that the UoA is conducting world-class research that is helping to define the field of surface water quality. A prime example here is the "discovery" of PFAS-contamination entering the surface water body that provides drinking water to Stockholm and the surrounding area. The group has characterized the contaminant source and is developing and testing methods for PFAS removal from water.

Evidence of the UoA's importance in the field and its impact can be seen from bibliometrics.

The UoA publishes some papers in the top journal Environmental Science and Technology. However, they more frequently publish in appropriate mid-tier peer reviewed journals (e.g., Science of the Total Environment, Chemosphere, Environmental Pollution, Ambio).

The review panel was impressed with the unit's scientific accomplishments in the area of water quality as connected to drinking water, agriculture (nutrients and pesticides), urban contaminants (e.g., PFASs), and forestry (e.g., mercury release). The UoA's research and EMA activities have direct societal impact through national and international programs (e.g., Swedish EPA, Swedish Agency for Marine and Water Management, Stockholm and Minamata Conventions). The panel recognized the contribution of the group to water quality protection in Sweden and that the UoA has provided the impetus to public agencies, based on excellent science, to develop a centre of competence in drinking water.

The UoA has accomplished its research output through funding from EMA and from successfully competing for external funding. The external funding was seen as essential for covering salaries of researchers and covering gaps in institutional funding for infrastructure. Further, the UoA views EMA as an excellent opportunity for continuing and expanding its research (as mentioned above). The UoA appreciates that the longevity of the EMA programs is unique at the global scale. As such, it gives the UoA the opportunity to track environmental processes as the landscape changes due to global warming and other anthropogenic activities within and beyond the Swedish borders. It should be emphasized that the contribution provided by EMA, to the understanding of global change, is invaluable.

The panel saw evidence of successful collaboration. The UoA has demonstrated substantial collaboration within SLU (e.g., with toxicologist), with other Swedish institutions (Lund, Uppsala, Stockholm), European institutions (e.g., University of Koblenz & Landau, RECETOX of Masaryk University, NERC Centre for Ecology and Hydrology) and international institutions (Trent University, University of Saskatchewan, SUNY Cortland). Half of all papers cited have been co-authored with international collaborators. Collaboration has also been promoted by hosting 19 visiting researchers and sending 5 researchers to other institutions. The number of exchanges appears to be a particular strength that was not seen in other UoAs. Evidence of the success of these collaborations comes from, for example, the numerous multi-authored, multi-institution publications.

The UoA is highly successful at attracting external funding. In 2016 the UoA attracted nearly 50 million SEK of which 56% was in competitive external research grants, 35% was from governmental allocations and 8% was commissioned research. Granting agencies include the Swedish EPA, Swedish Research Council, and FORMAS.

The panel noted that a significant fraction of the research was conducted by PhD students supervised or cosupervised by a UoA member, plus faculty from other units. Doctoral supervision is well distributed among the UoA members that include more junior researchers. This arrangement by the UoA of enrolling PhD students benefits SLU in terms of PhD training and benefits the unit by the infusion of junior researchers who are usually energetic and can bring new ideas. It also benefits the UoA by training junior faculty members to be supervisors and to support these junior faculty members in pursuing their projects through PhD students. We concluded that the UoA must be well regarded among prospective graduate students based on the large number of applicants for graduate positions that are received. This is in contrast to other UoAs who reported challenges with attracting PhD students.

The UoA has well anestablished reputation in more "mature" fields such as the acidification and eutrophication. Some of these fields, which were considered to be unimportant, are gaining increased importance as the climate changes and human activities expand to present new challenges to aquatic systems.

The group has successfully moved into the new field of emerging organic contaminants and plans to continue moving into new fields, such as microplastics. The latter is a very "hot" topic currently. The UoA is well positioned to being able to investigate land-to-water transfer of microplastics, which few groups are doing (at an international scale).

#### Score for Scientific Quality

#### 5.5

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

It is clear that the appointment of Prof. Wiberg has been instrumental in expanding the area of environmental chemistry. Prof. Wiberg has developed a strong research group with an international profile that has attracted students and funding. Generally, the contribution of Prof. Wiberg to the UoA demonstrates the value of attracting and retaining a strong academic leader who is able to build a research unit, and support and mentor junior researchers.

The UoA made a strategic move to attract Martyn Futter into a 50% modelling position. Dr.Futter has been highly productive in terms of research output by publishing high quality peer review papers that are well cited.

At least some of the vitality of the UoA appears to come from the practice of assigning PhD students to all researchers. The UoA has 8 FTE PhD students, contributing one third the personnel in the UoA.

Other contributions to creativity likely come from hosting external researchers (19 in total) and sending students on exchanges (5).

Researchers are also enriched by participating in activities within and beyond SLU. For example, Lars Sonesten is the Chairman of HELCOM Pressure and of OSPAR INPUT. Jana Weiss sits on the board of the International Panel on Chemical Pollution and Karin Wiberg sits on the board of SWETOX. Several researchers are involved with the Society oof Environmental Toxicology and Chemistry (SETAC) that is a logical orgnaization with which to be involved.

The gender balance of the UoA is good but could be better. The balance is 1:1 for professors. However, there is a gender imbalance among researchers (1.6 vs 7.7 FTE female/male, respectively), post-doctoral fellows and PhD students. PhD students are recruited from both outside and inSweden. The age structure in the UoA shows a good distribution among researchers.

1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

In the category of young researchers (31-40 years old), the UoA has 2 researchers, 5 PDFs, 4 PhDs. This represents a reasonable number of junior researchers. The UoA has engaged in career development of junior colleagues by encouraging them to attend courses for professional development. The UoA has a strategy of providing junior colleagues with access to EMA funding. This funding can allow them access to abundant data while freeing them from seeking competitive funding. The UoA also encourages junior faculty to take leading roles in the unit and beyond. Financing is provided for attending required courses in pedagogy, supervision and leadership, including the 10 week "docent" course. The department provides a one-semester research seminar to "ground" all PhD students in the department's areas of expertice. The panel supported the activities of promoting scientific discussions at the departmental level through a new seminar series, and a semi-annual "research outlook" day for all researchers and PhD students. The UoA holds a "friendly review" workshops for project applications. This can be helpful for younger researcher to succeed with applications.

Young faculty are supported in their research program by PhD students, which is a good strategy. The panel noted that this UoA was unusual in having many PhD students and striving for each researcher to supervise PhD students. We believe that this was the only UoA that the panel reviewed, that commented on the benefit of supporting undergraduate theses.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA does well with collaborations ranging from within SLU, to within Uppsala, Sweden, Europe and internationally. As noted above, 52% of cited publications are co-authored with international collaborators. Network analysis shows strongest ties with Uppsala, Umea and Stockholm. Secondary connections are with Universities of Koblenz & Landau, Aarhus, Norway, Trent, Masaryk (Czech Rebublic) and others,

While European collaborations appear to have a high priority, the UoA also collaborates with researchers in China and Africa. The UoA has several collaborations with Canadian academic and governmental organizations.

It is unclear how the international collaborations are funded since only 5% of funding comes from the EU and no grants are listed with collaborators from North America.

The review committee was not given sufficient bibliometric information to allow for a full analysis of the impact of the UoA in scientific debates in the field. However, we believe that it must be reasonably strong to give rise to several researchers with reasonable H-indices. Other evidence that the unit is making an impact on the field comes from the number of invitations to speak listed by faculty members (e.g., Brian Huser, Kristin Boye, Karin Wiberg and Lutz Ahrens).

1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential. The network of collaborative connections within SLU, especially given the relatively modest size of the UoA, suggests that this unit is taking advantage of collaborative opportunities. Indeed, any further expansion of this network of collaborations could over extend the capacity of the group.

The UoA collaborates with at least 17 different units in SLU. The network analysis suggests that the UoA is reaching its full potential for collaboration. The units with which the UoA collaborates at SLU range from the Dept of Forest Ecology and Management to the Dept of Economics and the Dept of Ecology. Collaboration with Economics and Forest Economics suggests that the UoA is seeking ways to make their data and results relevant to decision makers.

An example of multidisciplinarity comes from the goal to develop an early warning system for water quality based on in-vitro toxicological assays (bioassays). Other examples of multidisciplinarity are the effects of impaired water chemistry on aquatic biota; terrestrial processes on water chemistry and catchment hydrology; and the impact and management of anthropogenic activities on water quality.

The panel pointed out that the potential to cooperate within the Water area is not fully realized. Better realization of the Water area could happen by strengthening and coordinating involvement of researchers from several departments and faculties.

For some topics, cooperation already exists. However, cooperation can be strengthened for future research cooperation such as the socio- economic analysis (also suggested by the UoA themselves) and the influence of different sources (anthropogenic activity) on water quality.

The panel wondered whether incentives are provided for interdisciplinary collaboration.

#### Score for Scientific Environment

5.5

#### **1.3 Strategy for Scientific Development**

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA has thoughtfully developed goals and a strategy to achieve those goals. The strategy gives clear indications of aspirations and a concrete plan to achieve those aspirations. The plan is feasible. The UoA commented that their ability to sustain the group and to enable it to achieve future goals relies on filling research positions. The UoA noted that they effectively have 1 chair professor since the individual in the second position has been filling an administrative position. To fill the need, the unit would like to recruit associate senior lecturers and senior lecturers.

A threat to continued high quality research is the ability to maintain sophisticated analytical equipment that was purchased from "one-time-only" funding from SLU (e.g., LC-MS/MS). Such sophisticated analytical equipment is very expensive to run and maintain. The UoA does not have funding for maintenance contracts or for equipment renewal. Funding is also lacking for technicians to run and maintain the equipment. The UoA acknowledged that their ability to be at the leading edge of emerging contaminants work relies on this equipment.

We did not see a plan for seeking external funding from international sources, e.g., through EU Horizon2020, JPI Water, JPI Climate/Others.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

As noted above, the UoA presented a thoughtful and well considered plan for future research. The UoA presented plans that continue successful research avenues such as phosphorus dynamics in lakes. The UoA has also identified promising and "hot" new areas such as microplastic migration from agricultural soils influenced by waste water sludge. The group has developed new methods such as x-ray identification of microplastics in soil cores. Their plans include EMA-related projects and those coming from external funding.

An innovative idea of using EMA and enhancing the social impact of research is developing citizen science to contribute data and engage communities in understanding their own environments. As the group has written, this could be "part of transforming how EMA contributes to society's goals" which could strengthen public support for and appreciation of EMA. This is a strategic move as research funding comes under increasing public scrutiny and budgets are tightened. Another initiative in this vein is working within the framework of "ecosystem services".

