1st SILVA doctoral student conference of the Faculty of Forest Sciences May 31st – June 2nd

Conference schedule (PO Bäckströms aula at SLU, Umeå)**:**

31 May

12:00 Registration and lunch
13:00 Welcome and keynotes: ***Alexander Hasgall,*** *European University Association, Council for Doctoral Education, and* ***Dimitris Athanassiadis,*** *SLU:* European legislation and drivers for sustainable forestry
14:00 Mingling
14:30 ***Emily Delin:*** Modelling Forest Disturbance in Sweden - Risks under a Changing Climate
15:00 ***Rebecca Larsson:*** Towards integrated pest management in forest nurseries
15:30 Mingling and fika
16:00 ***Kristina Berggren Nieto:*** Combining new methods for increased plant protection
16:30 ***Patrik Ulvdal:*** The use of uncertain information in the hierarchical forest planning process

June 1st

09:00 ***Therése Strömvall:*** Establishment and management of a mixed conifer forest - with focus on Scots pine and Norway spruce
09:30 ***Keeli Curtis:*** Tensions in Swedish Forestry Advisory Services
10:00 Mingling and fika
10:30 N***ora Sophie Pohl:*** Managing stand structure to restore mixed oak-dominated forests for conservation of biodiversity
11:00 ***Teresa Fustel:*** Reduction of storm damage susceptibility in the forest by using spatial optimization in forest planning
11:30 ***Benoît Gozé:*** Model-based inference for abundance estimation using presence/absence data from large-area forest inventories together with covariate data from remote sensing
12:00 End of conference and lunch
15:00 Barbeque at Skogis Kårhus!

June 2nd
Excursion with Future Forests (only for those already registered for the excursion with Future Forests)

SLU
SILVA – RESEARCH SCHOOL
FACULTY OF FOREST SCIENCES

Modelling Forest Disturbance in Sweden: Risks under a Changing Climate

Emily Delin
Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences, Alnarp, Sweden.
Email: emily.viola.delin@slu.se

Background

Several types of natural disturbance are expected to increase in both frequency and severity under new conditions created by climate change. These disturbances (e.g., wind, fire, drought, and pests) can cause mortality and therefore economic loss in forest stands. There is also a potential positive feedback loop dynamic to these disturbances, where damage by one event can create more mortality instances from a following disturbance of the same or novel type. Direct anthropogenic influence on forest vulnerability occurs through management activities such as thinning and harvesting. In order to sustainably maintain ecosystem service accessibility in forest stands, we must understand what makes them vulnerable to said disturbances and how growth is impacted. There is much uncertainty regarding what the future holds for climate and weather conditions, and it is unclear whether current common management styles will be appropriate under anticipated conditions. Therefore, we need tools that allow for continuous input of up-to-date information and testing of different scenarios to allow for updates as knowledge and circumstances change. Modelling provides pathways to both of these important aspects, showing the current state of interrelations in a system and aiding prognoses accordingly. Throughout this project we aim to better understand the risks to forests in regards to climate change and disturbances in Sweden and create a useful tool for decision making. With this, thoroughly informed choices can be made for management activities throughout the stand rotation based on owner objectives. This information can also aid in the creation of policy and regulations regarding forest management.

Methods

My project will consist of four chapters focusing on different disturbances that commonly affect forests in Sweden: i) wind: using Swedish National Forest Inventory data, stand and landscape vulnerability to wind damage and mortality will be modelled based on a range of factors such as distance and angle to edges, time and strength of thinning, and site characteristics, ii) fire: historical maps and fire data will be used to model forest fire spread in the landscape to determine the role of broadleaf presence on the suppression of this disturbance, iii) drought: a variety of measurements have been collected in Norway spruce (*Picea abieas*) stands in Asa experimental park since 1992, this data along with new measurements will be used to model drought impact on young Norway spruce stands in southern Sweden, and iiii) synthesis of disturbance models with bark beetle as a case study: integrating the disturbances investigated in the preceding studies, one or more models will be created to predict the effect of different management strategies on forest production and growth under these risks and following consequences. Using statistical and GIS software (R and ArcGIS, respectively), disturbances will be modeled on a spatial scale ranging from plot to landscape level. Data will be sourced from the National Forest Inventory and SLU experimental sites.

