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Abstract

The great bustard (*Otis tarda*) became extinct in Sweden during the mid-19th century. Globally, populations have suffered dramatic declines during the past two centuries. Recently, local populations have stabilized or increased after hunting bans and conservation efforts. Despite positive trends the species is still classified by IUCN as vulnerable (VU), mainly due to withdrawals in the distribution. The limited distribution emphasizes the need for finding “new” areas suitable for a translocation or reintroduction. This thesis investigates the history of the great bustard in Sweden and analyses suitable habitats, current bustard conservation methods, and socioeconomic impacts of a reintroduction. As a flagship species a reintroduction of the great bustard could induce conservation efforts and tourism in agricultural regions. Areas with potentially good habitat large enough to sustain a bustard population can be found in both Skåne and Öland.

Sammanfattning

Stortrappen (*Otis tarda*) dog ut i Sverige under mitten av 1800-talet. Även världs-populationen har drastiskt minskat under de senaste två århundradena tills nyligen. Idag har dock flera populationer stabiliserats eller ökat efter naturvårdsinsatser och jaktförbud, vilket gör att den totala världs-populationen är stabil. Trots delvis positiva populationstrender så är arten fortfarande rödlistad i kategorin sårbar (VU) eftersom artens totala utbredningsområde fortfarande minskar. När artens utbredning minskar så ökar behovet av att hitta ”nya” lämpliga återintroduktionsområden för att säkra stortrappens fortlevnad på lång sikt. Den här uppsatsen behandlar stortrappens historik i Sverige, aktuella naturvårdsåtgärder för stortrapp utomlands samt analyserar lämpliga habitat och socioekonomiska konsekvenser vid en återintroduktion av stortrapp. Eftersom stortrappen är en flaggskeppsart för öppna gräsmarker så skulle en återintroduktion kunna medföra fler naturvårdsinsatser och en ökad turism i de aktuella jordbruksområdena. Både i Skåne och på Öland så förefaller det som tillräckligt stora områden med lämpliga habitat finns för att kunna bära en stortrappspopulation.

Introduction

The great bustard has together with other wildlife populations been reduced or gone extinct in Europe during the past centuries. This can directly be associated to the human expansion and development exploiting more land and natural resources than before. However, today people are moving into cities as there are few jobs on the countryside when agriculture has been rationalized or abandoned in less fertile regions. This urbanization has enabled many larger mammals and birds to recover. Ironically, the biodiversity is simultaneously decreasing when the traditional less intensive agriculture practices vanishes. When arable land no longer is used for food production it is desirable that conservation efforts should maintain biodiversity. This can for example be done by preserving traditional farming practices and reintroducing species or "rewild" grazers (Vera, 2000; Bradshaw, 2002). Rewilding aims to restore ecosystem functions and processes on a larger scale by reintroducing species. Reintroducing or rewilding species will not only promote biodiversity but also create new tourism-working opportunities in rural areas (*rewildingeurope.com*, 2014). Both the Rio-convention and the European habitat and bird directives support reintroduction or translocation of threatened species to its former range when feasible. The bird directive also lists species that needs "special attention" such as the great bustard. This opens up the possibilities for regionally extinct or threatened species to be brought back within Europe and Sweden. Consequently, since the great bustard previously was breeding in Sweden, is an umbrella species, and listed in the bird directive it is relevant to consider a reintroduction in Sweden.

Legal responsibilities

The EU-habitat and bird directives are the foundation of conservation work within EU today. Mainly through a network of protected Natura-2000 and the SPA-areas in all member states.

"*the main aim of this directive being to promote the maintenance of biodiversity, taking account of economic ,social, cultural and regional requirements, this Directive makes a contribution to the general objective of sustainable development*" (*Habitat Directive*, 1992)

To achieve sustainable development the directive obligates the member countries to identify, protect, maintain, and restore habitats and species such as the great bustard listed in annex 1. Restoring a habitat or a species should be done when it is considered to be feasible taking into account the parameters quoted above (*Habitat Directive*, 1992, *Bird Directive*, 2009). These directives have been incorporated into the Swedish law (*Artskyddsförordningen*, 1999) and the government has set up environmental goals to reach sustainable development.

The Swedish government adopted 16 environmental goals to work towards sustainable development. One or two goals are predicted to be reached year 2020 as a result of the management control measures taken today (*Miljomal.se*, 2014). A reintroduction of the great bustard could promote and contribute to the progress of at least two environmental goals: "a varied agriculture landscape" (Ett rikt odlingslandskap) and "A rich diversity of plant and animal life" (Ett rikt växt- och djurliv). Both goals will however not be reached by 2020 (*Miljomal.se*, 2014). To reach the environmental goals by 2020 the conservation efforts taken needs to increase (*Miljomal.se*, 2014). To reintroduce the great bustard would

enlighten the need of conservation in the agriculture landscape and contribute to “a more varied agriculture landscape”. In addition of improving the situation for the great bustard the measurements would benefit other species, for birds as well as for other organism groups. Today 1461 species associated with the agriculture landscape are listed in the Swedish national red list (*Artfakta.se*, 2014) .

Background

Species Biology

The great bustard is the heaviest bird in Europe and one of the heaviest flying birds worldwide (Morales & Martín, 2002). The scientific name *Otis tarda* (Linnaeus 1758) means “bustard tread” or “bustard slow/deliberate”, possibly referring to the birds walking style (*nhm.ac.uk*, 2014). The bustard has an extreme sexual dimorphism in terms of size; males weigh up to 19 kg while females weigh up to 5 kg (Alonso *et al.*, 2009). The species has a height of 105 cm and a wing span up to 240 cm (Svensson *et al.*, 2009). The breeding-male’s head and upper neck is blue-grey with a dominant moustache, followed by a cinnamon colored neck and chest that gradually changes into a creamy white color on the paunch (Svensson *et al.*, 2009). As the males grow older the mustache grows and the colors become more intense (Alonso *et al.*, 2009). In contrast to the breeding-male, the female has no mustache. Also, the head is light-grey with a grey-yellow neck and often no cinnamon color on the lower neck areas (Morales & Martín, 2002; Svensson *et al.*, 2009)

The lek in northern Europe starts in mid-March and ends in late April (Cramp, 1980). The females starts breeding at an age of 2-4 years and males from the age of 5-6 years (Morales & Martín, 2002). The lekking area is large and males are spaced out at least 50 m apart; as the display season continues they move further away from each other. While males are displaying their spectacular balloon-dance, the females are wandering around feeding as they inspect the males (Cramp, 1980). The oldest and heaviest males are normally the top ranked and the female’s choice of males is weight-dependent (Alonso *et al.*, 2009). Once fertilization is completed the females disperse to nest within a few kilometers from the display-ground (Magaña *et al.*, 2011).

The females lay eggs directly in a nest on the ground. Females usually tend to aggregate in the same nesting area, in Portugal on average 1.4 nests/100 hectares in a total area of 36 700 hectares (Rocha *et al.*, 2013). A female lay 1-4 eggs; normally she lays about 2 eggs per clutch directly in a ground nest (Faragó, 1992; Rocha *et al.*, 2013). If the eggs are predated she can lay replacement eggs. Often the replacement eggs are of lower quality and some are not fertilized. The incubation time is around 24 days until hatching (Langgemach, 2013) and the female is exclusively responsible for the parental care (Alonso *et al.*, 1998).

The female takes care of her offspring for at least 6 months, this is also the most critical period for the chicks (Alonso *et al.*, 1998; Martín *et al.*, 2007). Martín *et al.*, (2007) found that only 29.9 % of the marked great bustards survived the first year and during the second year the human induced causes of death such as collisions or illegal hunting increased. When the parental care ends, juvenile males are the first to disperse (6 – 11 months) and will later settle down in lek areas 5 – 65 km from their natal site. Female juveniles leave their mothers after 8 – 15 months. Usually females settle within a few kilometers range

from their natal site and later participate in the same leks as they were bred in (Alonso *et al.*, 1998).

The bustards prefer open habitats where they can see far in at least three directions. Ideally the landscape should be flat or gently rolling (Morales & Martín, 2002). The habitats preferred by bustards are steppe-like grasslands to mosaics of agricultural fields; sometimes dried fens are used but they avoid wetlands, rocky terrain, and forests. It is of great importance that the habitat during breeding season is undisturbed and rich in arthropods (Morales & Martín, 2002). The great bustard also keep distance to human infrastructure such as roads, power lines, and settlements (Lane *et al.*, 2001). The great bustard has a high co-specific attraction. For example the bustards will gather in areas already used by other bustards, even though other areas with suitable habitat are available (Lane *et al.*, 2001). This behavior could limit the great bustards from colonizing new areas or recolonizing previously occupied sites.