The group is also to be commended for looking for opportunities for adaptive management (e.g., with respect to eutrophication countermeasures).

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The most important challenge appears to be attracting and keeping skilled and creative researchers. Acknowledging that this a SLU-wide problem, this unit has difficulty attracting and maintaining researchers that are conducting leading-edge research of an international stature. The salary funding situation, which is not unique to this UoA, is simply not sufficiently attractive to young researchers and is exhausting for older researchers. Attracting the best and the brightest is especially a problem in a fast-moving, highly popular field like aquatic environmental chemistry and emerging contaminants.

The group's success comes from a few highly dedicated and motivated senior researchers. However, the situation may not be sustainable given the reliance on PhD students to conduct much of the research. It is difficult to maintain your position in a fast moving field without reasonable institutional support.

Another key threat is the ability to maintain and run the sophisticated analytical equipment that are expensive to purchase, but even more expensive (in the long run) to maintain. An associated challenge is the absence of technical support to run the sophisticated equipment.

The UoA noted that EMA funding is and has declined. The UoA has filled this declining revenue stream with external funding grants. The EMA presents a unique opportunity to use long-term monitoring to detect (or not to detect) trends from data with longer time series. This can be important for research topics like the effects of climate change (effects and adaptation) and environmental effects of the bioeconomy.

The UoA pointed out that SLU could strengthen the field of water quality protection in terms of education and research, involving competence from several research groups. Another challenge is increasing interdisciplinary research, e.g. include socio-economic aspects into models to enhance societal impact.

#### Score for Strategy for Scientific Development

#### 6

#### 1.4 Additional comments

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The following are recommendations to improve the research profile and sustainability of this UoA's research: Need to recruit another Full Professor.

Need to make more junior positions more attractive by offering better financial support.

Need to re-assign resources so that a relatively new unit has the opportunity to obtain technical and financial support. A vulnerability for the group is being able to maintain and run advanced analytical equipment.

Provide "high level" support for the UoA's intiative to develop a Water Competence Centre (e.g., Vice Provost, Deans, chairs).

Consider adding a new position of "external collaboration specialist" to help coordinate knowledge translation (outreach) from SLU to the community.

Support the "Water forum" as a SLU Platform.

SLU should recognize the value of continued, long-term, stable funding of EMA.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

This UoA's activities closely align with societal needs. We believe that the methods used, productivity and range and relevance of stakeholders are all appropriate and strong.

Some of those activities are responsive such as work on eutrophication and acidification. But it is particularly important to bring attention to the UoA's activities that have opened new issues that require attention. The notable example here is PFAS in drinking water. In this case, the UoA discovered the problem, brought it to the attention of authorities, and have subsequently worked to better defining the problem and seek solutions. The example here of discovering and acting on a new threat needs to be commended. Here, the UoA has reached out to municipalities and other government agencies.

Below, we summarize the key areas in which this UoA's activities have contributed to societal issues and the outputs that have been communicated. The contributions have been made through EMA activities and competitively funded research. The contributions have been directed towards the local, national, regional (EU) and international scales. Most stakeholders are related to EMA.

At the national level, the UoA has conducted several activities to supported work to establish Swedish Environmental Quality Objectives, which is part of the initiative to achieve "A non-toxic environment". The Centre for Chemical Pesticides (CKB) has done modelling and providing web-based decision support tools for water authorities, farmers, municipalities (to regulate pesticide use in water protection areas) • Support for drinking water sectors (involved in Swedish DRICKS- a framework program for drinking water research)

At the regional scale, the following initiatives have contributed:

- New data for REACH
- Contributions to the Baltic Blue Growth project.

At the international level, the UoA's activities have contributed

- new data for Stockholm Convention and, Minamata Convention
- reporting EU directives (like Water Frame Directive), HELCOM, OSPAR.

It is worthwhile to note the broad range of stakeholders to which the UoA responds: Swedish EPA, Swedish Board of Agriculture, Swedish Forest Agency and Swedish Energy Agency. The drinking water initiative has broadened the stakeholders to include municipalities.

Although the group has an impressive contact to stakeholders: national and international agencies, local, regional and national authorities – there is a potential for further societal contact to the general public. Such activities would recuire /benefit from support from an extention lecturer or communication service at SLU.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

We have commented on the strength of the UoA's publication record which provides direct evidence of research of high scientific quality. The Self Assessment Study provides many examples of research projects that have culminated in publications, advice to agencies, and guidance for stakeholders.

Major outcomes include both monitoring (EMA) and externally funded research activity. Guidelines and decision support tools (including models) are available in product such as "Guidance for assessing private sewage system". Other examples include: Eutrophication (environmental Quality Criteria for phosphorus), acidification (estimates and guidance for when to stop liming), Guidance for Baltic Sea Action Plan, decision support tool for pesticides, with the Macro model. The UoA provides input to authorities and national and international agencies through reporting of several programme and directives as e.g.the Water Frame Directive.

The UoA has contributed to the societal debate on the Water footprint where it is documented that this is not an appropriate tool for benchmarking in Nordic forestry.

Results from the UoA have contributed to the value based subsidies for agricultural countermeasures.

The UoA reported positive outcomes but there is potential to improve. An extension lecturer (outreach and extension) could help with dialogue and contact to agencies about their needs and also communicate research outcomes (in addition to monitoring). The UoA could possibly interact more with the groups like the Agricultural Water Management group and the Water Quality Management group which are strong in extention of applied resarch to stakeholders, e.g about measures to reduce eutrophication. These groups have External Collaboration Specialists to build links to societal stakeholders.

#### Score for Outcomes

#### 3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA's strategic goals for societal impact are clear – respond to "legacy" stresses and conduct research that will identify new stresses to aquatic ecosystems. Other parts of this report have discussed the UoA's responses to legacy and on-going issues such as eutrophication and acidification. The list of activities seems very broad, however a review of the UoA's accomplishments indicates that the list is realistic.

An important new initiative by the UoA is their work on drinking water quality, protection and treatment systems. The UoA is to be commended for their activities taken to establish a national competence centre for chemical hazards in drinking water. The UoA pointed out that SLU could take a leadership role in this new organization that clearly responds to the needs of society to protect drinking water from existing and emerging hazards. The UoA expressed some frustration that this initiative was not sufficiently supported by SLU.

There are several clear steps that can be taken to improve the ability of the UoA to reach their goals. Some of these steps need to be taken to ensure that the UoA continue with their accomplishments because the panel had some concerns that the current level of activity was not sustainable given the limited resources. These recommendations come at the end of this report.

#### Score for Impact Strategy

3

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA has identified key areas for collaboration with society – eutrophication, climate impacts, environmental impact of pesticides and acidification recovery. The topics are relevant for specific groups and follow different ways to approach the society:

- Monitoring and research as basis for dialogue, guidance and advice to governmental and agencies for national and international reporting. .
- Host the Center for Chemical Pesticides (CKB) that promotes dialogue between researchers and farming sector, regulatory agencies to reduce impact of pesticides in agriculture. It includes analytical expertice, education, information, development of decision support tools.
- Priority to develop guidelines, decision tools, models that are available for stakeholders.

The group stressed that many publications are not available to stakeholders because of lack of open access publication. The UoA also calls for the need to have a dialogue with the public which is different then one-way dissemination of information to the public. Acknowledging the need for dialogue illustrates the UoA's philosophy guiding public engagement.

The group is clear in identifying the importance of communicating results to the public and going farther to include the public in research (e.g., citizen science). They highlight that the monitoring activities are important for responding to societal needs. They also underline that societal contact comes second after the need to perform research and publish.

For contact with agencies, public and extension, the UoA clearly states that resources are needed, and point of the need of having an extension lecturer and help from SLU communication personnel with webpages, communication etc. The group has initiated the need for a national centre of competence regarding drinking water which is an important link between research and society.

## 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The panel got the impression that the UoA is already operating at full capacity. It would be unrealistic to recommend that the UoA further expand its activities in either research or societal outreach given its current resources.

The following points suggest practical ways in which capacity for research and societal collaboration can be improved:

- Fund staff position to coordinate societal engagement with stakeholders
- Provide more stable funding for researchers' salaries. It is evident that too much time and effort is being devoted to raising grant money to cover researchers' salaries. The time taken to raise external funding could be more efficiently directed towards research and societal engagement. Moreover, having stable salary lines will help with attracting and retaining the "best and brightest".
- SLU can provide institutional support for a national competence centre for chemical hazards related to drinking water. This opportunity, of advancing a new national centre to the benefit of society based on SLU's research, is a prime example of how this UoA is striving to meet the needs to society. Currently, researchers are expending considerable effort to advance this initiative without, apparently, institutional support and leadership from SLU. We recommend that SLU assume leadership for this important initiative.

• Consider adding another professorship to keep pace with the UoA's productivity and need for senior leadership.

- Provide technical support for recently established lab in emerging organic contaminants.
- Provide better institutional support for writing large, multi-unit grants such as those from the EU.
- Acknowledge and reward new initiatives such as incorporating citizen science into EMA.

#### Quality and Impact 2018 - KoN2018; PANEL 19 - "Genetics, Molecular Biology and

#### Physiology" STRATEGIC RECOMMENDATIONS

1. The strategy process Part of the six UoAs this Panel assessed had developed clear research strategies, whereas others were disconnected from this goal and presented no strategy. We recommend that the latter UoAs be encouraged to present a strategy in a time-limited process. To maintain the momentum of strategic thinking, each faculty could appoint a dedicated Strategic Advisory Board, which would pick up the recommendations of KoN2018 and support implementation of the strategies. All in all, the units at different levels would benefit from a centrally instigated long-term strategy regarding the mission and scientific and societal impact of SLU. In the frame of development of this strategy, SLU is recommended to consider reduction of the duplication of disciplines across the faculties.

**2.** Academic leadership SLU needs to strike a balance between top-down and bottom-up approaches. This requires academic leadership at all organizational levels. The Panel encourages the management to support acquisition of these competencies if deficient.

**3. Research Excellence** The Panel identified outstanding research and weaker performance. We recommend that at all levels the ambition level concerning the quality of research is raised, and PIs encouraged to publish in top-ranked journals and apply for the most prestigious grants (e.g. ERC and Wallenberg Foundation). SLU is recommended to embrace high gain/ high risk research, perhaps with an internal call with its own resources, modelling the ERC application concept and forms, like many top universities do to train their PIs for ERC calls. Talent should be identified early, and they should be coached in writing and presenting.