Results and Conclusions

I began my work on this project in January 2022, so there are not yet any results or conclusions. We look forward to being able to present these in the future.

Towards integrated pest management in forest nurseries

Rebecca Larsson
Department of Forest Mycology and Plant Pathology, Swedish University of Agricultural Sciences, Uppsala, Sweden.
Email: rebecca.larsson@slu.se

Background

In Sweden, about 400 million forest tree seedlings are produced annually and are primarily cultivated using a container system. In this system, intensive management practices may stress seedlings, thereby creating favourable conditions for the establishment and outbreak of fungal diseases. Fungal infections can have a high economic impact, and these are often controlled with different management methods including cultural and fungicidal applications. Better knowledge about local fungal communities, especially common pathogens, would improve preventative and directed control methods and ultimately reduce the use of chemical treatments. The overall goal with this project is to generate new knowledge and competence on integrated pest management (IPM) in Swedish forest nurseries. IPM includes several components and address aspects of pest management options, knowledge gain, monitoring, and timely action to prevent and control pests. The project includes four study areas: 1) introduction of fungal pathogens through seed material, 2) local spread and distribution of fungal pathogens, 3) fungal communities associated with nursery-grown *Pinus sylvestris*-seedlings, and the effect of microbial treatments on seedling growth and disease control, 4) in-depth study of populations structure and fungicide resistance in the nursery pathogen *Phoma herbarum*.

Methods

Fungal communities were obtained from: 1) seed material collected from geographically separated seed orchards (both Swedish and non-Swedish origin) of Norway spruce (*Picea abies*), Scots pine (*Pinus sylvestris*), Siberian larch (*Larix sibirica*), and Douglas-fir (*Pseudotsuga menziesi*), 2) filter papers collected weekly during 2020 and 2021 from spore trapes located at five geographically separated forest nurseries, and 3) needles and growth substrate from *Pinus sylvestris*-seedlings applied with four microbial treatments during 2019. Seedlings subjected to microbial treatments were planted in a southern and a northern area in Sweden during autumn 2019 and spring 2020 and sampled for needles to follow changes in fungal community after freeze storage and out-planting. DNA was extracted from collected samples, followed by amplification with fungal-specific primer-pairs and high-throughput sequencing of the ITS2 region. Sequences were filtered for quality and clustered using the SCATA sequencing pipeline and fungal OTUs were taxonomically identified through GenBank (NCBI) database. Isolates of *Phoma herbarum* were cultivated from diseased *Pinus sylvestris*- and *Picea abies*-seedlings collected during 2021.

Results

Results from study 3) showed large changes in fungal community composition over time (MANOVA, $p<0.0001$). Common fungal species occurred differently among the nurseries, suggesting a potential geographical variation. The fungal pathogens *Phoma herbarum*, *Cladosporium sp*., *Sydowia polyspora*, *Botrytis cinerea*, and *Alternaria alternata* were among the most abundant species. However, a low number of disease incidents were reported throughout the whole study period (overall infection rate < 0.6%). Microbial treatments were not found to impact seedling growth or survival, nor the fungal community structure or species composition.

Conclusions

This project provides information about fungal communities associated with *Pinus sylvestris* and *Picea abies* seedlings, and occurrence of common pathogenic species within and around forest nurseries, which will be useful to improve disease control strategies.