The preferred nesting sites are situated in meadows, fallows, or cereal growing areas (see Table 1). An important criteria when the female selects a nesting site is the availability of bare soil (David Waters, pers. comm.) or short vegetation close to the nest (State of Brandenburg, 2009). Higher vegetation can provide cover for the female bustard while nesting but short vegetation enables the newly hatched chicks to move freely (State of Brandenburg, 2009). In localities with dense cereal farming, the great bustard prefer fallows while other areas with sparsely sown cereal is favored instead of fallows (Rocha *et al.*, 2013). The population that remained in Sweden during the first half of the 19th century preferred to nest in sandy cereal fields with rye (Nilsson, 1858).

Table 1 Nesting habitat preference (%) of great bustard in three different countries: Portugal, Hungary and Russia.

Country		**Habitat (%)**							**Source**
		Fallow	Black fallow	Cereal	Plought	Lucrérne	Meadows	Other	
Portugal (Castro Verde)	%	51.5		28.7	3.9			2.9	(Rocha *et al.*, 2013)
Hungary	**%**			5.5		50.1	33.1	6.8	(Faragó, 1992)
Russia (Saratov)	%		38	53				9	(Watzke, 2007a)

During winter individuals aggregate in larger flocks on agricultural fields, mainly oil-seed rape, stubby fields, fallows, and cereal growing areas; essentially where they can find food. According to experiences in Germany it is enough with a “few fields” to sustain the bustard population there during the winter (State of Brandenburg, 2009).

The overall diet of great bustard consists of 90 % plant material (except seeds), 7 % invertebrates, and 3 % seeds (Lane *et al.*, 1999). During summer up to 40 % of the diet consists of arthropods, otherwise it includes mainly green plant material (Lane *et al.*, 1999). Bustards mostly eat the leafy plant parts and occasionally flowers and stems (Bravo & Ponce, 2012). Throughout the autumn the fraction of plant matter and seeds gradually

increases and during winter the diet almost exclusively consists of plant matter (Lane *et al.*, 1999). The German bustard population can withstand a whole winter with just oil-seed rape (*Brassica napus*) as food source (State of Brandenburg, 2009). Especially important bulk plants identified in northern Spain are: alfalfa *Medicago sativa*, grasses (*Gramineae*), corn poppy *(Papaver rhoeas*), grape *Vitis vinifera*), (*Spergularia spp*), narrow clover (*Trifolium angustifolium*), camomilla tomentosa (*Anacylus clavatus*), shepherd's purse (*Capsella bursa-pastoris*), purple viper´s bugloss (*Echium plantagineum*), and white wall rocket (*Diplotaxis erucoides*) (Lane *et al.*, 1999).

In contrast to the adults the chicks are mainly feeding on arthropods (Bravo & Ponce, 2012). The arthropod diet consists mainly of the three orders *Orthoptera* (69 %, grasshoppers and crickets), *Hymenoptera* (18 %, sawflies, wasps, bees and ants), and *Coleoptera* (~10 %, beetles) (Lane *et al.*, 1999). The young males grow faster as they consume larger volumes (Bravo & Ponce, 2012) and already after three weeks there is a noticeable size difference between the sexes (Alonso *et al.*, 2009).

The migration behavior of the great bustard varies from annual migration to facultative to stationary, depending on the population. In the Russian Saratov region individuals migrate up to 1100 km to reach south Ukraine during winter. However, individuals are wintering in Saratov as well and it is not clear if those birds are arriving from other regions or if they are residential (Watzke, 2007b). In central Europe the pattern is different; longer migration usually only take place during harsh winters when the snow cover restricts food availability forcing the birds to move (Morales & Martín, 2002). Great bustards seem unwilling to migrate after January despite snowfall, possibly due to the upcoming breeding season (Morales & Martín, 2002).

The great bustard populations in Iberia show different migration behaviors; one group of sedentary males staying around the lek and others moving from the lek to post-breeding areas, showing strong yearly fidelity to both areas (Morales *et al.*, 2000). The females also have a strong fidelity and seasonal movements. (Alonso *et al.*, 2000). Palacín *et al.*, (2011) also concluded an age related migration tendency to post-breeding areas in the province of Madrid (up to 180 km for the males and 110 km for the females). A successful wintering in a favorable post-breeding area can easily become an annual wintering area (Glutz von Blotzheim *et al.*, 1973 in Morales & Martín 2002).

The inherited migration instincts seems to be transferred by mother to offspring or shaped by social transmission (Palacín *et al.*, 2011). Migratory behavior has been documented as flexible trait in other species as well (Sutherland, 1998). Young (Iberian) females learn the migration-behavior from their mothers during the first year or from other migratory females during the second year. In every age cohort, 15 -30 % of the females changed wintering ground between years (Palacín *et al.*, 2011). Males learns from other adult males rather than from their mothers (Palacín *et al.*, 2011).

Status

The world population of the great bustard (*Otis tarda*) is today estimated to be between 43500 - 51200 individuals. The species has a wide distribution within several countries (Fig. 1) and the main populations are in Spain, Portugal, Russia, China, Mongolia, and Hungary (Palacín & Alonso López, 2008). The species has suffered a rapid decline all over its range and has gone extinct in more than 20 countries since the beginning of the 19th

century (Szabolcs, 2009). Today the rapid population decline has stopped. Instead local populations stabilized or increased, often after conservation efforts and hunting bans. The populations are today more aggregated and the geographical range of the species is still decreasing (Palacín & Alonso López, 2008). Despite some positive trends during the past decade the species is classified as vulnerable (VU) on the IUCN-red list (Bird life International, 2013).

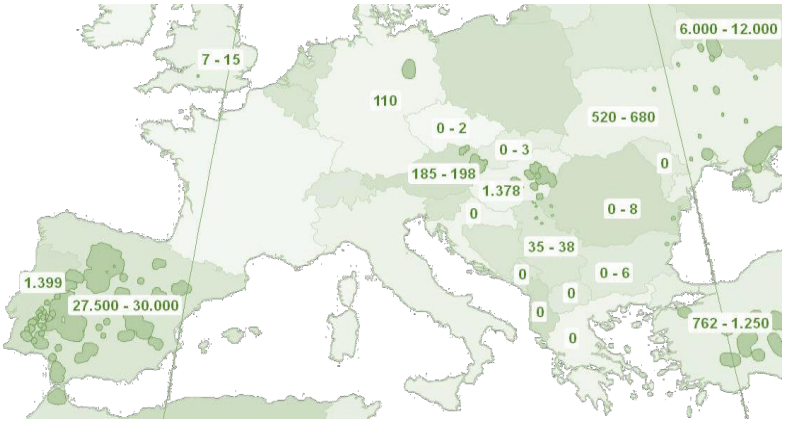

Figure 1 Great bustard distribution and population estimates (2008) within Europe (Modified from. http://www.grosstrappe.at/en/great-bustard/distribution-and-population.html, downloaded 2014-11-10).

Conservation concerns and measures

There are nine concerns identified in the international action plan for the great bustard (Szabolcs, 2009). All issues are briefly presented along with suggested measures to be taken, in the following nine paragraphs:

1. *Loss of undisturbed open habitat with suitable vegetation structure*

Intensification of the agriculture regime reduces the open and extensively used farmland favored by the bustard (e.g. cereals, rape-seed oil and vineyards) (Lane *et al.*, 2001; Langgemach, 2008; Palacín *et al.*, 2012). Firstly, the use of fertilizers (State of Brandenburg, 2009; Taylor, 2011) and the cultivation of "new crops", like corn or sunflower (Palacín *et al.*, 2012), increase biomass production but reduces the availability of a short vegetation structure necessary for the chick rearing (State of Brandenburg, 2009). Higher densities of cattle is increasing the risk of trampling. Secondly, the fragmentation of the habitat has increased by afforestation as well as by the expansion of infrastructure (Lane *et al.*, 2001; Szabolcs, 2009). The fact that the great bustard generally keeps a distance to infrastructure and connective tree lines reduce the available habitat as these features expand (Lane *et al.*, 2001; Osborne *et al.*, 2001). Loss of habitat is considered to be one of the main reasons for the decline of the species (Szabolcs, 2009).

To mitigate the present agriculture intensification it is firstly important to continue with traditional and extensive farming (Palacín *et al.*, 2012). In addition, reversing stripes of farmland into permanent organic grassland, bare soil or a short nectar rich vegetation favors both arthropods and bustards (Taylor, 2011). In addition it is also necessary to stop afforestation and to remove trees in bustard habitats (Langgemach, 2014).

2. *Collision with power lines*

The great bustard is a poor flyer and can easily collide with power lines (Janss & Ferrer, 2000). Collisions could be critical especially for local populations (Szabolcs, 2009) when power lines are placed close to or on the route to a breeding-, feeding- or a wintering-ground (Raab *et al.*, 2012). In Spanish sub-adult animals, 55 % of the deaths were caused by power lines and it is believed to be the main reason for adult mortality as well (Martín *et al.*, 2007). Janss and Ferrer (2000) found that annual mortality of the great bustard was 0.9 – 3.9 % in a local Spanish population, corresponding to 1.58 – 4.02 bustards per km power line. Underground cabling eliminates the collisions and marking of the power lines reduce the collision risk. Medium voltage power lines are economically reasonable to bury, while larger overhead power lines are more cost efficient to mark out (Raab *et al.*, 2012).