**4. Succession planning** Waves of retirements have occurred and are expected to occur. The Panel encountered both cases where no plans had been developed to bridge the past to the future, and exemplary planning. Retirements offer opportunities for renewal of SLU. It should be decided at the Vice-Chancellor level, whether to continue the research theme of a leaving professor, or whether to reorient the research theme in accordance with the research strategy and priorities of SLU. Recruitments should evidently follow the institutional strategy.

**5. Research infrastructure** The UoAs were content with their research infrastructures (RI). The Panel recommends that the responsibility of medium-sized RI acquisition be moved from the UoAs to the university-level. Investment decisions should be made according to an institutional RI-strategy linked to the overall research strategy. Most of the interviewees seemed to lack knowledge of Sweden's national RI strategy and Roadmap and the significance of an RI belonging to the Roadmap, as well as of the opportunities that Swedish state memberships in European RIs (ESFRIs) and the European Molecular Biology Laboratory EMBL offer.

**6. Impact on society** SLU's mission is excellent research and impact on society. We found fine examples of concrete impact, such as industry-academia collaboration, science advocacy, and capacity to collaborate with stakeholders. An extended strategy for societal impact can be realized *via* a circular pathway to innovation "from field/forest - to the lab - to the industry - and back to the field/forest". Grogrund was taken advantage of to deliver impact by one of our UoAs, whereas others perceived it only as a funding program, and doubted the transparency of the

funding process. The mission and opportunities of Grogrund need better communication. Lifelong-learning is an essential research-based activity whereby SLU can deliver impact on society. The Panel heard of one laudable example of a training program for professionals, and recommends such activities to be modelled across SLU.

**7. Education** Quality research is nurtured by education activities and researchers' contact to students, which is the essence of the "research university" concept. The Panel learnt that several interviewees cannot teach at SLU as much as they wish due to lack of students. As SLU management wishes to double the number of students under conditions where students in certain subject areas are too few, serious consideration should be devoted for analysis on why these subject areas are unattractive. Should these subject areas nevertheless be important for Sweden, the curricula need to be re-designed to inspire youth, the subject area's names up-dated and all of this better communicated.

Panel/ ResearchGenetics, Molecular Biology and Physiologyfield

#### UoA

Plant Biotechnology

#### Introduction

#### General assessment of the Unit of Assessment

This UoA builds heavily on work done throughout the past several decades, by retired professor Stymme. The UoA is now led by two professors, one of whom serves as department head but neither of these principals were available to meet with the panel. The current researchers are applying modern genetic approaches to improve quality and profile of storage molecules, especially starch. The group's productivity is staying about constant, and is not regularly publishing in highest impact journals. This group appears to be solid, working on subjects of practical importance for Sweden in potato and other species using up to date and appropriate methods for their objectives including genome editing. They received a very large grant, ICON, which has provided substantial funding for their work along with MISTRA Biotech, Protein2Food, and Oil Crops for the Future. They have strong interactions and a good history of collaboration with industry. The discussion focused among many topics on the consequences of broadening the technical basis of their research beyond "transgenic plant biotechnology" per se.

#### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The scientific quality of this work appears to be satisfactory. There is a wide array of efforts underway that appear to be reasonable extensions and translations of the basic science that has been underway in this program for a number of years. They do not publish in top tier journals, but their publication record appears quite solid. They do publish in international journals with modest levels of citation. The ideas that underpin this research are not highly original, but are sensible next steps for this group with its strengths in biotechnology and some key groups of metabolites. The over arching vision focuses on the generation of plant-based high quality and quantity oils, starch and proteins relevant for the human diet and non-food applications. A key goal of this group was stated to be the innovations necessary to bring in genome editing to species of practical importance.

#### Score for Scientific Quality

4

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

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This UoA document does not describe its strategies to maintain or enhance a creative, intellectually vigorous environment explicitly. One way this group does look forward is with a wide range of newer projects focused on unusual species such as Lepidium capstere, Camelina sativa and Crambe abyssinica. Several major funding sources are identified as crucial for this group's future including Mistra Biotech and Oil Crops for the future. They appear to do quite a bit of successful outreach and publicity.

The professor gender balance is excellent with one male, one female. In general, there are more males represented in the graduate students and other more junior ranks with the exception of researchers. Women predominate in the researcher category and all the technicians are female.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

"We have a flat organization, which is non-prestigious and where younger researchers can take a front seat.? • Younger researchers often get the main responsibility of interacting with and helping out visiting researchers and students to develop collaborative and supervision skills.? • Younger researchers are encouraged to be cosupervisors of PhD students to develop supervision and leadership skills.? • Younger researchers are encouraged to take pedagogic courses and teach at opportunity to develop pedagogic skills.? • Younger researchers are encouraged to build on and expanding their international network by attending conferences, workshops, and take contact for collaborations.? • Younger researchers are encouraged to apply for funding on ongoing research as well as on own research ideas. "

This is what the proposal says, but it is not described how exactly this works, or whether the extra work given to junior people is a help or not. In the interview, the team stressed that younger scientists were encouraged to "take a front seat" in collaborations. The panel feels that more specific thought could be given to support younger scientists' progress into stable, productive independent positions.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

This work on potato and other crops is relevant to the Nordic region. This group plans to deliver products of potential commercial importance in their region via genome editing. An interesting collaboration on pheromones with U Nebraska was cited as an example of a collaboration that broadens the group's focus beyond Scandinavia.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

This group does broadly interdisciplinary work involving genetics, biochemistry, trait evaluation. They understand that the term, biotechnology, may be too narrow to describe their activities and may even be a liability as they move into newer techniques.

#### Score for Scientific Environment

#### **1.3 Strategy for Scientific Development**

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

There is some room for more intense and strategic thinking about how this effort can stoke both the science and the talent pipeline.

We had good discussion about the need for succession planning.

Consideration has been given to moving new and compelling lines of work forward.

A more coherent vision for these projects going forward would be helpful.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The group does not present a highly compelling and integrated guiding vision for present and future work. This work appears to be solid, and largely extensions of existing work. There is evidence of innovation with the submission of several patents. The team was not able to produce a highly compelling vision for the fundamental importance of their work.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The team cited lack of "infrastructure" and a need for better PhD student funding.

#### Score for Strategy for Scientific Development

#### 3

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

A university-wide approach to investing in genome editing in both eukaryotes and microbes relevant to agriculture would be highly advisable and could potentially benefit this group and many others. This group specifically cites the difficulty of funding the types of technicians who are necessary for large scale tissue culture activity.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The unit focuses on development of new food products with improved fatty acid, starch and protein profiles using plant biotechnology. The unit has had collaborations with companies both in Sweden and abroad, producing potato clones with specific starch profiles and Camellina sativa with suitable fatty acid profile for the production of insect pheromones to be applied in pest management in agri- and horticulture. Some of these developments have resulted in patent applications. Thus, the traits and topics are important as evidenced by invitations they get from farmers and others. This group is playing an important translational role in bringing the products of this research to full impact. Although these collaborations demonstrate societal impact, there is room to further integrate society in research planning.

#### Score for Activities and Outputs

2

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

Although the productivity of articles has not been exceptional, the quality of the published material is good. The results have not been published in extremely high impact journals. On a question from the panel the UoA reported that they are in the process to find a procedure to move a large amount of scientific data from the drawer to new publications,

#### Score for Outcomes

3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

Due to the political climate in Europe there has been a move in the plant breeding from methods resulting in genetically modified organisms to methods editing the genome and producing organisms that cannot be differentiated from spontaneous mutations. The strategy to achieve impact in this UoA involves scientific publications demonstrating the efficiency of the new methods, intellectual property and collaboration with farmers and industry. Students were identified by the UoA as perhaps the most important stakeholder for the future. The panel suggests that it may be appropriate to focus a bit more on the recruitment of PhD students. The group appears to be successful in making the transition through the retirement of the previous group lead. They struggled with the question, "What is the problem you are trying to solve?"

#### Score for Impact Strategy

#### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

# 3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

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This group focuses on producing plant varieties with altered levels or composition of storage compounds (oil, starch, protein) for food, feed and biobased materials. The research directions presented to the panel appear to be solid, but not extraordinary, positioned largely based on their history rather than considered strategic justifications. In general, this group had some problems articulating an overarching scientific or academic vision for their future. This apparent lack of clarity regarding the overarching research strategy can impede the identification of the most crucial collaborations to advance their scientific vision and excellence. The panel feels they need to work to more effectively include the underpinning basic research into basic plant lipid biochemistry, methods and then also a strong focused on applied research projects. They seem to have a good understanding of the collaborative process but have not yet set into place especially creative approaches to engage stakeholders. The university is establishing a platform, Grogrund, that might be a helpful catalyst toward more considered and strategically robust strategies for this group in the future.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The panel felt that this team could benefit from a stronger and more concerted focus on building direct, very active and broadened interfaces with industry and other stakeholders. One of the ongoing projects aims to domesticate a wild plant, Lepidium campestre, to become a novel oil crop for food and non-food purposes (technical oils). Such a crop would in Europe be defined as a novel food. It could be useful to have early contacts with the authorities that are responsible for interpreting the appropriate EU legislation at the national level in order to avoid any unnecessary delay in project development.

 Panel/ Research
 Genetics, Molecular Biology and Physiology

 field

UoA

Forest genetics and plant physiology

#### Introduction

#### General assessment of the Unit of Assessment

The unit is a prime example on how coordinated planning, internal collaboration and recruiting strategies geared towards high scientific quality will result in World Class unit that is among the best in it is field, not only in Europe, but also in the whole world. The research is ambitious basic research, but at the same time ids dealing with processes which are of direct relevance for various external interest groups and the society in larger sense. Actually, most of the research questions are coming from this kind of interaction with various stakeholders. Almost all of the excellent development during the last two decades is, actually, based on not only the leadership and development only in this unit under evaluation, but a result of the concentrated collaborative efforts with Umeå University in forming Umeå Plant Science Centre (UPSC), which has brought a laudable benefit for both units.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The scientific quality of the UoA is in one word excellent. During the last two decades after the founding of the UPSC, it has become a prominent and well-recognized research centre internationally known for its quality of research. The strategic decision to concentrate on research that is relevant for trees and forestry, but at the same time to recruit personnel based on scientific quality and not on the research object has proven as very successful decision. The depth and breadth of the research are both excellent, major selected scientific publications are published in the best, highly selective journals; they are well cited and cover research on both trees and model systems. The research ideas and approaches are very original and often first proven in model systems and subsequently applied to trees. The methods used are modern and suitable for addressing the questions. The scientific productivity in quantity is not impressive when compared to the number of scientists and resources available in the UOA; however, in quality the productivity is very good, several large comprehensive, and well cited publications in the best journals. The scientific impact especially in the research that concentrates on trees is outstanding and one can almost say that most groundbreaking new publications on trees come from this unit.