Combining new methods for increased plant protection

Kristina Berggren Nieto
Department of Ecology; Forest Entomology Unit. Swedish University of Agricultural Sciences, Uppsala, Sweden.
Email: kristina.berggren@slu.se

Background

Utilizing plants with enhanced resistance traits in plant protection is gaining interest when chemical pesticides are being phased out and new sustainable methods are needed. The plant defence signalling hormone methyl jasmonate (MeJA) has recently been proposed as a novel plant protection method since exogenous application of MeJA induces plant defences and has been shown to be effective against damage by the pine weevil, one of the major forest regeneration pests in Europe. Another recent finding shows that Norway spruce seedlings propagated through somatic embryogenesis (SE), an *in vitro* mass clonal propagation technique, display higher resistance against the pine weevil than regular spruce seedlings (Puentes at al. 2018). Due to the higher resistance seen in SE seedlings, MeJA being an alternative plant protection method, and an increasing interest in producing SE plants for commercial use, it is timely to examine the effect of SE in combination with MeJA.
In this study, we examined the effects of MeJA treatment on seedling resistance (and survival), comparing SE seedlings (emblings hereafter) and regular nursery seedlings. If SE plants are primed or induced during production, a second stimulus from MeJA could provide an even faster or greater onset of defenses relative to non-SE plants. Alternatively, SE plants could already be expressing greater levels of defense, and treatment with MeJA would elucidate no further response in SE.

Materials and methods

Plant material consisted of 528 1.5-year-old Norway spruce seedlings, 124 larger 3-year-old bare-root seedlings, and 652 ~1-year-old emblings, of which half were used in a field experiment (clear-cut) and the other half in a non-choice lab experiment (9 rounds). Half in each experiment were sprayed with 10 mM MeJA ~1.5 week prior to the experimental start. Pine weevil damage (total area debarked per plant and girdling) was scored 3 and 11 weeks after planting in the field, and after each round in the lab. Mortality was recorded after 11-weeks in the field.

Results

MeJA treatment on emblings resulted in higher resistance and survival than both the non-treated and MeJA-treated seedlings and to some extent also the bare-root seedlings. In the field, MeJA-treated emblings decreased stem damage with 86% and girdling rate and mortality with 98% compared to the control. In the lab, stem damage was decreased 48%. Results also indicated that the effect of MeJA on SE is similar to the effect of MeJA on larger plants since the MeJA-treated emblings showed a similar response as the MeJA-treated bare-root seedlings.

Conclusions

Results showed that the effect of MeJA on seedling resistance and survival differed between SE and non-SE plants, indicating that SE is compatible with (other) plant defense inducing strategies. Both can separately and similarly increase plant resistance against the pine weevil, but together they can enhance resistance to an even greater level than each on their own. This gives the opportunity of forest regeneration using young resistant plants at a size convenient for planting, with higher likelihood of survival the first year when they are vulnerable and pine weevil pressure is the highest.

The use of uncertain information in the hierarchical forest planning process

Patrik Ulvdal[1*], Karin Öhman[1], Ljusk Ola Eriksson[2], Dianne Staal Wästerlund[1] and Tomas Lämås[1]

[1]Department of Forest Resource Management, Swedish University of Agricultural Sciences, Umeå, Sweden, [2]Department of Southern Swedish Forest Research Center, Swedish University of Agricultural Sciences, Alnarp, Sweden. Email: patrik.ulvdal@slu.se

Background

This qualitative study aimed to map what information is used in the forest planning process at large forest owning companies, how it is used, its level of uncertainty, and currently employed strategies to handle forest information uncertainty. An additional aim was to assess the status of the paradigm on the forest planning hierarchy in forestry.

Methods

We used data from semi-structured interviews with representatives of six large forest companies in Sweden. The total area in the sample represented more than 30 % (7.8 million ha) of the productive forest land in the country.