3. *Destruction of eggs and chicks during agriculture field practice*

The great bustard is sensitive to agriculture activities because the preferred nest site lies in agriculture fields (Szabolcs, 2009). Fields that are being mowed or harvested before the chicks can flee will act as "death traps" for the young chicks (Rocha *et al.*, 2013). The percentage of nests being destroyed is between 15 % (Spain) - 35 % (Hungary) (Szabolcs, 2009; Rocha *et al.*, 2013). It is not only the nest that is destroyed, also the sufficient shelter that higher grass offer, decreases after harvest. Less vegetation cover is known to increase the predation risk in other bird species (Götmark, 2002). This "death trap"-phenomenon was already mention by Nilsson (1858) even though the agriculture was much less mechanized then. This is a clear conflict between rational agriculture and the life history of ground nesting birds in farmland habitats. However, it is possible to adapt agricultural activities by working early in the season or not working in a field for longer periods (>10 weeks), or delaying the harvest (*grosstrappe.at*, 2014). Another alternative is to protect nests from being destroyed by agriculture work by marking out buffer zones. In Hungary protection zones larger than 900 m^2 around the nest seems to be most successful. When the zone is smaller the female will be more likely to abandon the nest or predation will increase (Demeter *et al.*, 1994). In Germany squares of 100 m x 100 m are being used for the moment but if possible the squares will be enlarged to 250 m x 250 m (Dorothee, 2014).

4. *Predation*

Predation of eggs and chicks is frequent (Martín *et al.*, 2007; Langgemach, 2008; Rocha *et al.*, 2013). The main predators are red fox (*Vulpes vulpes*) and corvids. Other known predators are the badger (*Meles meles*), the raccoon-dog (*Nyctereutes procyonoides)*, mustelids (*Mustelidae*) and the white-tailed eagle (*Haliaeetus albicilla*) (Langgemach, 2008). The predation pressure has increased in Europe, partly due to a successful vaccination program against rabies in red fox (Szabolcs, 2009). Martín *et al.* (2007) could assign 44.5 % of deaths in chicks to predation, in Spain. In Germany predator proof fencing is used, in order to lower the predation pressure. Fencing has proved to be an effective strategy, both for wild birds nesting within lager pens and to provide safe areas while releasing captive reared individuals (Langgemach, 2008). An alternative to the fence is predation control. Intensive hunting of the main predators like fox and corvids will enhance the breeding success for all ground nesting birds including the great bustard (Langgemach, 2008). An interesting thought is that larger predators like wolf and lynx could reduce the impact from mesopredators like the fox.

5. *Insufficient arthropod food supply*

The use of pesticides will cause a reduction in the arthropod fauna as well as the weed flora, both an important food source for the bustards (Bravo & Ponce, 2012). Naturally a reduction in food availability is known to lower the breeding success in farmland birds (Boatman *et al.*, 2004) and therefore likely to reduce the great bustard breeding success as well. However to increase vertebrate food supply, plots or fields with a low vegetation structure and a rich flora will attract more arthropods and therefore ensure food availability and mobility for the bustard chicks (State of Brandenburg, 2009). In addition organic farming will promote a diversified flora of weeds and arthropods, on average species richness increase with 30 % compared to non-organic farming (Bengtsson *et al.*, 2005). Also so called beetle banks can harbor high abundance of arthropods and become an important foraging area for farmland birds (Collins *et al.*, 2003).

6. *Climate change*

The latest predictions from International panel on climate change (IPCC) describe different scenarios ranging from a global rise in mean temperature from 2 – 6 °C (Solomon *et al.*, 2007). This will indeed affect our wildlife as the distribution of many bird species are shifting northwards as the climate gets warmer (Huntley, 2007). The simulation of the future range of the great bustard in the late 21th century is based on climatic data, present species distribution and climate predictions. The model predicts that the future range is constricted and shifted northwards. Pockets with suitable climate will be left scattered across the Mediterranean counties including Spain, but other "new" suitable areas are predicted to appear in Sweden, Belarus, Ukraine, and Russia (Huntley, 2007). Synes and Osborne (2011) are more imprecise in their prediction of the potential future climatic habitat in Europe. In Sweden the eastern areas in the south are expected to become suitable within this century.

Under the condition that there is suitable habitat available the change in climate improves Sweden's future potential for conservation of the European bird fauna. While the current climatic range diminishes it is believed that today's populations could be reduced at several localities, particularly in Spain. As mentioned earlier the great bustard is a bad colonizer and therefore it is unlikely that the species will be able to spread to its "new climatic range" (RSPB, 2010).

7. *Hunting*

The great bustard has been a popular game throughout its whole range. It is believed that hunting is one of the main factors behind the rapid decline of the species (Alonso *et al.*, 2003; Palacín & Alonso López, 2008). Today hunting of the great bustard is banned in all countries (Szabolcs, 2009). After the hunting ban a positive reaction could be seen in a few countries for example Spain and Portugal. In other countries (Russia, Ukraine, and Turkey) the legislation has not been as effective and illegal hunting is still a problem (Palacín & Alonso López, 2008).

8. *Stochastic mortality (during harsh winters)*

During winters with high levels of snow, the food access in the normal wintering area can be limited. As a consequence the bustards need to find food elsewhere and disperse into further away (Streich *et al.*, 1996). The lack of food and the forced migration can increase mortality with more than 15 %, due to starvation, illegal hunting, and collisions (Langgemach, 2008). High mortality because an irregular migration could normally be seen

as a fluctuation in the population dynamic. However, small and fragmented populations together with the species low reproductive value will speed up the decline of local populations (Szabolcs, 2009). Both in Germany and in England where the populations are small, fields with oil-seed rape are cleared of snow during harsh winters (Langgemach, 2008, 2014; State of Brandenburg, 2009)

9. *Human disturbance*

Frequent disturbance can interrupt a display, make the female abandon her nest or cause a flight response increasing the collision risk with power lines (Szabolcs, 2009). In central Spain the main disturbances were from walkers and cars. The traffic increase during weekends mainly due to hunting activities of other game species than the great bustard. Other human disturbances were motorcycles, helicopters, airplanes, sheep herding, and farming activities. Activities related to farming seldom caused a flight response and are usally necessary since they are maintaining the habitat (Sastre *et al.*, 2009).

Biodiversity effects

Conservation work for the great bustard is known to enhance biodiversity. Since the new management regime and conservation work were adapted to the great bustard in Germany 18 different bird species re-occurred as breeding within the special protection area (SPA) "Havelländisches luch" (Langgemach & Watzke, 2013). In addition also invertebrates and voles are more numerous and the more diverse flora which previously only persisted in pockets is now starting to spread. However, changes in the flora takes long time (Langgemach, 2014). Also in England the great bustard project has recorded 7 - 8 threatened bird species nesting within the release area which is managed for the great bustard (David Waters pers. comm.). Some examples of species from across the great bustards range that is known to benefit from the same conservation measurements are: montagu´s harrier (*Circus pygargus*), red-footed falcon (*Falco vespertinus*), saker (*Falco cherrug*), stone curlew (*Burhinus oedicnemus*), collared pratincole (*Glareola pratincola*), black-bellied sandgrouse (*Pterocles orientalis*), pin-tailed sandgrouse (*Pterocles alchata*), roller (*Coracias garrulous*, calandra lark, (*Melanocorypha calandra*) short-toed lark, (*Calandrella brachydactyla*), tawny pipit (*Anthus campestris*), black-eared wheatear (*Oenanthe hispanica*), corn bunting (*Miliaria calandra*), and mammals like: souslik (*Spermophilus citellus*) (EU, n.d.). This highlights that conservation work aiming for the great bustard promotes other bird species, even species with different biology.

Objectives

This thesis investigates, via a feasibility analysis, the possibilities for an active reintroduction project of the great bustard in Sweden. This is achieved by three means:

1. Compiling the history of the great bustard and its current and previous population trends in Sweden and Europe.

2. Analyse areas with suitable habitats and potential restoration efforts needed for a reintroduction project.

3. Examine biological, climatic, socio-economical and practical implications for a reintroduction project based on interviews with stakeholders.

Great bustard restoration projects

Germany

The great bustard population in Germany has experienced a rapid decline from over 3000 individuals in year 1940 to 57 birds year in 1997 (State of Brandenburg, 2009). Today, after intense conservation efforts, the population has started to recover with a population of 165 individuals (Langgemach, 2014). The German population now remains in three SPA-areas (special protection areas) each around 5000 hectares. Within one SPA-area "Havelländisches Luch" the local great bustard organization (Förderverein Großtrappenschutz) together with the local administrative board owns around 2100 hectares and has therefore a stronger protection where the agriculture regime is more strictly adapted to the bustards (Langgemach, 2014). In the other areas "Fiener Bruch" and "Belziger Landsehafts wiesen" only minor parts of the SPA:s benefit from strong protection and the restrictions in the agriculture regime are few (Dorothee, 2014).