#### Score for Scientific Quality

6

#### **1.2 Scientific Environment and Leadership**

#### 1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

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The UoA has one of the best scientific environments in its field and this is a result of strong and visionary leadership. However, in this case it is difficult to evaluate whether it has been a result in the leadership of this particular unit, or that of the umbrella organization UPSC which has had its own, strong and visionary leadership to get all the synergy benefits from bringing two different departments from two different universities together under the same leadership. Nevertheless, this has resulted in this UoA creating a creative, intellectually vigorous and productive scientific environment that works well and fosters excellent research.. The gender balance in Ph.D. students and postdoc recruitments is biased towards men, overall balance in staff is equal, but male dominance is still visible in professors and female dominance in technical support staff. The balance between the junior principal investigators and senior staff members is good but a vital question for the UoA is the replacement of the four professors who will retire during the next years. This should not be a problem (providing that the resources are there) since the unit has already now analysed the situation and has concrete and realistic plans on where they have need for new openings and new expertise. Of the 63 new recruitments during the last five years only four were from a Swedish university, which clearly demonstrates the emphasis on international recruiting which brings new ideas and views that help the unit to continuously keep itself up to current developments.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA has a rather unique strict requirement that junior faculty members must be completely independent and not allowed to work under a senior faculty member, and have created support measures to enable this with financial support and integrating junior faculty members in large research programs. Additionally they are connected to teaching from the beginning to gain the experience required in later phases of their careers when seeking for higher positions. This is a very brave and excellent example of how junior faculty members are given possibilities to build their own line of research independently.

### 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA has researchers of over forty nationalities and has ongoing collaboration with top institutes and research centers around the world. The magnitude of visitors (over one month of duration) in the UoA is very significant, but it is a bit worrisome that visits from the UoA are non-existent during the evaluation period of five years.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

As already stated, the depth and breadth of the research of the UoA is excellent, and frequently based on interdisciplinary studies. Although many research projects utilise expertise from several UoAs, there is always room for additional collaboration. However, this issue is not limiting the success of this UoA.

#### Score for Scientific Environment

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#### **1.3 Strategy for Scientific Development**

## 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The UoA has a clear aim and goal to develop the research environment to become the world's most innovative milieu in forest research, where top class basic research is transformed into innovations. The goal and aim are very bold and ambitious, but the UoA has also very concrete plans on how this is done and what is needed. Instead of describing general goals, the plans for the future seem to be well thought and focused on strategically important new developments and recruitments.

## 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The UoA has a very clear and focused strategy for the future directions: a better understanding of factors that regulate tree growth and productivity. The strategy includes genetic components and the adaptation of new technical developments that are relevant to reach this aim, connected with new recruitments that support the strategy. This is a very well thought of and planned strategy that will lead the UoA towards significant scientific contributions.

## 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The most important challenges relate to the rejuvenation of the staff after retirements and successful new recruitments. The UoA needs to be able to attract world-class new group leaders also in the future and need to have the economic resources for this.

#### Score for Strategy for Scientific Development

#### 6

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The teaching commitment of the unit is limited by the SLU faculty-level student degree programs, which concentrate on educating foresters (which as such is naturally relevant for the University and related industry). The University most likely would benefit on widening the education structure relating to this UoA if the degree-structure would be modified according to the suggestions of the UoA, which would offer a wider selection of degrees and student backgrounds and allow even better interaction and education structure with and for the related industry.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

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This UoA is large (84 persons, delivering 54.3 full time positions) and includes ten professors. The unit is also very broad with a cross-disciplinary research profile, stretching from basic cell biology and biochemistry research over plant molecular biology, genetics, developmental biology and plant physiology to analytical chemistry and multivariate analyses of complex data sets. There is a depth in all these scientific fields. This is demonstrated by one of the research groups of the UoA, the metabolomics platform, being recently elevated to "National platform" status, meaning that it is recognized and is serving scientists all over the country working in life science and medicine.

Researchers from the UoA pioneered the use of transgenic trees to solve basic questions regarding tree biology and physiology. The international collaborations could be exemplified with the first transgenic Eucalyptus tree lines produced, and these were developed based on UoA's research and are now being commercialized in Brazil. UoA researchers also pioneered the use of genomics and functional genomics in trees, including full genome-sequencing of Norway spruce.

SweTree Technologies AB (STT) and Arevo are plant and forest biotech R&D companies that are spin-out from the UoA and commercialize its innovations. The UoA also actively interact with the largest Swedish forestry companies, as well as with the private research institute Skogforsk which is responsible for the Swedish operational tree breeding programs. The collaboration with three of these companies is formalised by each having an adjunct professor working part time within the UoA. There is also regular interaction with smaller Swedish forest enterprises and with Swedish Authorities. The UoA have extensive societal impact and stakeholders seem satisfied.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

Experience has demonstrated that it takes 10-15 years to launch a product for the forestry sector on the market. Consequently, it is much too early to evaluate the outcome of the research performed by the UoA during the most recent 5-6 years. However, researchers within the UoA are continuously actively involved in developing their discoveries in collaboration with stakeholders.

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In addition to the arginine-based fertilizers arGrow and SeedPAD, developed for a more efficient breeding of spruce and pine, and use of embryogenesis for propagation of elite tree families described in more detail in three case studies, a very large gene-mining program has been performed by the UoA to identify genes controlling growth and wood properties in hybrid aspen. Based on data from functional genomics studies, more than 2000 genes potentially involved in the wood formation process have been identified. Together with SweTree Technologies, all these genes were analysed in transgenic hybrid aspen trees for effects on growth or wood properties when down-regulated or over-expressed. About 200 of these genes showed clear effects and more than 100 have been tested in field trials with transgenic aspen trees in southern Sweden 2010-2017. Some of these genes can double the growth rate and drastically change wood properties and chemistry. Some of the most promising leads have also been tested in transgenic Eucalypts in Brazil, providing dramatic increases in growth rates. The first of these trees are now being commercialized.

The UoA has demonstrated that they efficiently associate with the society. The outcome of research projects described as case studies, as well as other research activities are expected to have extensive societal impact.

#### **Score for Outcomes**

#### 3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The UoA has as a major goal to produce cutting edge basic and applied research and education that will have a positive impact on the society in Sweden and abroad. In addition, the research aims at facilitating the creation of new companies and industries based on the sustainable production and use of renewable superior plant raw materials. The unit history has demonstrated that this impact strategy is functioning.

Without efficient methods for tree breeding, plant production, forest management, plantation forestry, methods to improve forest health and to find new uses for wood, it will not be possible to enter a true sustainable bio-based economy.

The panel found the tiered approach set up by the UoA to reach its goal regards societal impact included to increase both the number of industrial graduate students serving as bridges to forest companies and institutes, and the number of adjunct professors and industry-employed personnel working in a collaborative academic environment particularly excellent. At the same time other stakeholders were not neglected in the impact strategy.

An important commitment is the active participation in debates related to various modern technologies used in research, and to investigate the possibility for new uses of the innovations. The comparatively low acceptance of GMOs and unclear status of new breeding technologies and clonal forestry in the EU context at the political level, may limit the implementation of several of the technologies used by the UoA.

#### Score for Impact Strategy

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

# 3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

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The major goal of the UoA is to produce cutting edge basic and applied research in the many field of science that are required in forestry (from basic cell biology and biochemistry research over plant molecular biology, genetics, developmental biology and plant physiology to analytical chemistry and multivariate analyses of complex data sets) in order to have a positive impact on the society in Sweden and abroad. A specific goal is to increase the possibility for Sweden to enter a true sustainable bio-based economy, which will be heavily dependent on a continuous and increasing supply of forest products. This requires efficient methods for tree breeding, plant production, forest management, plantation forestry, methods to improve forest health and to find new uses for wood. To disseminate research results that might contribute to find solutions to these challenges, the UoA works on increasing the number of adjunct professors and other industry- or institute-employed personnel working in the academic environment of the UoA. Researchers of the UoA also present their research and innovations to smaller forest enterprises, and to ministries and governmental agencies seeking advice on the implementation of new technologies and how to create sustainable bio-based economy. Media and the public are supplied information by the UoA participating in debates, workshops and teachers training.

In parallel the UoA is keen to bring out innovations to practical applications within the forest and agricultural sectors. Routes to achieve this goal are through working in academic/industry competence centres, and through spin-off companies of the UoA.

The experts of the UoA also participate in various national and international expert bodies.

In the self assessment report, the UoA have demonstrated that they understand the collaborative process required in the interaction with society, and they do it very well.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

This UoA has performed very well in is collaboration with academic and non-academic actors.

Panel/ ResearchGenetics, Molecular Biology and Physiologyfield

UoA

Genetics and Plant Breeding

#### Introduction

#### General assessment of the Unit of Assessment

This UoA is a part of a larger department and formed just for this evaluation, so it is not an operational unit that would, as such, plan its activities together. This makes the evaluation of, especially strategic and future issues difficult as the UoA has no possibility and mandate to plan these. When the past performance is analysed, the unit has performed reasonably well when the quality of the research is assessed. Over all the performance is on rather solid level with some scientific highlights especially from the epigenetics-related research, which is also visible in major grants and speaker invitations. The external funding among the units assessed is on the lower end, but the decision to evaluate the Department of Plant Biology as two separate UoAs can be one reason for this. The UoA has a long history in research concentrating on the use of Willows in bioenergy and apparently, reasonable progress has been made there. This research is directly relevant for societal needs and has strong collaborative aspects with the end-users. With the introduction of the modern genomic and whole genome sequencing approaches there is a possibility that this part of research could also in the future produce outcome that could be included in the list of major selected publications.

#### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

On average the scientific quality of the unit is average; however, with rather high SD. The research topics vary from excellent basic research on epigenetics to highly applied research in field crops and pre-breeding of willows for use in bioenergy production. These diverse topics are also visible in the quality of the scientific output, for example in the list of selected publications, which do not contain any papers on the more applied research. The research approaches and ideas follow the same pattern, on the one hand, there is partly very original and high-quality research on epigenetics, plant pathogen interactions and adaptation of plants, but on the other hand also research that could be described as safe and sound, but not exciting. On average the scientific output is good, well cited, and contains also some scientific highlights. Similarly, some of the work has had a significant scientific impact, and the more application-oriented work has had a significant. Similar can be said about the prominence in the field of science; the UoA has a PI who has five out of eight invitations to scientific conferences during the period of evaluation, which shows high prominence, but the UoA as such does not have similar status – especially since it is "artificial" unit and in reality not acting as an operational unit with common planned strategy.

#### Score for Scientific Quality

#### 1.2 Scientific Environment and Leadership

#### 1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

Since the UoA is "artificial", it does not have a leadership of its own. The department to which this UoA belongs is using the "usual" or "traditional" and proven methods for creating a research-friendly environment for its research and teaching staff. The size of the unit (19.6 FTE in May 2017) is rather small, so these usual actions (seminars, staff meetings etc) will reach the whole unit, but reaching a 'critical' mass' to create an intellectually vigorous and productive environment can be challenging. With this size, exposure to new approaches and ideas is difficult to achieve even with active participation and traveling in conferences – usually the best new approaches, ideas and similar come with new members recruited from outside, as is the case here with the 2010 and 2015 new recruitments; these have both brought new approaches, ideas, activity and international visibility for the UoA. There are only seven new recruitments in the UoA during the last five years and five of these are postdocs. The gender balance and age structure are good, but the international mobility, and mobility in general, could have been better. However, this is dependent on the funding structure and restricted by the rather low level of competitive funding among the UoAs in this panel.

### 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The UoA offers several measures to promote the career of the junior members of the UoA. Mostly these consist of encouragement to apply for external grants, assisting in participating pedagogic and leadership courses and offering mentoring programs and also start up grants (the size or duration of these is not mentioned). These are good measures and should offer possibilities for the younger faculty members help in establishing independent research careers. However, the measures presented in the self-evaluation do not offer information whether the more junior members working in the UoA are connected to the research programs of the senior menbers or not, i.e., are they allowed or promoted to be completely independent research career. Based on the interview the junior members appear to be independent.

## 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA has researchers from different nationalities and most recent senior faculty recruitments include international staff. Half of the few postdoc recruitments are also from foreign universities. In the major collaborations, however, only one ERA-NET consortium is listed. The international collaboration and contacts (based on what is presented in the self-evaluation) could be a bit better.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The UoA is a part of a larger department and the individual investigators who have been allocated to this unit are acting in the department as independent researchers who have their scientific connections inside the department and between different units of SLU according to their specific needs.

#### Score for Scientific Environment

#### **1.3 Strategy for Scientific Development**

### 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The goals, strategy and future directions of the UoA contain most of the current 'key words' for the most recent development and the aim is to perform world-leading plant research. This as such is good aim. However, in the self-evaluation the plans for the future, even though all are relevant and good, are not really developed into concrete level of actions. It seems that the unit wants to get somewhere, knows what is needed, but the actions how to get there are not yet developed into concrete plans and actions in the department to which the UoA belongs.

### 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The plans of the UoA for future research are strategically sound and relevant. However, most of them are based on describing development and introduction of new techniques and instrumentation, and collaborations with 'core facilities' with high throughput analyses (genomics and proteomics) - without clearly considering to which scientific questions and fields these would be applied and where the UoA wants to be in science in the coming years. The goal to perform world-class science is good, but basing this only on technologies may not be the best strategy for development.

### 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The most important challenges relate to the successful new recruitments. The UoA needs to be able to attract world-class new group leaders also in the future and need to have the economic resources for this. The UoA is also rather small, about 20 FTEs and as such rather vulnerable to fluctuations in funding.

#### Score for Strategy for Scientific Development

3

#### 1.4 Additional comments

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

It is regrettable that the department/faculty has decided to form two artificial UoAs for the evaluation – this prevents a proper evaluation of, especially the strategy and future development of this unit.

#### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The UoA cover many different activities and outputs towards the society. The UoA has hosted study tours and visits. One of the professors has participated in writing a report on effects of clonal forestry for informing public authorities and forest companies on current knowledge of clonal forestry. The UoA has assisted with surveys and tests of viral and fungal pathogens on crop plants. Two industrial PhD projects has been run by the UoA. The department arrange "Fascination of Plants Day" regularly and they frequently give lectures and seminars directed towards the general public and the society. Joint projects to promote capacity building in Uganda and Kenya have been ongoing for the last five years. Popular science papers are produced. Staff from the UoA participate as experts in radio and professional-oriented journals.

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Important and relevant stakeholders are Lantmännen, DLF/MariboHilleshög, SweTree Technology AB, Skogforsk, Swedish authorities and industry branch organizations. UoA provide these stakeholders with competence, counselling and collaboration in a wide range of topics.

A variety of different methods are used for activities and outputs directed towards relevant stakeholders.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The case studies "Biological soil mapping", "Salix Molecular Breeding Actions" and "Genomic selection in Eucalyptus" are good examples of the UoA's potential for outcomes in terms of realized societal impact. The researchers think the most important impact from their research is forest and agriculture industries awareness and practical application of genomic tools to improve gains in breeding. More cooperation with companies, institutes, authorities and other organisations could be a way to increase the output from research. This kind of collaboration is also a way to get ideas to important and relevant

research projects for the society.

#### **Score for Outcomes**

#### 2

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The strategy for societal impact of research is not clear. The UoA will run important research but how it will be implemented for the society is a challenge. It is not clear how the strategy will be implemented and what measure have been taken to implement the strategy.

The UoA will be active in promoting collaboration between academic researchers, industry and other organisations to increase the impact of plant breeding. The strategy has resulted in case studies such as biological soil mapping, molecular breeding of Salix and genomic selection in Eucalyptus.

Main challenges in breeding are the regulatory framework that governs the use of gene technology both in agriculture applications and in basic research. This is an important issue for the UoA to work with. The department has identified this and invested in an extension lecturer in biotechnology with specific focus on gene technology. The UoA is one of Sweden's most trusted institutions when it comes to policy issues and general source of information regarding agricultural biotechnology.

The establishment of the new plant breeding platform Grogrund could be a good way to find partners for collaboration.

#### Score for Impact Strategy

2

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

A successful collaboration with the society requires a dialogue with the relevant stakeholders. It is also important with mutuality to create a win-win situation. The UoA has the capacity to work closer with the society and will also raise the skills at the department solving practical problems. It is important to formulate a joint goal with the stakeholders at the start of a joint project and have a well-defined problem. An example of successful project is the development of a genomic based breeding programme for eucalyptus using material available at Veracel, Brazil. This collaboration activity has raised group members skills in statistics and quantitative genetics.

The UoA should also have a closer cooperation with authorities increase their knowledge about latest research results.

Strategies for establishment of new crops suitable for Swedish conditions are relevant project for the UoA to work with. Climate change include challenges in breeding for stress tolerance such as adaption, pests, pathogens, fungi. Collaboration with stakeholders in the chain pre-breeding – plant breeding – cultivation of plants is important for implementing new breeding strategies.

3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.
• Advisory groups including stakeholders could be a way get new ideas and to help prioritise research important for the society.

• Industrial PhD students can be a way to increase the cooperation between the university and institutes, companies or other organizations. This will increase skills at collaborating partners, both for academic researcher that get better understanding of practical problems and stakeholder's acceptance for academic research.

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• Adjunct researchers and professors may be a way to increase the cooperation between the university and different stakeholders.

• Exchange of staff between academia, institutes, companies, authorities for shorter periods. This can also give access to research material, field trials etc.

• Collaboration with companies, institutes, authorities, etc should increase.

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 Panel/ Research
 Genetics, Molecular Biology and Physiology

 field
 Control

#### UoA

Plant Breeding

### Introduction

#### General assessment of the Unit of Assessment

The unit Plant Breeding is composed of 3 professors, 10 research staff, 7 PhD students and 9 research support staff members. Gender balance seems okay except for PhD students which are mostly male. Almost all PhD students are grant students which is okay for the moment but should be brought more in balance. The unit is rather traditional in their research approaches although actions are undertaken to include more modern technologies (molecular markers in apple, genomic selection in potato). The research is solid although many different crops are being investigated. This is perceived as a strength by the unit itself to maintain all their personnel involved who are on soft money to the largest extent. They have a number of obligations towards the Swedish government in order to do pre-breeding in some cereals and do breeding (variety development) in amongst others black current, apple and potato. They have a high number of publications in the best plant breeding related journals but so far seem to lack an ambition and strategy to also publish in higher impact journals. Although not evident from the report they collaborate with many groups within and outside SLU. The group interacts at different levels with society both in the form of tangible deliverables like varieties and markers but also in the form of educating new breeders especially in the lesser developed crops and countries which may not be of direct use to Sweden but certainly of indirect benefit. Somewhat more visibility as thé plant breeding group in Sweden could be expected and may be found in specializing in a particular field of breeding such as eg breeding for climate adaptation to the Nordic countries. This could give both new research exposure as well as could lead to (in the longer term) spin out opportunities for breeding activities specialized in the changing climate with emphasis on the Nordic climate and crops.

### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The group has a large portfolio of many different topics, crops and issues. Next to the practical breeding efforts in their 'mandate' crops they work on a large variety of tropical crops. A general vision or focus in all this research is not evident albeit they themselves mention that this research is conducted within the realm of genetic diversity and crop domestication. The linking of their practical breeding activities and their actual research is a logic thing to do and strengthens both their research and practical breeding activities. The scientific quality is satisfactory to good but somewhat more ambition would not be wrong. Their publications are cited well.

#### Score for Scientific Quality

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

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The professors are getting of age and a strategy for eventual replacement and or a rooftile construction is not apparent. It is important that this is done in a timely fashion since this group is key because of its practical breeding activities. From the presentation and interview it became clear that PhD students are part of a research school in which they will receive training and in depth education. Overall the age distribution is not bad but timely action should be taken to replace important people/positions. The fact that almost all PhD Students are grant students is in the long run not positive to atract more younger staff to the group. There should be a healthy mix of foreign and Swedish, male and female, PhD students.

# 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The group has no clear strategy regarding the development of young researchers into independent researchers but are aware of the fact that this is important. They offer the possibility to become and remain independent as long as money for the research can be found.

# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The group has a large and international and geographic broad network both in the research field as well as in the practical breeding field. The work with the international centres in Africa and south America as well as the interaction in different European networks is excellent. Their breeding work is very relevant to Sweden. Their work on tropical crops is very relevant firstly to the lesser developed countries but likewise indirectly for the more developed countries.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The group is conducting quite some interdisciplinary research and also multi-disciplinary research (participatory breeding research) and in the future also trans-disciplinary research should be possible. Tools and people are around. During the interview it became apparent that research with other units within SLU does happen (resulting in combined publications) but the general feeling is that this is not done to its fullest extent. Likewise the obvious lack of interaction between the different groups who do something in the field of breeding is not strengthening SLU as a whole and although this for sure is not the fault of this unit it certainly hampers them as well as SLU in becoming a world player in the domain of plant breeding.

#### Score for Scientific Environment

4

1.3 Strategy for Scientific Development

# 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

Ample opportunities are around to increase the scientific exposure and recognition of the group and first steps are made to this effect. A further clear vision and mission of the group with a focussed approach (without throwing away the current research strategy and diversity) would help to gear activities towards a recognizable unit with a clear spot in the field of plant breeding. Good people and facilities are around so with somewhat more ambition this could be achieved (like eg earlier mentioned focusing on breeding for the Nordic hemisphere in a climate changing world).

# 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

As stated earlier practical breeding programs could be the sand boxes to test new approaches and ideas. People and facilities are available so no stopping there.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The establishment of the new plant breeding vehicle Grogrund could be a very strong point in focussing scientific development in some selected fields of research. Funding for PhDs not only on grants seems an important point. New leads will have to be attracted in view of the fact that some professors and senior staff are close to retirement.

#### Score for Strategy for Scientific Development

#### 4

#### **1.4 Additional comments**

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

There seem to be a lot of groups involved in breeding within SLU. This might be historic but it would be good if the higher management of SLU would look very carefully at this and try to bring some order in this at least for outsiders duplication. Furthermore, more strategic discussions regarding to what breeding activities should be carried out by whom and with what kind of resources as well as discussion about hiring new staff in advance between the different groups and departments is highly needed. After all resources can only be spend once and the amount of activities in this field could, with good interaction and sufficient internal consultation, make of SLU a world player in (a selected field) of this domain. (To name just two; Tree breeding and Nordic hemisphere breeding).

### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

This unit is well placed to deliver good societal impact of their research both by delivering useful molecular markers as well as varieties and trained personnel.

#### Score for Activities and Outputs

#### 3

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The choice for the case study (1) in the report was somewhat strange and not further explained. It shows the width of this units involvement with societal actors but more could be expected especially in the field of their variety development in Sweden. On the other hand they were very successful in contributing to a case for wheat in the Senegal basin.

#### Score for Outcomes

#### 3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The activities are certainly providing societal impact. It is however not entirely clear whether this is the result of performing the research or whether it was beforehand already planned and thus part of a strategic focus. Further interaction with societal actors is possible and done although there is no clear strategic goal discerned in the written report.

#### Score for Impact Strategy

#### 2

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

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There is good interaction with certain parties in society (apple growers, potato and barley growers, Lantmannen company). Attempts are made to involve society more with new developments and techniques in plant breeding which is extremely important to provide sufficient and as much as possible objective info about possibilities and risks of these new techniques. This is not only important for plant sciences in Europe but also for (commercial) plant breeding (either still existing or new to be erected) in Sweden and other Nordic countries.

# 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

The unit is already doing a great job but could do more in terms of creating awareness (in high schools and general public) about the importance of plant breeding in securing food supply particularly for the Nordic sphere now and in the future.

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 Panel/ Research
 Genetics, Molecular Biology and Physiology

 field
 Field

UoA

Microbial ecology, genomics and metabolism

#### Introduction

#### General assessment of the Unit of Assessment

The UoA 390\_3\_NJ Microbial Ecology, Genomics and Metabolism is composed of 14 people, of which only 2 have a secured employment, each holding a research line (Microbial Ecology and Microbial Metabolism, respectively). Both groups work independently, with separate goals and approaches, and have been put together for assessment purposes. Given that the groups differ markedly in scientific impact, productivity and prominence in their respective fields, the panel will discuss them separately.

The Microbial Ecology group has an outstanding research line and record, being one of the leaders in their main research line (ecological and evolutionary aspects of denitrifiers). The group participates in several international and national projects, many of which have societal impact. The group is already actively involved in multiple collaborations with academic and non-academic partners although the potential for interactions is not fully explored.

The Microbial Metabolism group has an interesting research line of good quality with a satisfactory publication record and a few national grants. Compared to Microbial Ecology, this group is less active in seeking collaboration outside academia and exploring the societal relevance of their knowledge.

### Panel - Section 1 Quality of Research

#### 1.1 Scientific Quality

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The Microbial Ecology group is leading in the area of nitrogen cycling, specifically in what concerns denitrification and the ecology of organisms involved in this process. A recent progress being the discovery of denitrifiers that consume N2O instead of producing it, thus reducing greenhouse gas emissions. This finding by the UoA is original and will influence the environmental microbiology community. Despite the fact that most of the research focuses on denitrification, both the breadth and depth of the research are quite significant given the large number of environments (terrestrial vs aquatic, agricultural, natural, wastewater treatment plants); the breadth of microbial groups (different functional guilds associated with each step of denitrification, bacterial and fungal denitrifiers) and the wide variety of questions (ecological and evolutionary, applied and fundamental) and methods (genomics etc) considered. This research group occupies a unique niche in the Microbial Ecology/environmental microbiology communities, being comparable mainly to Philippot's group in France, with whom there is a strong collaboration. The group is well recognized internationally, as demonstrated by invitation as speaker in prestigious meetings (ISME, ESA), receiving several missions and an outstanding publication record (high citation index; 30% of publications in the top 5% journals).

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The Microbial Metabolism group is smaller, with research focusing on the metabolism of mosses and yeasts and how these model systems respond to different forms of stress, from a molecular perspective. Other interesting aspects of research within this group include the potential to use yeast to study anticancer drugs, and the development of molecular genetic tools to study mosses (shuttle plasmids that can replicate in moss). Looking at the types of organisms and aspects evaluated, the research profile must be considered broad, but worth pursuing. The scientific productivity and impact is not exceptional but of good quality. Missions received has been very limited during the time period on which this assessment is based.

#### Score for Scientific Quality

(ME) 6 (MM) 4

#### 1.2 Scientific Environment and Leadership

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

The small sizes of the research groups are balanced out by organizing national and international meetings. In addition, guest researchers (4) and internationally recognized speakers are welcomed. which promote networking among young researchers and create an intellectual atmosphere.

Gender is not an issue in this UoA. With only 2 professors, one in each research group, the number of fixed positions, in particular when one of the professors fairly soon retires, might be a point of concern for this UoA. Recruitment of two senior lecturers reduce the severity of the problem. The fact that most of the remaining senior staff need to finance their employment via grants brings forward issues of continuity and stability in the research environment. The number of PhD students could be increased in the future.

# 1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The apparent openness and collegiality of the scientific environment should stimulate creativity and discussion among peers. The organization of workshops on writing proposals provides an important opportunity for young researchers to develop this competence, which then could be put in practise by encouraging young researchers to apply for personal grants and the opportunity to actively supervise PhD and MSc students are important measures taken place at this UoA that support the scientific development of young staff.

# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA is internationally well established. It participates in 2 EU projects as partners and has a large number of national projects, including a few with societal relevance.

The Microbial Ecology group is clearly well established in the academic network and receives missions from several institutes and countries.

The Microbial Metabolism group has received less missions and has only been successful in acquiring national founds (although one of them represents quite a relevant amount). Application for an additional grant has been submitted recently and is currently under evaluation.

1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The interdisciplinary aspect of the research carried out by the UoA is well demonstrated by both research groups (Microbial Ecology and Microbial Metabolism), as seen by the breadth of the projects in collaboration with UoAs having other fields of scientific expertise, such as in Ecology, Wildlife, Environmental Toxicology, Veterinary Medicine and Animal Science. Again, the Microbial Ecology group is more active in seeking interactions within SLU than the Microbial Metabolism group.

There is potential for synergies within SLU through the use of research facilities, such as the SLU metabarcoding lab (run by this UoA), climate chambers and greenhouses, as well as in long-term field experiments.

#### Score for Scientific Environment

#### (ME) 6 (MM) 3

#### 1.3 Strategy for Scientific Development

# 1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

Both the Microbial Ecology and Microbial Metabolism group have ideas on how to maintain or increase the scientific quality of the group. The strategy from Microbial Ecology to broaden its scope by expanding the research to C cycling and fungal ecology (recent hiring of a senior lecturer) indicates clear and realistic strategic vision of the principal investigators involved.

The Microbial Metabolism group faces the retirement of its senior professor in the coming 4-5 years, which will greatly impact the scientific productivity of this part of the UoA. The hiring of an associate senior lecturer in the coming period will contribute to development of the UoA but will not provide the academic leadership provided by a professor. A bit odd, the research topic of the new hire is based on approaches (use of model systems) rather than on research ideas. As indicated earlier, hiring additional senior personnel might be necessary to keep the high standards of the scientific productivity and ensure the credibility of the proposed strategy.

# 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

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The plans laid down by Microbial Ecology are clear and scientifically sound. Part of it relies on digging deeper on the ecological interactions among denitrifying species and identifying the ecological niches of the various functional guilds. Another part is to expand into looking also at the carbon cycle, a task for the newly appointed lecturer.

The plans for the future of the Microbial Metabolism team is less clear and seem to rely heavily on the new hire.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The main challenges regarding the scientific development of the UoA lies on the implementation of the new research lines by the 2 new associate senior lecturers, one for each group. The future goals and research plan laid down for the unit might not be successful without investment in high quality bioinformatics support as the research profile of the UoA will be heavily based on genomic approaches.

#### Score for Strategy for Scientific Development

(ME) 5 (MM) 2

#### **1.4 Additional comments**

#### 1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The group Microbial Metabolism is constituted by only four individuals and is very fragile given the future retirement of its professor. The ongoing recruitment of a new position only partly influences this situation. Although a new position has been allocated, only one professor in the group is still very limited and does not provide sufficient critical mass for the planned future activity. A higher investment from SLU in this UoA (new temporary and permanent positions, funding) could ensure a better transition for the current staff and stimulate scientific productivity.

### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The Microbial Ecology group is actively involved in outreach activities and commissioned research. This has led to the identification and involvement of several stakeholders in projects mostly related to removal of nitrogen from aquatic sources and to soil remediation. Collaboration on water quality is related both to drinking water and to follow environmental standards of processing waters in industrial settings. Collaboration with the agricultural sector involve farmers, companies and authorities.

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The Microbial Metabolism group has potential to associate with plant breeders and biotech companies (development of shuttle plasmid for plant modification), as well as with pharmaceutical companies (has taken place in the previous period) and other parties but has demonstrated limited activity in this respect during the last five years.

#### Score for Activities and Outputs

(ME) 3 (MM) 1

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The Microbial Ecology group has great potential for societal impact. Up to now it has focused on ways of handling nitrogen-polluted water from mining and rock quarry activity, which has become an emerging environmental problem, ways of recharging the aquifer in Uppsala producing drinking water with surface water, and ways of handling soils contaminated by polycyclic aromatic hydrocarbon (PAH). The experience from the project with several participating stakeholders on the risk assessment of PAH-contaminated soils in the environment and how such soils could be managed, gave a good insight into the importance of understanding all stakeholder's expectations. Due to divergent views among stakeholders and researches, and between different researchers, on how the environmental risk assessment should be performed, revealed only late in the project, only parts of the goal could be reached in the time allocated to the project.

Although the demonstrated outreach to society is considerable, there is a potential for more extensive interaction were the staff to be increased. It should be stressed that a large part of the research performed by this UoA is basic rather than applied, but as indicated by the success of the case studies on N removal, applying the research findings confirms a real societal impact. Other areas where the research lines of the UoA could contribute to societal needs and challenges could for instance be on environmental issues associated with climate change and greenhouse gas emission (United Nations Framework Convention on Climate Change), or on improving resistance to stress in both plants and fungal species used for fermentation purposes by the industry.

#### Score for Outcomes

(ME) 3 (MM) 1

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The continuous line of research in nitrogen cycling and de-nitrification for over 25 years has resulted in a knowledge base within the Microbial Ecology group that move the research team to the forefront in this are of research. This is the foundation on which the interaction with society is established. Of course, the main goal of the UoA is not to drive applied research but to perform basic research, but the knowledgebase created in basic research on ecology of microbial communities in soils, sub-soils, marine sediments, wetlands and arctic tundra environments, and genomics of nitrogen and carbon cycling microorganisms contribute to initiatives where the expertise of the UoA is needed and is valuable for society. Areas where such knowledge is required include climate change, climate adaptation, nitrogen-use efficiency in agriculture and industry, and such areas are included in the United Nations sustainable development goals.

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As mentioned above, the Microbial Ecology group has demonstrated considerable societal impact. The goals of this group are realistic from the research perspective but given the shortage of senior personnel and the focus on fundamental research, the panel believes that full exploitation of the potential for societal impact is unlikely without additional incentives from SLU with regard to staffing and/or establishment of contact points between stakeholders and researchers.

Regarding the Microbial Metabolism group, the panel observed the research on gene expression, metabolism, aging, stress and drug resistance in plants and microorganisms to be in important research areas. However, the topics are diverse, the size of the research team small (at present 4 persons) to keep a scientific depth in all areas and the strategy to achieve societal impact diffuse. should be noted that there is potential to have impact on societal challenges, for instance with regard to understanding the mechanisms of action of anticancer drugs and their degradation.

Although the UoA has considerable experience in collaborating with stakeholders and is thus aware of the special challenges that must be overcome in order to establish a successful collaboration, the network with certain stakeholders, for example those responsible for regulatory issues, is limited and there is potential for improvement.

#### Score for Impact Strategy

(ME) 3 (MM) 1

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

The UoA has demonstrated excellent collaboration with stakeholders in the society within the limited possibilities of this rather small UoA. From the examples provided in the case studies, it is clear that the UoA realizes the aspects that should be taken into account during collaborative processes with external actors such as defining clear goals, deadlines and very important, expectation for all parties involved in the beginning of the collaboration. A proof of their appreciation for the collaborative process is the completion of the tasks, including the implementation of solutions into innovation phase, and the graduation of several PhD students involved in the projects.

# 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

As mentioned above in different sections, this UoA has a great potential to collaborate with actors outside academia, given the breadth and depth of the research lines that have direct impact in several societal aspects. Despite the focus on fundamental knowledge, this UoA has shown vision on how to consolidate collaborations with external actors and willingness to do so. The expected outcomes were frequently reached and collaborations were successful. There is however a larger potential that remains to be explored within the Microbial Ecology and, more importantly, within the Microbial Metabolism group, for which no case study was presented and strategy to reach societal impact was diffuse.

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Society have substantially reduced financing or even stopped financing research and development units at Swedish Authorities. As Authorities still are responsible for interpreting and handling the various legislations in their field of expertise, as for example national and EU-regulations on environmental issues, the Authorities still have experts on risk assessment of environmental issues. The environmental risk assessment on regulated issues is generally internationally harmonized, and questions related to such risk assessments might require competence that individual specialists and researchers do not have. Therefore, a good collaboration with Authorities active in the area where this UoA is active might be useful. Such collaborations might be arranged by the researchers themselves or smoothened by the university hierarchy.

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 Panel/ Research
 Genetics, Molecular Biology and Physiology

 field
 Control

#### UoA Plant Molecular Biology

#### Introduction

#### General assessment of the Unit of Assessment

The UoA 480\_2 represents one of two units of the Department of Plant Biology, which is located at the Uppsala Biocentre. The unit consists of 6 professors, 1 senior lecturer, 1 associate senior lecturer, 14 researchers, 13 postdocs, 8 PhD students and 3 support staff. In the past 5 years the unit was remarkably successful in delivering on basic science with the aim for translation. The unit aims to deliver towards societal problems related to climate change, food security and energy production. They focus resources and talent in the research areas of genetics and epigenetics in plant development, diversity and plant defence.

The research is ambitious and the unit has operated with a multi-part strategy to achieve scientific output: • It recruits the best talents from within and outside the Department, and internationally.

• It contributes to high-quality education and training for both pre- and post-graduate levels, and promotes the career development of early stage project leaders.

• It engages to interact within the Department, the Uppsala Biocentre, through the Linnean Center for Plant Biology to make best use of available knowledge and resources, create novel collaborations, and raise international visibility under the umbrella of the Linnean Centre.

• It makes use of state-of-the art technologies (genome editing via CRISPR/Cas, next generation sequencing, high-throughput drug chemical screening, single cell harvest by laser capturing, etc.) available either at the Biocentre, the SciLife Laboratory, or other national platforms, and create novel approaches.

The unit is committed to deliver solutions to societal challenges. They cover many activities and outputs with impact for the society. This includes a significant level of science advocacy, for which the unit is to be congratulated. Furthermore, their case studies show good examples of successful collaboration with stakeholders.

### Panel - Section 1 Quality of Research

#### **1.1 Scientific Quality**

1.1a Comment on the scientific quality (depth and breadth of research profile, originality of ideas, choice of methods, scientific productivity, scientific impact, and prominence in the field of science) with emphasis on identifying strong research and successful research constellations.

The quality and quantity of the unit's scientific output, including 222 publications, during the past 5 years were found to be among the top rankings of Plant Biology Departments of Universities at an international scale. The unit has produced impressively and relevant scientific outputs. Unit project leaders were found to be leading scientists in plant biology, having made significant breakthrough discoveries and innovations in the research areas development, diversity, and defence. Their research stands out for continued publication in the highest ranked journals internationally, including Nature, Nature Plants, Dev Cell, eLife, PNAS, Genes & Development. The publications demonstrate that they are clear leaders in their field. Significantly, the excellent publication output was achieved across project leaders strengthening the Department as a whole.

Overall research publication metrics revealed that UoA 480\_2 project leaders were not only highly productive, but they were most highly cited, with around 30 citations per publication and 4.9% highly cited publications, indicating that the unit's discoveries have had a major impact. These outputs compare UoA 480\_2 favourably to other Universities in plant biology i.e. UC Davis and Wageningen, yet, overall publication productivity is lower. However, the unit aims at scientific quality not quantity per se. Collectively, the publication record of the unit leaves little doubt about the scientific quality of the unit and impact in the field.

The unit has been very successful in sourcing significant levels of external funding over the past 5 years to support research with a total of 75,4 MSEK. Unit project leaders (Köhler, Melnyk, Gill, Sundberg, Moschou, Hofius) made impressive strides toward securing competitive funding, including two KAW awards, one FORMAS grant, four grants from the Swedish Research Council, and one award by the Göran Gustafssons charity. The unit also strives to secure ERC grants, and 3 ERC starting grant applications were successfully evaluated at stage 1. The number of research awards received by the unit project leaders attest to their standing in the field.

#### Score for Scientific Quality

6

#### **1.2 Scientific Environment and Leadership**

1.2a Comment on how the UoA manages to maintain a creative, intellectually vigorous and productive environment. Comment on the level of diversity within the unit in terms of gender and the balance between senior and junior faculty. Comment on the degree of external influence through international recruitment, mobility, etc

A strong indicator of UoA 480\_2 leadership is the creation of the Linnean Centre for Plant Science in Uppsala currently directed by the head of department. In a collaborative effort across SLU and Uppsala University, unit project leaders made an important positive development that resulted in the Linnean Centre for Plant Science to market excellent plants science that led to higher international visibility and recruitment of the best talents. The unit also advocates and communicates with the society through the Linnean Centre.

The unit has remained a good age balance across professors, and with a good balance to younger faculty. Gender balance is good at the level of PhD and postdocs but falls short for researchers, senior lecturers and professors having a male dominance. The unit promotes dual careers, a process which recently led to the successful recruitment of a female associate senior lecturer.

Success of unit and future sustainability of scientific excellence was concluded to result from consistent recruitment such as the recent attraction of four high potential associate senior lecturers, one of which as extension senior lecturer to promote societal impact. Together with a significant number of research exchange visits, it has positioned the unit to maintain a high level of a creative and productive research.

1.2b Comment on how the UoA supports young faculty and encourages their development into independent researchers.

The unit stands out is with respect to student training through actively supporting Docentship education, thus ensuring the best quality of PhD supervisor. PhD students are embedded on the Research School "Organismal Biology" facilitating knowledge exchange and collaborations.

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Financial support is provided to early career stage scientists enabling the hosting of scientific leaders in the field and attendance of international conferences. The unit is fully embracing in promoting early career stage scientists through successful nominations to fellow grant programs, encouragement and support of young project leaders.