Main results

Our results show that the forest planning process is a hierarchical system of decisions where the information used in the different planning stages is of varying quality. All data supported the conclusion that the traditional hierarchical planning paradigm still plays a vital role in practical forestry. The most central source of information in the whole forest planning process is the forest stand database (forest inventory). Its information includes uncertainties arising from various sources, including subjective field measurements, aerial image interpretation and guessing. However, the use of remote sensing estimates to feed the registers is increasing, which will probably improve the overall quality of the registers. Another important finding is that forest companies tend not to use decision support systems or optimisation models to solve planning problems outside the scope of strategic planning; thus, most planning is done by hand, e.g. in a GIS. Furthermore, we identified six main strategies that forest companies employ to control or handle uncertainties in forest information: 1) lock the future by deciding on a plan that should be followed, which means that the company can forget about the uncertainties and pretend that the plan is certain. 2) utilise a buffer or extra inventory like the planning reserve to increase the degrees of freedom, making the plan more implementable. 3) control or update forest information that highly impacts the downstream planning process or production. Updating is done automatically, for example, with LIDAR estimates and manually as in the inventory by harvest area planners. 4) re-plan the actions in the immediate future to make up for differences between the plan and realised outcome. This strategy is the same as the concept of adaptive planning. 5) look backwards to decide the future, with the best example being how the companies procure harvesting resources by looking at the previous years' harvest levels instead of the contents of the tactical plan, and 6) ignore the uncertainty, either intendedly or unintendedly

Conclusions

The results from this study increase our understanding of contemporary forest planning practices and will be helpful in the development of decision support systems and methods for information collection.

Establishment and management of a mixed conifer forest
- with focus on Scots pine and Norway spruce

Therése Strömvall Nyberg
Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences, Alnarp, Sweden.
Email: therese.stromvall@slu.se

Background

Almost 70 % of Sweden is covered in forest. Roughly 40 % consists of Norway spruce and 40 % of Scots pine. With a lot of different species dependent on them, pine and spruce are not only important for habitats but also has a great economical value. The survival rate of seedling establishment is generally low, sometimes as low as 60 %. And even after a stand has been established, browsing, drought, storms and insect attacks are all threats that could potentially damage or destroy whole stands.

Establishment of mixed conifer forest, with both spruce and pine could potentially solve many of the issues for planted forests of today, eg: i) reduce the severity of forest damage on production, economy, habitat and stand development, ii) increase the chances of successful seedling establishment, iii) create a higher diversification of the landscape and iv) ensure sustainable timber supply for the future. However, with different growth cycles of the two tree species, we need more empirical data in how to stablish and manage mixed conifer forest.

Methods

I will conduct four projects during my time as a PhD-student, which will all evolve around establishment and management of young stands, and how the stands should be managed to promote a mixture of pine and spruce. I will establish trials in the field and then later on collect data through measurements. The projects I will conduct are;

i) a regeneration experiment, where two scarification methods will be compared together with the planting design of planted seedlings of pine and spruce.

ii) a pre-commercial thinning trial, with five different treatments evaluating the development of mixtures of pine and spruce.

iii) a revisit of a series of old mixed forest regeneration experiments using a combination of pine shelter woods for natural regeneration, and planting of spruce (the so called Drettingemethod in Swedish).

iv) a modified Drettinge experiment where the spruce seedlings will be planted during 1 to 3 years after scarification, in order to study which year after scarification would be preferable to plant if the objective is a mixture of pine and spruce.

Results and Conclusion

I started my doctoral studies in November 2021 so it is too early to say anything about either the main results or the conclusions. I will hopefully have something soon though to report.

Tensions in Swedish Forestry Advisory Services

Keeli Curtis
Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences, Alnarp, Sweden
Email: keeli.curtis@slu.se

Background

The core of Swedish forest policy is built on the concept of 'freedom under responsibility,' with few regulations on management practices. This is complemented by 'sectoral responsibility,' meaning the forest sector has a duty to ensure that best management practices are applied. The Swedish system relies fundamentally on informational policy instruments to meet policy targets, and both private and public actors provide advisory services to some extent. However, in recent years, the providers, extent, and format of advisory services have been changing. At the same time, there is an increasingly heated public debate regarding what purposes forests should serve and how forestry practices should develop. It is unclear how well existing advisory services are adapting to these pressures to apply new forest management practices. There is a great deal of research trying to categorize Swedish forest owners and their behavior, as well as how Swedish forest policies compare to other countries. There is a need to understand what kinds of information and advice guiding landowner decisions, and I study the related advisory services processes.