To supplement the current population, eggs are collected from nests outside the in-fenced areas, since these eggs are considered to be doomed to be predated or destroyed. The eggs will be incubated, hatched, raised and finally released back into the wild. The individuals are gradually released inside the in-fenced areas and have a post-release survival rate between 15 % to 40 % annually (Eisenberg, 2008). Later in life released individuals have been recorded to be able to reproduce (Langgemach, 2014). It can be compared with 29.9 % survival during the first year in the wild in Spain (Martín *et al.*, 2007). The reinforcement of chicks has been in operation for more than 25 years and the population has increased from 57 to 165 individuals (Langgemach, 2014). Recently the reinforcement in "Havelländisches Luch" (one of three SPA-areas) was ended and this population will now rely on recruitment from wild breeding within the in-fenced areas (Langgemach & Watzke, 2013).

The main issue in the German population is the low chick survival due to a high predation pressure. The mammalian predators are fox, raccoon dog, raccoon and marten. Birds like corvids and the white-tailed eagle predate on eggs, chicks, and sometimes females (Langgemach, 2014). To lower the predation pressure large in-fenced areas (17 – 30 hectares) have been constructed in all three breeding areas. The wild individuals realizes that the predation is lower within the fence and are attracted to nest there (Langgemach, 2014). In the year 2013, 21 juveniles fledged from the in-fenced areas, to compare with one fledged year 1991, on average 14 juveniles fledged annually (2003-2013) (Langgemach & Watzke, 2013). Other bird species also nest within the in-fenced area, like short-eared owl (*Asio flammeus*), montagu´s harrier, and Eurasian curlew (*Numenius aquata*) (Dorothee, 2014; Langgemach, 2014). In the "Fiener bruch area" there is a newly started predator control program to complement the in-fenced areas. The program has 120 traps of three different models and it is carried out by the local hunters coordinated by one professional hunter. In the year 2013 372 predators were captured (Dorothee, 2014).

Habitat management is performed in close cooperation with the local farmers. To increase food availability and cover the farmers leaves 10 % of the grass standing until next year in "bustard stripes" (Fig. 3 and 4) (Dorothee, 2014).

Figure 2 "Bustard stripe" in "Havelländisches Luch" (Photo: Karl Fritzson).

To further promote a low vegetation structure and diversity (food availability) the use of fertilizers and pesticides are restricted and organic farming is encouraged. Today there are seven organic farmers within the SPA:s (Langgemach, 2014). Naturally, it can be necessary to delay harvest in breeding areas or leaving the fields undisturbed for a longer period of time (i.e. 10 weeks) in order to give the chicks time to escape farming activates. All the financial losses due to the measurements are compensated to the farmers, 75 % from the EU and 25 % from Brandenburg state (Dorothee, 2014; Langgemach, 2014)

Figure 3 A part of the lekking area in "Havelländisches Luch" (Photo: Karl Fritzson).

The connectivity in and between the SPA:s is fragmented by trees, power lines and wind turbines. To increase the connectivity the great bustard project is actively removing trees,

especially continuous rows that form barriers for the great bustard. When a tree row is removed the bustards normally start to use the area more frequently.

Figure 4 The scenic view of the lekking area in "Fiener bruch" (Photo: Karl Fritzson).

The constant monitoring (Fig. 5) of individuals by ringing, radio tracking and observations are key elements to follow up the effectiveness of different measurements, detect treats and to delineate areas used by the bustards (State of Brandenburg, 2009).

Figure 5 Wild Female and juvenile great bustards foraging oil-seed rape at the wintering ground in "Havelländisches Luch" (Photo: Karl Fritzson).

United Kingdom, UK

The current British reintroduction project started in 2003 after a feasibility study concluded that suitable conditions still exist for the great bustard in and around Salisbury plain, the largest chalkstone grassland in northwestern Europe (RSPB, 2010). From 2004 – 2009 a

total of 86 individuals had been released into the Salisbury plain and a lekking area was established. In the year 2007 the first breeding attempts occurred and in 2009 two females successfully nested and fledged one chick each. The number of individuals released each year has been half of the intended (40 individuals/year) (Burnside *et al.*, 2012). A low post release survival of 18.3 % the first year has reduced the progress, although the survival during the second year was higher 74.6 % (Burnside *et al.*, 2012). Until 2014 a donor population from the Saratov region in Russia was used, recent findings show a relatively high genetic distance between the populations and the Spanish population is in fact the genetically closest related living population to the former British population (Anonymous, 2013). After these genetic findings, eggs were imported from Spain in 2014 and the project released 33 individuals in one year, the highest number of released birds annually so far (*greatbustard.org*, 2014).

Currently the project has one release area ("site 2") and one permanently in-fenced area (7ha) called "site 1". The predation and collision mortality proved to be higher at "site 1" so since 2012 all releases takes place at "site 2" (Anonymous, 2013). The release sites were selected according to the following conditions: 1. Risk of predation, 2. Land ownership and designations, 3. Landscape suitability, 4. Human disturbance, 5. Flight hazards, 6. Proximity to other populations or suitable habitat. Furthermore the project is working to improve the habitat in the surrounding 2800 hectares, mainly by informing and contracting farmers to environmental stewardship agreements within the rural development program for England (RDPE) (Anonymous, 2013). In addition the bustard habitat around Salisbury plain is improved by the stone curlew (*Burhinus oedicnemus*) project that contract one to two hectares plots of bare soil to provide good breeding opportunities for the stone curlew (Ash *et al.*, 2005).

The goal of the project is to get a population of 50 individuals until year 2015. Furthermore a population of 100 individuals is believed to be self-sustaining and the total area of Salisbury plain is thought to have a carrying capacity of approximately 200 individuals (RSPB, 2010).

Austria

The great bustard population in Austria is a part of the west Pannonia population living in Hungary, Czech Republic and Slovakia. The breeding population in Austria has increased from 60 individuals in the 1990s to approximately 250 individuals in year 2012 (Raab, 2012).

The conservation work with the great bustard started in 1995 by establishing "bustard set aside plots" cultivated with vegetation favored by great bustards (Raab, 2012). Special environmentally friendly agriculture schemes of different significance are also in place. The schemes are contracted for at least five years and the area should be at least three hectares. No irrigation, pesticides, artificial fertilizers, and manure may be used in the areas, also the access to the field is not permitted from first of April until harvest (*grosstrappe.at*, 2014). In 2012 a total area of 5150 hectares are under environmental schemes scattered within the SPA (6 % of the total SPA) (Raab, 2012). The total area being used by the west Pannonian population year 2005 was 515 km^2 and 336 km^2 was within Austria (Raab *et al.*, 2010)

In addition to the habitat management, the Austrian project tries to mitigate the great bustard collisions with power lines which is the main adult mortality cause in Austria.

Burying power lines eliminates the problem whereas marking reduce the collision risk. Due to high costs larger overhead power lines are marked and medium voltage power lines are buried (Raab *et al.*, 2012). During the first LIFE-project in Austria (2003 - 2008) 47 km of medium voltage power line was buried and 123 km of power line was marked. Mortality due to collisions declined during the period of the project and now a follow up project is running, aiming to bury more power lines (Raab *et al.*, 2012).

Methods

Literature review

The qualitative literature review focused on the great bustard history, ecology, and habitat. The sources were selected based on their quality and relevance for the thesis objectives. My primary source was scientific literature, but because of the practical implications of the subject also official reports and webpages of authorities and conservation projects were used as well. By searching keywords like great bustard, Otis tarda, reintroduction and habitat, and by using the reference list in these articles I found more relevant literature. During the interviews I also got referred to many useful articles and reports.

Study visits

Three study visits were selected beforehand; the animal park Nordens Ark, the great bustard project in Brandenburg (Germany) and former great bustard breeding sites in Skåne. The purpose with these "study visits" were to investigate the current bustard conservation status, practical captive breeding strategies and potential habitats available in Sweden for a reintroduction program.

Nordens Ark is a non-profit foundation established 1988 that works with threatened animal species and breeding programs. Since then Nordens ark has been working with captive breeding, research and information about biodiversity. Today Nordens Ark is well-established within Swedish conservation work and are, amongst others, responsible for captive breeding of white-backed woodpecker (*Dendrocopos leucotos*), lesser white fronted goose (*Anser erythropus*) and peregrine falcon (*Falco peregrinus*) (*nordensark.se*, 2014). In a future reintroduction of the great bustard, Nordens Ark could play a major role since the institution has a solid knowledge about captive rearing of wild animals in Sweden. Secondly, Nordens Ark has areas large enough to build a well-functioning breeding center for the great bustard. In a reintroduction project Nordens Ark would preferably work together with other organizations such as a county administrative board or other foundations.