Early career scientists are supported by mentorship i.e. to apply for highly competitive funding such as the ERC, of which 3 are now going forward to interview stage. Early career scientists within the unit were encouraged to apply for positions that resulted in promotion to senior lecturers, in addition to novel recruitments from abroad. Significantly, the unit promotes project leaders through start-up packages to enable their independent research programs.

# 1.2c Comment on the geographical scope and character of the academic networks and collaborations, and how the unit impacts the scientific debate in its field

The UoA 480\_2 runs an extraordinarily collaborative research environment. The unit actively promotes interactions through the Linnean Centre for Plant Science bringing together plant biologists within and outside SLU. Unit project leaders are also actively engaging in EU wide collaborative initiatives such as the COST Action. These strong collaborations have not only led to 40 joint publications, but also to several awards for collaborative research including a joint KAW grant.

### 1.2d Comment on the depth and breadth of the interdisciplinarity of the research unit. Comment on whether synergies between different UoAs at SLU are being developed to their full potential.

The diversity of focus research areas (development, diversity, defence) has resulted in a highly interdisciplinary environment across scientific projects and technologies. The unit has also been an active contributor to the interdisciplinary programs BarleyFunFood, BioSoM and Future Agriculture, collaborative programs across SLU.

#### Score for Scientific Environment

#### 6

#### **1.3 Strategy for Scientific Development**

1.3a Assess the UoA's strategy for scientific quality and in particular for scientific renewal. How insightful and realistic is the strategy?

The main vision of the unit is to perform world-leading plant research in the focus research areas and to contribute to high-quality education and training at both pre- and post-graduate levels. The goal is to promote research, education and innovation in for sustainable feed, food and fibre production, strategically important research areas.

The unit has developed solid plans that favour continued scientific excellence and productivity. This will be achieved by recruitment aiming for the best talents and outstanding early career project leaders, as well as by acquisition of state-of-the-art instruments to drive technological development, both are highly relevant.

The unit has already made extremely valuable contributions to the pioneering and development of these novel technologies, enabled through shared facilities and platforms at the Biocentre, the SciLife Laboratory and as national capacity centres. UoA 480\_2 is fully engaged in attracting funding for the establishment and/or upgrading of these facilities.

# 1.3b Comment on the plans for future research directions and the units potential for making significant contributions within these

The unit has a solid plan to achieve world-leading research in the focus research areas development, diversity and defence. They will follow a three-part strategy:

- Continue to recruit the best talent (people).
- Continue to develop state-of-the-art technologies (research infrastructure).
- Continue to promote within and outside collaborations (integration and network potential).

This people and technology-driven strategy will maintain a creative and productive environment, fuelled by a collaborative environment, and in the longer term will deliver to society. Due to the anticipated climate change, the Swedish agriculture and forestry sector are facing several novel challenges from biotic and abiotic factors. The upcoming climate change will increase the need for collaboration between experts from different areas, and world-leading plant research will be needed to tackle these global challenges.

# 1.3c What are the most important challenges for further successful scientific development (internal as well as external factors)?

The unit needs to be in the position to continue recruit external talent while at the same time provide career development for internal talent, and if necessary a pathway to maintain attractive for full professors preventing them from accepting abroad offers.

Overhead costs (63%) are not covered by most international (and Swedish) grants, which leaves the unit in a financially difficult situation. For example, if any of the 3 ERC starting grants will be successful, the unit/Department will be under financial pressure, as ERC grants do not bring 63% overhead costs.

#### Score for Strategy for Scientific Development

6

#### **1.4 Additional comments**

1.4a Comment on other issues of choice that SLU should consider at a strategic level.

The Linnean Centre for Plant Science as currently deployed as excellent marketing instrument needs careful attention for sustainability. The unit needs to continue to identify sources of funding to support the Linnean Centre aiming to maximize potential impact for education and collaboration with society.

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The unit's scientific leadership should develop clearer articulation of their scientific strategy consistent with expectations for societal impact and along SLU mission. The unit should continue to identify and develop their innovation potential accordingly. These could include:

- Adjunct Professorships in new areas the unit has identified as a potential novel research focus (i.e. Computational biology).
- Formulized University/Institute partnerships for driving technological developments (i.e. Microscopy) and student training (i.e. international placements of PhD students).
- Formulized Industry partnerships for driving societal impact and training students in areas relevant for industry/economy (i.e. PhD student placements).

### Panel - Section 2 Societal Impact of Research

#### 2.1 Activities and Outputs

2.1a Given the UoA's current research profile, is the full potential for societal impact realized in terms of activities and outputs (methods, productivity, range and relevance of stakeholders, etc.)?

The main challenge for research in applied and basic research is the potential societal impact of the regulatory framework in the EU that governs the use of gene technology. The negative aura around genetic modification has shunned scientists away from using the possible best available research technology. The restriction in prospects for societal output has also reduced student interest in plant science. The unit has been very active trying to counteract this trend, and even forced the competent authority in Sweden, and our government to express their view on whether they find new genome editing technologies falling within or outside the definition on genetic modification. In 2015 the Board of Agriculture stated that based on the applications they so far considered these techniques do not result in GMOs as long as no transgenic DNA remains in the product. The department invests in an extension lecturer in biotechnology with a specific focus on gene technology. This lectureship has allowed the department to become one of Sweden's most trusted institutions when it comes to policy issues and a general source of information regarding agricultural biotechnology and demonstrates the true societal engagement of the unit.

UoA 480\_2 has also strongly engaged with generating impact in agriculture through translation. Prof. Sun has published the first low-methane rice, a unique innovation to mitigate methane emission, which was published in Nature and has received great media attention, was discussed by EU parliament members, won international awards and attracted external funding.

The unit has an extensive amount of activities and output directed towards different target groups. Through their engagement the group has contributed to societal impact of their research. The type of activities mentioned in the self-assessment should continue and can also be increased.

#### Score for Activities and Outputs

#### 2.2 Outcomes

2.2a Comment on the outcomes of the unit's research, given their current profile and scientific quality. Is the full potential for societal impact realised in terms of outcomes, as far as the UoA could affect it? The case studies serve as a set number of examples on how research within the UoA has been realised in terms of societal impact.

The case studies "Mitigation of methane emission from rice", "Genome editing using CHRISPR/Cas9" and "Bypassing hybridization barriers" show examples of valuable outcomes of the research. UoA 480\_2 has given recommendations to farmers through Swedish Board of agriculture how to control virus diseases. They have coordinated the strategic research agenda "Plant Biotechnology for a bio-based economy. An industrial PhD project regarding soil-borne pathogens on oilseed rape, sugar beet and clover has been run in collaboration with Eurofins. A project on early cone-setting in Norway spruce has been run in collaboration with Skogforsk and seed orchard owners.

The outcomes from the unit has been good, but it is the stakeholders that must put the results into operation and this is mainly out of what the unit can affect.

#### Score for Outcomes

3

#### 2.3 Impact strategy

2.3a Comment on the UoA's strategic goals for societal impact. How realistic is the strategy given the depth and breadth of the unit's research profile? Are incentives and measures sufficient for implementing the strategy?

The unit's strategic goals are ambitious. The overall goal is to promote research, education and innovation for sustainable feed, food and fibre production.

To achieve high agricultural and forestry production while at the same time ensuring the sustainable use of natural resources, increasing greenhouse gas uptake, develop systems to reduce greenhouse gas emissions and reduce nutrient losses and release of nutrients due to water runoff is a challenge. Due to anticipated climate changes, the Swedish agriculture and forestry sectors are facing several novel challenges from biotic and abiotic factors. There is also increasing problems with plant pathogens and insect pests that mainly arise due to decreasing days with frost.

The unit has strong competences in many areas of plant science, including genetic and epigenetic regulation of plant development, quality and production, as well as of plant responses to biotic and abiotic stress. These are areas of importance for the development of new varieties of crops and trees having a better adaptation to environmental changes, and improved quality and production.

The research of the unit has many goals. One of them is to breed new varieties of traditional rice that have been estimated to very efficiently mitigate greenhouse gas emissions. Other goals are to exploit novel mechanisms (e.g. autophagy) for developing disease resistance in crops that can help reduce the use of pesticides and increase sustainability of pest management (see case study on sugar beet resistant to rhizomania), and to develop new breeding technologies easing the introgression of traits from ancestral varieties to modern crops by employing epigenetic mechanisms (see case study 3). Unit project leaders have strong expertise in these research directions that will be transferred into practical applications. The unit needs to continue the dialogue with industry to deliver on societal problems.

Project leaders also need to be on mission to explain the usefulness of applying new technologies such as those involving genetic modification to safely develop plant varieties with traits suitable for the future environment.

#### Score for Impact Strategy

2

### Panel - Section 3 Capacity for Collaboration with Society

#### 3.1 Collaboration

# 3.1a Comment on the UoA's approach to collaboration with society. Give your impression on their understanding of the collaborative process (factors affecting collaboration, importance of mutuality, dialogue, etc.)

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The unit has a good understanding of the collaborative process with industry and society. Main challenges in breeding are the regulatory framework that governs the use of gene technology both in agriculture applications and in basic research. The lack of public acceptance has influenced national and international funding agencies making it difficult to receive funding for research that involves the use of genetically modified plants. The department has identified this and invested in an extension lecturer in biotechnology with specific focus on gene technology. UoA 480\_2 is one of Sweden's most trusted institutions when it comes to policy issues and general source of information regarding agricultural biotechnology.

A successful collaboration with the society requires a dialogue with the relevant stakeholders. Well defined goals and expectations among partners are important for success. It is also important with mutuality to create a win-win situation. The unit has the capacity to work closer with the society and solving practical problems will also raise the skills at the department. Joint goals should be formulated together with the stakeholders at the start of a joint project. Furthermore, the project should have a well-defined description of the problem to be successful.

### 3.1b Give the panel's recommendations on how the unit can develop their capacity for collaboration with actors outside academia.

- Advisory groups at the unit to get new ideas and to help prioritise research important for the society.
- Industrial PhD students can be a way to increase the cooperation between the university and institutes, companies or other organizations. This will increase skills at collaborating partners, both for academic researcher that get better understanding of practical problems and stakeholder's acceptance for academic research.
- Adjunct researchers and professors may be a way to increase the cooperation between the university and different stakeholders.
- Exchange of staff between academia, institutes, companies, authorities for shorter periods. This can also give access to research material, field trials etc.

A problem may be that solving practical problems often do not give academic qualifications.