Methods

My work aims to fill the research gaps regarding advisory services in the context of forest governance. I focus on three closely linked challenges within advisory services, including the appropriateness of different types of services, the strengths and weaknesses of public and private advisors, and how the sector handles inherent scale conflicts in management goals. My research is organized based on the 4 dimensions of Lawrence et al.'s (2020) Forestry Knowledge and Information Systems (FOKIS) framework, which include forest owners, policy objectives, advice providers, and tools & processes. I also add a spatial element to evaluating advisory services from a landscape perspective. I expand Hägerstrand's nested domains framework and adapt it to the context of forestry governance. Using nested domains, I examine the abilities of different actors to provide different types of services and how effectively they can influence landowner behavior. I use qualitative methods to analyze these topics, including document analysis and semi-structured interviews with employees of the Swedish Forest Agency and private companies. Some overall goals of my work are to highlight scale mismatches between levels of forestry governance, management objectives, and ecological processes.

Managing stand structure to restore mixed oak-dominated forests for conservation of biodiversity

Nora Sophie Pohl
Southern Swedish Forest Research Centre, Swedish University of Agricultural Sciences, Alnarp, Sweden
Email: nora.sophie.pohl@slu.se

Background

Oak-dominated and mixed oak forest are widely distributed across Eurasia and North America. Their importance is attributed to their long lifespan, unique wood traits and in regards to nature conservation. Oak can be regarded as a foundational species that provides critical habitats for red-listed invertebrates, lichens, fungi, birds and microbes. Further, oak is highly interesting for production purposes such as timber, forage and firewood. Regardless of its importance, oak dominance is declining worldwide, putting oak-associated biodiversity and ecosystem services at risk. The main explanation for the decline in oak forests is failure in oak regeneration and its inability to establish into the overstory. So far, research has focused on influences, such as browsing and fire, on the early stages of natural regeneration of oak. However, not much is known about the stand and light conditions necessary for the regeneration layer to develop into the canopy. It is important to obtain new knowledge about pathways to prevent further habitat degradation and improve the rate of successful, natural regeneration for nature conservation.

Methods

To get a better insight into the recruitment of oak into the overstory, several projects will be implemented. In one study, a dataset from the permanent plots of the Swedish National Forest Inventory will be analysed for factors that influenced the growth and mortality of oak and the development of mixed oak forests from 1983 to 2020. Another study will include data from 2016 and 2019 from the TransForest project with field sites in Southern Sweden and Norway. In the TransForest project the interest is focused on the reaction of mixed oak forests to a selective cutting treatment compared to an unthinned treatment. New data for the natural regeneration of oak, the understory light conditions, as well as growth and mortality of oaks in the thinned and unthinned plots, will be collected in summer 2022. During a third study, 50 study sites will be established in 60- to 100-year old, oak-dominated forests in southern Sweden. Further establishment conditions will be a limited management during the past 20 years and an oak component higher than 20 % in the canopy. The measured stand structural attributes will be used to create a stand structural complexity index which can be compared along a gradient of site productivity and its influence on light availability. Additionally, on a subset of these sites the most favourable conditions for a successful recruitment of oak saplings into the canopy will be analysed. The overall objective of these projects is to analyse different stand structural complexity types in mixed oak-dominated forests and how they change along a gradient of site productivity, concerning light availability and regarding the recruitment of the regeneration layer of oak into the canopy.

Reduction of storm damage susceptibility in the forest by using spatial optimization in forest planning

Teresa Fustel, Jeanette Eggers, Tomas Lämås, Karin Öhman
Department of Forest Resource Management, Swedish University of Agricultural Sciences, Umeå, Sweden.
Email: teresa.fustel@slu.se

Background

In the last decades, natural disturbances have caused substantial timber damages in Europe. In Sweden, storms represent one of the most important disturbances with important timber damages annually. Climate change projections forecast increased average temperatures throughout the year as well as increased precipitations during the winter season for the end of this century and compared to today. As a result of this, the length of the soil frost period and its thickness, which contributes to reduce the risk of storm damage, is expected to be reduced by the end of this century.