A captive breeding program is pointless if there is no potential suitable habitat left for the great bustard. The topical areas in Sweden were selected based on recommendations from the respondents during the interviews, especially Martin Green which is an expert in the bird localities and habitats in southern Sweden. I visited all three previously known localities of the great bustard. In addition, I visited five possible reintroduction areas, likely to harbor suitable habitat. The areas selected were interesting because they are large extensively managed grasslands within the former range of the great bustard. Furthermore the investigated areas are at least partly integrated in a larger open landscape. All the localities were documented by taking photos and by taking notes on relevant information and observations. For three of the localities, an estimation of the suitable habitat was done

(using data from the Swedish agriculture agency's database). The estimation was done by selecting a center point in each area and analyzing land use within a five km radius (~78.5 km^2), approximately covering the home range of female bustards (62-75km^2) (Watzke, 2007b).

To obtain more up to date information about captive rearing of the great bustard, bustard habitat, and conservation work, I visited the great bustard restoration project in Germany. The first day I visited the SPA-area "Havelländisches Luch". We covered large parts of the SPA-area carrying out a yearly bird monitoring program. Apart from the lekking area which is an extensive grassland, most of the SPA is managed with a modern agriculture regime. The second day was mainly spent interviewing Torsten Langgemach while he showed me the facilities at the Brandenburg bird conservation center. The Last day was spent in another SPA-area, "Fiener bruch", together with a coworker to Mr. Langgemach. I got to see the predator control program traps in action and also the vast lekking area with one of the in-fenced release areas. (Further reading about the German project: under title "Germany" or the interview with Tosten Langgemach in Appendix I)

The qualitative analysis was done by comparing the results from the qualitative literature review and observations during the study visit in Germany. By comparing areal data together with my observations of the topical areas I was able to make an analysis of the potential suitability for a great bustard population.

Interview

The interviews were performed as semi structured interviews (Britten, 1995), following a question form (see Appendix I) to cover the core aspects of a reintroduction of the great bustard to Sweden. The respondents are experts within bird conservation or represent stakeholders that could be involved in a reintroduction of the great bustard. The respondents were selected based on recommendations from my supervisors and by the respondents themselves. The interviews took place during the autumn year 2014, usually by meeting the respondent at their office or via the telephone. The interviews lasted between one to three hours and at all occasions notes were taken. Afterwards the respondents were contacted to confirm that no misunderstandings had occurred. In the next passage is a brief summary of the main points that has been brought up during the interviews.

Results

Great bustard population history

The family Otididae originated from a common ancestor about 30 million years ago (Pitra *et al.*, 2002). The bustards colonized Eurasia and Indo-Australia starting to spread from the east or the south of Africa (Pitra *et al.*, 2002). Early remnants of the great bustard have been found in Spain (170-350 KA BP), and Italy (200-750 KA BP), later in the Holocene period (<11,7 KA BP) there are findings of great bustard across the Mediterranean (Tyrberg, 2008). In postglacial times before humans formed larger agriculture landscapes, Europe was predominated by forest. The open landscape was then created by fire and large herbivores, frequently occurring on floodplains, infertile soil and chalkstone grassland (Svenning, 2002). Larger open areas of chalkstone or sand in northern Europe could have been a sufficient habitat for a great bustard population. However, without any early

postglacial finings we can assume that the great bustard along with many other species spread northwards together with human agriculture. At latest in the medieval-period (16th century) the great bustard had spread to the northern parts of Europe including England (Allen, 2009; Shrubb, 2011). Based on land use maps, the great bustard population is believed to have reached its maximum during the end of the 18th century (Isakov, 1974)

In Sweden the species was breeding in several locations in the county of Skåne at the end of 18th century (Nilsson, 1858). The breeding locations that are mentioned in the literature are “Skanörs ljung”, “Simmered-marken” east of “Trelleborg” and the sandy fields around “Trolle-Ljungby”, and “Åhus” (Nilsson, 1858). Nilsson (1835) also mentions that the species occurred around “Sandhamnen” in Skåne. The population around “Åhus” survived longer and the last confirmed breeding was year 1862 (Mathiasson, 1960). There is also an egg originating from “Åhus” from year 1888 at the national history museum in Stockholm but the reliability of the date has been questioned (Ulf Johansson, pers. comm. 2014). During the 20th century stray birds have been observed nine times, last in 1979 (Breife, 2003).

It is difficult to determine when the species colonized Sweden. There are no sub-fossil findings of the great bustard in Sweden. Larger areas of open agricultural landscape started to appear around 12th century in Skåne, making it possible for the great bustard to thrive (Ekberg *et al.*, 1994). Wallengren (1854) describes that the species were occurring in large numbers in the northeast to east parts of Skåne during the 16th century and that people were dog-hunting the great bustards during this period. This is the earliest indication of the great bustard in Sweden. There is also a record of a bustard being shot on Öland 1572 (Samzelius, 1915) but since this is the only record of a bustard on Öland it is likely to be a temporary finding. The first confirmed occurrence of the great bustard in Skåne was year 1793 (Tuneld, 1793). However, it is important to keep in mind that the zoological record in Sweden before the Linnaeus time (around 1740) is very limited (Dal, 1996).

Carl von Linnaeus, (1751) visited both “Åhus” and “Skanörs ljung” on his journey through Skåne. Linnaeus did not mention the bustards at all, which could indicate that the great bustard was not numerous at this time. The great bustard is a poor colonizer due to their breeding system, high conspecific attraction and lek site fidelity (Lane *et al.*, 2001). Considering its ecology, a likely scenario is that the great bustard could have started appearing in Sweden when larger open areas became available (12th century) (Ekberg *et al.*, 1994) and that the early description of the great bustard in the 16th century is correct. A second possible, but unlikely, scenario is that the great bustard colonized Sweden in at least three locations late in the 18th century and then after just 100 years disappeared again.

Factors behind the extinction in Sweden

It is difficult to ascribe the great bustard extinction in Sweden to only one parameter. Intensive hunting did play a role (Gadamer, 1852). In 1789 King Gustav III released the hunting rights to everyone who owned land. This led to a rapid decline in all game species, for example the roe deer (*Capreolus capreolus*) and the Eurasian elk (*Alces alces*) almost went extinct in Sweden (Brusewitz, 1999). The great bustard certainly belonged to the group of species that suffered from hunting and the species disappeared from both “Skanörs Ljung” and “Simmered-marken” before year 1820 (Nilsson, 1858), the species only persisted longer around “Åhus” and “Trolle-Ljungby”.

Not only had the hunting practice changed during this period, correspondingly the agriculture practice changed. At the beginning of the 19th century an agriculture reformation called “Enskiftesförordningen” later followed by similar reforms “Lagaskifte” and “Storskifte” changed the landscape. Stripes of farmland were joined together; now one farmer had a few larger fields instead of small strips (Fig. 6). In Skåne up to 65 % farmers joined the reform during the years 1803 – 1816 (Myrdal, 1998). Pastor Wallengren believed that this reform was the main factor behind the rapid decline (Nilsson, 1858). Interestingly, another ground nesting bird; the grey partridge (*Perdix perdix*), also declined dramatically in Skåne during the same period (Nilsson, 1858).

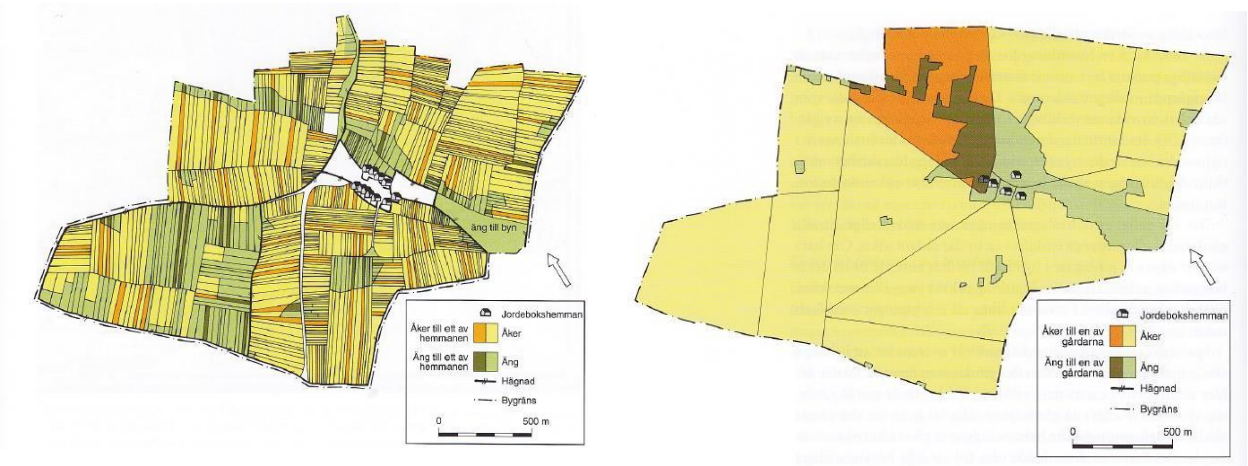

Figure 6 "Lilla Uppåkra" in south west Scania 1703 and 1813, after the reform "Enskiftesindelningen" all land belonging to one farmer were gathered in one unit, Farmland and meadows belonging to one farm is exemplified with the darker orange area on both images (Enskifte och laga skifte 1998).