Materials and methods

In this study, we present a new mathematical model to minimize forest exposure at the property level during a long planning horizon. The model minimizes the height difference between neighboring spruce stands in the forest property based on a user defined parameter, i.e. a user defined parameter was used to indicate the minimum height difference needed between two neighbor stands to consider a forest edge as vulnerable and therefore minimize it by the model. The user defined parameters used where 5, 10 and 15 m of height difference between neighboring stands. Forest exposure was only minimized for spruce stands due to their higher sensitivity to storm damages compared to other species. In the case study, we selected a forest property located in Southern Sweden with Scots pine and Norway spruce as dominant species. We investigated the trade-off between the net present value from wood production and the length of vulnerable forest edges in the property.

Results

The results show that small declines on the net present value can reduce largely the length of vulnerable edges in the property resulting in the clustering of stands with similar heights throughout the property. The model successfully decreased largely vulnerable edges for the three user defined parameters.

Conclusion

In conclusion, the presented model could be applied to similar planning problems where forest edges are relevant.

Model-based inference for abundance estimation using presence/absence data from large-area forest inventories together with covariate data from remote sensing

Benoît Gozé[1], Magnus Ekström[1], Göran Ståhl[1], Bengt-Gunnar Jonsson[2], Jörgen Wallerman[1], Saskia Sandring[1] and Jonas Dahlgren[1]
[1]Department of Forest Resource Management, Swedish University of Agricultural Sciences, Umeå, Sweden and [2]Department of Natural Sciences, Mid Sweden University, Sundsvall, Sweden.
Email: benoit.goze@slu.se

Background

Monitoring of plant populations has become more and more important, especially in this context of environmental crisis. It is of interest to many, including monitoring programmes, authorities, and even citizens, to get to know the state of biodiversity. In this paper, we investigate methods to estimate plant population size and density with help from presence/absence data. Presence/absence sampling is a useful and relatively simple method for monitoring state and change of plant species communities. Moreover, it has advantages compared to traditional plant cover assessment, the latter being more prone to surveyor judgement error. Some monitoring programmes already have a lot presence/absence data in their databases, and we believe more should be made out of it.

Methods

We use inhomogeneous Poisson point process models concerning plant locations, and generalised linear models (GLM) with a complementary log-log link function for linking presence/absence data to plant density. In these models, auxiliary covariate information coming from remote sensing (i.e. wall-to-wall data from SLU Forest Map and Skogliga Grunddata) are used. We estimate plant density for a selection of forest plants, as well as plot probabilities of presence of these species for parts of Sweden. The estimations of plant population sizes and intensities are made not only locally but also for larger regions. An estimator of the variance of the estimator of the expected number of plants in an area of interest is also proposed. For evaluating the estimators, we use both Monte-Carlo simulations, where we create artificial plant populations, and empirical data from the Swedish National Forest Inventory (NFI), coming from permanent sampling plots. We also develop a test for our models, to check the underlying Poisson point process model assumption (i.e. complete randomness and independence) and protect inference against model misspecification (i.e. our methods cannot be applied if this assumption is not met). The suggested hypothesis test is evaluated through Monte-Carlo simulations, with two variants used: chi-squared approximation and parametric bootstrap.

Main results

The Monte-Carlo simulations show that the actual levels of significance are quite close to the nominal (0.05) if bootstrap is used, contrary to the chi-squared approximation which produce levels which are too high. The power for detecting departures from a Poisson process depends on several factors, including distance between pairs of plots. Some models, for *Lysimachia europaea* and *Luzula pilosa* in the region of Norrbotten lappmarken for forested areas with at least 3-meter canopy height, could be produced and passed the Poisson test, whereas corresponding models for other plant species were rejected. Maps of pixel-wise estimated probabilities of presence can be created for the species that have passed the test, as well as an estimation of their plant densities and related variance estimation.

Conclusion

We showed that it is possible to estimate densities for some forest plant species if they respect the hypothesis of the Poisson point process model. Then, if a monitoring program has some presence/absence data, it would be possible to get more information out of these thanks to our methods.