The human population in the county of Kristianstad in Skåne more than doubled from 1772 to 1860 (Vinge, 1969). Strong population growth together with new settlements in remote areas (Myrdal, 1998) indicates that disturbance increased as well as the resources used. Since the great bustard still persists in Germany and Austria, where the agriculture is far more rationalized than during the 19th century in Sweden, this reason alone is unlikely to have caused the extinction. The climate during this period (15th -19th) were dominated by a phenomena called “the little ice-age”. It peaked around year 1600 with an average temperature dropping by 0.6 ºC and terminated in the mid-19th century (Mann, 2002). It is possible that “the little ice age” played a role in the previous Swedish great bustard population occurrence and migration behavior. Nevertheless, considering the warmer temperature trends in the mid-19th century “the little ice age” is unlikely to be a factor behind the extinction. Another explanation may be features at the unknown migration route or at the wintering ground. If negative factors were operating there they are likely to have caused declines in the Swedish great bustard population.

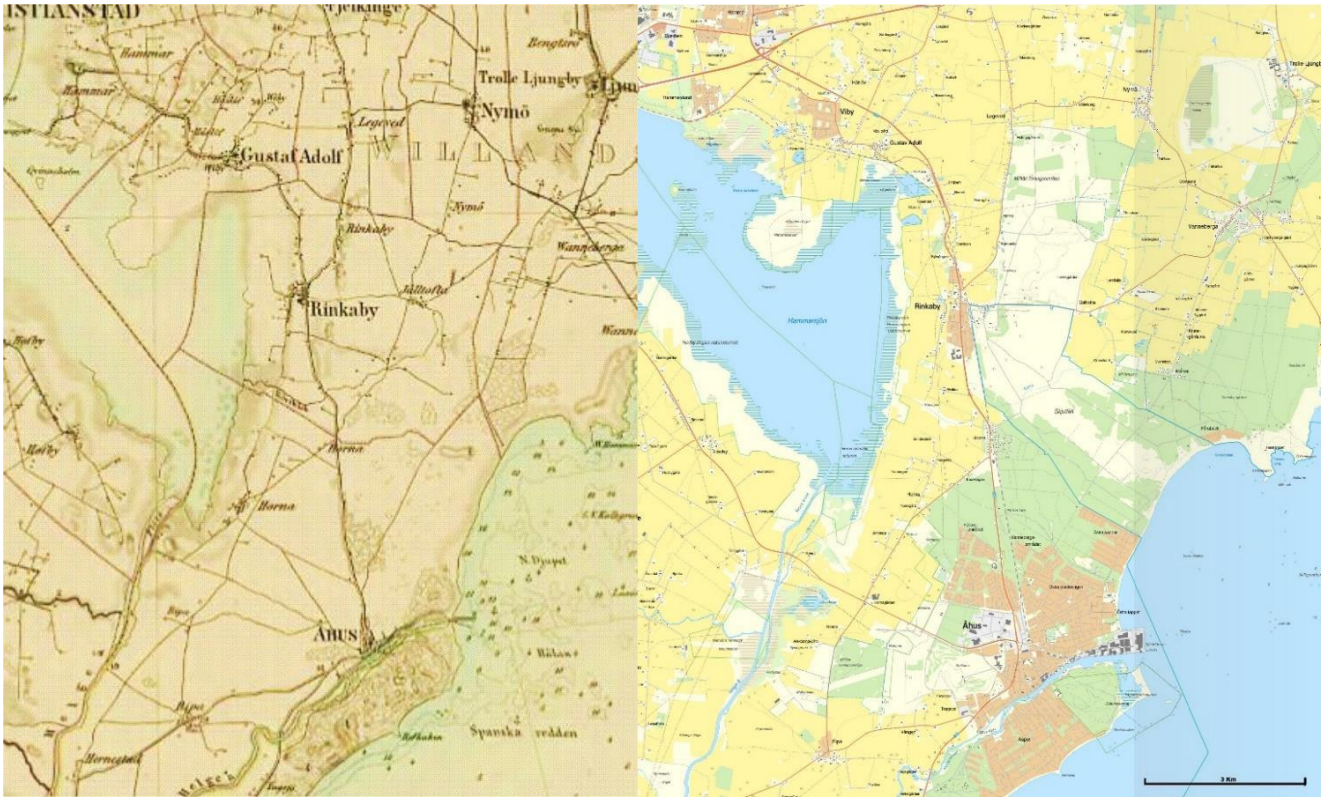

Figure 7 Maps displaying the last known breeding location in Sweden, the map to the left is from 1862, the year when the last breeding happened. The map to the right is the same area today (2014). Major changes has happened around Åhus where the city (beige) has expanded as well as the forest (green). Other new features in the more rural areas are wind turbines, a railway and power lines. (Map to the right obtained from the land survey office (lantmäteriet) and the map to the right from http://www.viss.lansstyrelsen.se/, downloaded 2014-11-19)

Available habitats in Sweden

The former range of the great bustard in Sweden was restricted to the province of Skåne in southern Sweden. The three localities that are mentioned in the literature by name is "Skanörs ljung", "Simmered-marken" east of "Trelleborg", and the sandy fields around "Åhus" and "Trolle-Ljungby" (Nilsson, 1858).

The locality at "Skanörs Ljung" is today smaller than 200 years ago. Today there are settlements on both sides of the heath and pine plantations to the north. The area that remains (360 hectares) of the heath is today a nature reserve (*Lansstyrelsen.se*, 2014). Although there are agriculture areas not too far away, the heathland area is today unlikely to harbor a great bustard population. Also "Simmered-marken" east of "Trelleborg" is almost gone, most of the area is a settlement with summer residence and permanent housing. According to a local citizen most of the area called "Simmered-marken" was earlier meadow- and pasture- land and during the 70´s and 80´s most of the exploitation occurred. The only area of the three previous localities that still can be large enough for the great bustard is "Rinkaby skjutfält" outside "Åhus".

Rinkaby

The military practice field "Rinkaby skjutfält" is maintained by extensive cattle grazing. The main area is a vast open grassland with few trees (Fig. 8), but there is one public road crossing the area and an overhead power line crossing the northern part of the field. The major part of "Rinkaby skjutfält" is directly connected to agriculture fields in the west and in the east. Within a five km radius from the center of "Rinkaby" the portion of grassland is

1878 hectares (24 % of the total area) and other farmland covers 1705 hectares. In addition less than 10 km away from “Rinkaby” the area “Ripa sandar” is situated, which also is a former known locality of the great bustard. Today the area is a grass heath mixed with farmland. The valley around Helge river also has patches of suitable habitats but on the east side several power lines makes the area unsuitable.

Figure 8 "Rinkaby skjutfält" (Photo: Karl Fritzson)

Revinge heath

Revinge heath is also a military practice area and it is the largest grassland area in the province of Skåne. Within a five km radius from the center of Revinge heath the portion of grassland bustard is 3428 hectares (44% of the total area) and other farmland covers 1230 hectares. The heath is maintained by free ranging cows grazing within the area, today around 700 cows (Jan-Åke Nilsson pers. comm.). Several fields within the area seem to be large enough to function as a lekking area for the great bustard, especially in the North West part of Revinge heath (Fig. 9).

The military are generally positive to conservation work in the area as long as it is not conflicting with their own activities. The local farmer has previously been positive to conservation work and it would probably be possible to fence out cattle during the breeding period (Jan-Åke Nilsson pers. comm.). Other measurements that could be essential for a reintroduction are: building an in-fenced release area, burying power lines within Revenge heath, cutting down pine plantations to connect larger fields and restricting military operations during breeding season.

Figure 9 North-west part of Revinge heath (Photo: Karl Fritzson).

Ravlunda

“Ravlunda skjutfält” is a grazed grassland as well, situated at the Baltic coast. Except the southern entrance the area borders to forest and the Baltic Sea, making the area more isolated than Rinkaby or Reving heath. The area is also hillier than the previously described locations. As seen in figure 10 the vegetation structure seems to be shorter in general then at Revinge heath or at Rinkaby. Within a five km radius from the center of Ravlunda the portion of grassland bustard is 2623 hectares (33 % of the total area) and other farmland covers 683 hectares.

Figure 102 "Ravlunda skjutfält" (Photo: Karl Fritzson)

Kabusa

Kabusa military field (560 hectares) lies directly at the southernmost coast in Skåne (Fig. 11). The area is an undulating grazed grassland. The northern part of the field connects to a nature reserve and larger farmland areas. In the east lies another nature reserve (602 hectares) with a mosaic of farmland and grassland. There are few trees and power lines and the vegetation structure is in general lower than in Rinkaby and Revenge heath. The Kabusa-region is also the only persisting locality of the corn bunting in Sweden.

Figure 11 "Kabusa skjutfält" (Photo: Karl Fritzson)

Skåne summary

"Rinkaby skjutfält" and Revinge heath appears to be the most suitable areas although all four locations have a potential for a reintroduction. They are all bordering larger agriculture areas which also could be used by bustards, especially for wintering. Of all four areas the furthest distance to one of the other localities is approximately 40 km, within the same range as birds in Germany are known to fly regularly (Langgemach, 2008).

Measures that need to be taken in the grasslands prior or during a reintroduction are: establishing an in-fenced release area, predation control, burying power lines within Revinge heath, marking of high voltage power lines at Rinkaby, cutting pine plantations to connect larger fields, and restricting military operations during breeding season.

The military activities are mainly shooting practice or driving with tanks. It could disturb the bustards during the breeding season but does also create sections of bare soil that are likely to favor the bustards. Less frequent (every second year or so) the military practice with helicopter in Revinge heath (Jan-Åke Nilsson Pers. Comm.). A helicopter landing in a field with great bustards nesting could be fatal for the breeding success that year. Potential conflicts between military operation and the great bustard should be brought up to discussion before a reintroduction project could start. To avoid conflicts, the release pen could be placed just next to the military area as an example. Predation control would probably be necessary as well since predation is a major mortality cause in Germany and England (Langgemach, 2008; Anonymous, 2013). However, the predation pressure could be more favorable in Sweden than in Germany since there are no raccoons or raccoon dogs.

South Öland

The Great Alvar (260 000 hectares) on the isle of Öland, together with the surrounding agriculture landscape, is in comparison large and undisturbed. The Alvar is defined by the flat limestone plateau and a thin layer of soil (Fig. 12). Several threatened plant- and arthropod species still thrives on the Alvar, including the *Psophus stridulus* (in Swedish "trumgräshoppa") which could be an important food source for the great bustard chicks. The farmland situated on the eastern cost is more extensive since the soil is less fertile. In contrast, the west side of Öland is among Sweden's most fertile farmland. Compared with the sites in Skåne the Alvar is undisturbed and much larger even if it only partly would be useful to the bustards. To use the Alvar as a lek- and breeding ground would probably be the best option. Öland is however more isolated than Skåne and the average temperature during winter is lower (Fig. 14). During a harsh winter the migration route to reach bare farmland would be further away.

Figure 12 View of the great Alvar on Öland from the "Altarstone" (Photo: Karl Fritzson).

Interviews

All the respondents are presented together with a summary of the interviews following the question form used in the interviews (The respondents complete answers are displayed in appendix I)

1	Staffan Ulfstarand	Professor emeritus, ecological zoology
2	Claes Andrén	Professor, conservation biology, Nordens Ark
3	Christer Larsson	Project leader, Nordens Ark
4	Torsten Langgemach	Head, Brandenburg Bird conservation center
5	Martin Green	Researcher, Lund university (the Swedish bird survey)
6	Petter Haldén	Agronomist and Biologist, Swedish Rural Economy and Agriculture Societies, Uppsala
7	Martin Tjernberg	Zoologist, Artdatabaken
8	Jan Hultgren	Business developer, LRF-region Skåne
9	Richard Ottvall	Consult within bird conservation and monitoring
10	Helena Lager	County administrative board in Kalmar
11	David Waters	Director, The great bustard group, United Kingdom
12	Michael Svensson	Biologist, Artdatabanken
13	Hans Cronert	County administrative board and municipality in Kristianstad

What is your knowledge about the great bustard?

("Vad har du för kunskap om stortrapp?")

Apart from Torsten which has been working with the great bustard for 15 years and David Waters that started to be involved in bustard conservation as 13 year old kid, the interviewees had a rather limited knowledge about the species. This is not unexpected since the great bustard is extinct in Sweden. Nonetheless, most interviewed had seen the great bustard several times and had a general knowledge about the species.

How would a reintroduction of the great bustard affect biodiversity?

("Möjliga effekter av en återintroduktion av stortrapp för biologisk mångfald?")

According to Torsten Langgemach the great bustard is an umbrella species and a symbol for conservation work in an open landscape. Since the German project started with habitat management for the great bustard, more than 18 bird species reoccurred as breeding in "Havelländisches Luch". Petter Haldén points out tawny pipit (*Anthus campestris*) as a "sister species" to the great bustard and David Waters says that in their great bustard release area (7 hectares) they had 7 – 8 threatened bird species nesting. All of the interviewed had difficulty to see that the great bustard could be a threat to biodiversity. Most argued that a reintroduction could be positive for biodiversity, mainly because of conservation measurements that would be taken and by preserving already species-rich habitats from future exploitation. However, Jan Hultgren has a different view and says that the biodiversity already present within Sweden has persisted without the great bustard since its disappearance.

How would a reintroduction of the great bustard affect economic development?

("Möjliga effekter av en återintroduktion av stortrapp för ekonomisk utveckling?")

Most experts interviewed claims that the great bustard has a tourism value. It is among the heaviest flying bird worldwide and has a spectacular display. It would even interest "regular people" not only bird watchers, says Martin Tjernberg, Petter Haldén can see a potential in the great bustard display and relates to other species as the cranes at "Hornborgasjön" and the whooper swans at "Tysslingen", both events with many visitors. According to Torsten Langgemach the Brandenburg bird center has over 2000 visits each year. In England the great bustard project has over 10 000 visitors each year. Martin Green also points out that a reintroduction project could generate compensation payments to the framers, which could be an economic development in a rural area. Jan Hultgren on the other hand, does not see any general benefits for farmers except for estate owners with special interests.

How would a reintroduction of the great bustard affect society?

(”Möjliga effekter av en återintroduktion av stortrapp för samhället?”)

David Waters says that the great bustard is now a symbol for the region of Wiltshire County. For example, the local brewery makes great bustard beer. Furthermore, the species would increase the interest for our nature which always is needed, claims Helena Lager. If the population would become large enough, the great bustard would be interesting to hunt says Martin Green and Jan Hultgren. Martin Tjernberg points out that a project of this magnitude would take long time and cost a lot of money. Maybe it is a cost that the society would be willing to pay?

What could a reintroduction to Sweden mean for the species?

(”Vad skulle en återintroduktion till Sverige kunna betyda för arten?”)

All interviewed agrees that a successful reintroduction of the great bustard would be positive but probably of minor importance for the species worldwide. A Swedish population will be isolated and therefore it needs to be of a certain size to be self-sustaining says Claes Andrén. Mikael Svensson agrees that as long as a Swedish population is isolated it is of minor importance, but connected to other populations it could become more valuable. Comparing available habitats in for example Hungary and Sweden the available habitats in Sweden are minor says Christer Larsson. David Waters mentions that the climatic range of the great bustard will shift northwards, so in that sense it is positive to have a population in Sweden.

What reasons could have caused the great bustard extinction in Sweden?

(”Vilka anledningar kan man se till att stortrappen dog ut i Sverige?”)

All of the interviewed could just speculate about the reasons why the great bustard disappeared. However, almost everyone believed that hunting played a major role during the extinction of the great bustard, as well as changes in land use. Several species have reoccurred after we stopped hunting them e.g. the grey lagged goose, the herring gull, and the great snipe says Martin Tjernberg. In addition, the land use changes have been dramatic in Skåne with Pine plantations, irrigation, no long time fallows, and increased disturbance says Hans Cronert. However, Petter Haldén said “considering that the species still is present in Germany it is unlikely that changes in agriculture practice could have been the main reason”. Claes Andrén also points out that local climatic changes could have been another possible reason.

What problems could appear while reintroducing the great bustard?

(”Vilka problem kan en återintroduktion av stortrapp föra med sig?”)

The great bustard seems to cause humans few problems. However, if the bustard would become numerous there could be problems with damaging oil-seed rape. Today we have

problems with large flocks of barnacle goose says Jan Hultgren. It is good to include the local farmers and society as early as possible to make them a part of the project, says Petter Haldén. Christer Larsson thinks that captive breeding with parental birds are always preferred and he reasons that it would be worth to try captive breeding with the great bustard, even if it has been proved to be troublesome to get adult females to nest and lay eggs.

Which localities in Sweden would be best suited for a reintroduction of the great bustard?

("Om möjligt, var i Sverige anser du att en återintroduktion av stortrapp skulle lämpa sig bäst?")

Most of the interviewed answered that Öland with the Alvar and the surrounding arable land harbors the largest undisturbed areas which could be suitable for the great bustard. Other possible sites are the military areas in Skåne; Revinge heath, Rinkaby, or Ravlunda. There could be areas large enough in Halland or Gotland as well says Claes Andrén. Staffan Ulfstrand and Claes Andrén point out that the most suitable areas today are not necessarily within its former distribution range.

What measurements needs to be taken to succeed with a reintroduction?

("Vad krävs för att vi skulle kunna lyckas med en återintroduktion?")

The habitat needs to be a mosaic of grassland and arable land. Present habitats could be good enough, maybe supplemental feeding during winter would be needed says Martin Tjernberg. Jan Hultgren thinks that the new subsidies to "organic focus areas" that aims to enhance ecosystem services and biodiversity could benefit a reintroduction. Otherwise the interest for a reintroduction from farmers is probably low. Martin Green also wonders what the farmers will get out of a project like this. David Waters describes the need of a reintroduction project very simplified; "you need one of the German in-fences areas (18 hectares) where you can have 20 nesting females and then you need a field of the same size with rape-seed oil during winter and then you are quite far". David also emphasize that all nests of the great bustard he has observed has been located on, or less than 10 meters from, bare soil. He thinks this is extremely important for the newly born chicks.

To succeed with a reintroduction, a captive breeding program would be necessary. Nordens Ark have a great knowledge about captive breeding of wild animals and we are interested in working with the great bustard, says both Christer Larson and Claes Andrén.

Do you think a reintroduction to Sweden is a good proposal?

("Anser du att en återintroduktion av Stortrapp är ett bra förslag?")

Eleven out of thirteen interviewed are positive to a reintroduction of the great bustard, especially if there is an available habitat. Jan Hultgren has difficulties to see the benefits for farmers and if the great bustard would be numerous it could create substantial damage to oil-seed rape. Martin Green is also more skeptical and thinks that the money spent on

reintroducing the great bustard could as well be spent on other endangered species currently present in Sweden. However, if a species were to be reintroduced, it would be for the synergy effects, continues Martin. Martin Tjernberg and Michael Svensson are also afraid that reintroduction of the great bustard could "take" financial resources from other conservation projects. However, if external money becomes available they see few problems with a reintroduction.

Discussion

The great bustard is an endangered species and has suffered from a rapid decline all over its range during the past 100 years (Palacín & Alonso López, 2008; Bird life International, 2013). After a hunting ban and intensive conservation efforts the species is now recovering or stabilizing in parts of its range (Langgemach, 2008; Palacín & Alonso López, 2008; Raab, 2012). Concerns like habitat loss, collision with power lines and modern agriculture are the main factors operating today (Szabolcs, 2009). However, the future climate change is thought to play a major role in contracting and pushing the species range northwards (Huntley, 2007; Synes and Osborne, 2011). Due to a fragmented distribution and small population size it is very unlikely that the great bustard will be able to recolonize northwards to e.g. Sweden without assistance.

Available habitats and conservation efforts

The general agriculture regime in Sweden is today intensive with multiple harvests, high cattle densities and dense vegetation due to fertilizers. Too intensive farming is unsuitable for the great bustard (Szabolcs, 2009) that needs areas with extensive farming and/or grassland areas (Morales & Martín, 2002; Palacín *et al.*, 2012; Rocha *et al.*, 2013). Therefore the general agriculture regions in Sweden can be considered as unsuitable in their present condition even though pockets of suitable habitats exists. The Five areas identified are interesting because they are large extensively managed grassland areas situated in an agriculture landscape with short winters and low precipitation. The areas in Skåne appear to be large enough to function as a lekking area for a Swedish great bustard population. However, since the home range of a female bustard is 62 to 75 km^2 (Watzke, 2007b) the bustards will also use the arable land surrounding the military fields for nesting. This would make the arable land close to the topical areas an object for conservation work such as set asides, organic farming or growing oil-seed rape.

The great bustard also prefer undisturbed areas and avoid infrastructure (Lane *et al.*, 2001; Osborne *et al.*, 2001). The most sensitive period for disturbance is during the breeding season. The population in Spain keep an average distance around 1000 m to buildings and roads according to Lane *et al.*, (2001). However, in the German population the bustards stays much closer to roads and settlements, sometimes during winter the great bustards are just next to a road (Langgemach, 2014). The negative effect of infrastructure can therefore be considered to be highly variable between populations and the effect of existing power lines within or close to the areas in Skåne will highly depend on how the bustards use and move between different areas. Some of the power lines close to Rinkaby and Revinge heath are situated in valleys or close to forest and are therefore less likely to increase the mortality of adult great bustards, but might however fragment the bustards land use. Also cutting down pine plantations at these two localities would be an effective measure to

increase the connectivity. The great bustard is sensitive to disturbance during the breeding season (Szabolcs, 2009) and it would therefore be important to in detail plan, or if necessary restrict, the activities of the military and grazers during the breeding season. Nonetheless it is also these activities that maintain a habitat with a varied vegetation structure.

A different possible reintroduction area is south Öland. The great Alvar together with the surrounding east arable land appears to be the most suitable location in Sweden. Firstly, it is a vast open landscape with a sparse vegetation (260 000 hectares), Secondly, it is undisturbed from military activities and from infrastructure compared to Skåne. It is also likely to continue to be so in the future. South Öland also has the same average snow cover as Skåne (Fig. 13). The negative side is that it is located outside the former range or the great bustard and it is on average slightly colder (Fig. 14). A snowy winter would force the bustards to migrate further (150-200 km longer) and could therefore increase the mortality, compared to the localities in Skåne.

In all five areas predation needs to be avoided as far as possible, it can be done by building in-fenced areas or via predation control. Also the abundance of arthropods needs to be further analyzed. High abundance of arthropods, in particular grasshoppers and beetles, are necessary for the female's chick rearing (Rocha *et al.*, 2013). All the topical areas both on Öland and in Skåne are known to have high species diversity (Berlin & Rosquist, 2014). High diversity is not always related to high biomass but it is at least an indication of good food availability.

Habitat management and maintenance would be needed for a reintroduced great bustard population. In Sweden the agriculture subsidy program will have major changes from year 2015, a few environmental subsidies will disappear as a consequence of a limited budget. The renewed program that will be in place from the next year has particularly one new promising "component" called "organic focus areas" (Ekologiska fokus arealer) (*jordbruksverket.se*, 2014). The "organic focus areas" applies to all larger non-organic farming units. They are obligated to have 5 % of their arable land as an "organic focus area". The "focus area" could be: Salix farming, fallow, nitrogen fixating plants, a set aside or ley farming. This will be applied in the main agriculture provinces in Sweden and has a potential to enhance heterogeneity in the agriculture landscape on a larger scale. Other environmental subsidies that can be used in bustard habitat management is "Organic production" (Ekologisk produktion), "Pastures and meadows" (Betesmarker och slåtterängar) and "Ley farming" (Vallodling). In the year 2016 there will also be subsidies for "Protection zones" (skyddszoner) and "Decreased nitrogen leakage" (minskat kväveläckage) (*jordbruksverket.se*, 2014).

Most of the restoration measures in other European countries has been achieved within European Union common agriculture policy (CAP) supporting farming and rural development. This suggest that it is possible to maintain and promote bustard habitats within an EU-framework and if necessary in the future, to adopt parts of the Swedish national framework to benefit bustard conservation. In fact, habitat measures needed for bustard conservation are already in place or under discussion in Sweden.

Even without a future reintroduction of the great bustard, habitat management will be necessary to maintain a high biodiversity in the topical areas. Future measures discussed on

Öland are predation control, clearance of afforestation, and meadow management (Richard Ottvall pers. comm.). These measures would clearly benefit a great bustard population and again underlines the synergy effects for other species while working with great bustard conservation. The need of predation control has previously been controversial and not preferred within conservation work (Dorothee, 2014). However, the past years the attitude seems to have changed and today predation control is more acceptable (Richard Ottvall pers. comm.).

The agriculture landscape is constantly changing and further analyses of the suitability of the habitats in Sweden would be most welcome. However, major changes in crops or land use outside the military fields and the Alvar could come about quickly and the agriculture regimes are not likely to become more bustard friendly by themselves in a near future. Also a reintroduction project will depend close cooperation with landowners and a key issue is therefore to motivate and interest landowners as well as finding the most suitable areas today. A reintroduction project could start and the habitat measures can be done simultaneously since the great bustard is a long-lived species and a favorable habitat can be farmed quickly (RSPB, 2010).

Reintroduction effects

The habitat requirements of the great bustard makes the great bustard one of our most charismatic so called flagship- and umbrella species in Europe (EU, n.d.; State of Brandenburg, 2009) and that is one reason why the great bustard is a prioritized species within the EU-bird directive (*Bird Directive*, 2009). A reintroduction of the great bustard will promote and contribute to the ongoing work with the Swedish environmental goals (Krister Mild pers. comm. Swedish environmental protection agency). It would also lead to designations of new SPA-areas.

From the interviews it is possible to conclude that the great bustard has potential economic value for the local region, mainly through tourism. One example is the great bustard project in the UK visited by 10 000 tourists each year (David Waters pers. comm.). Even if the people visiting a bird's lek site do not pay entrance, they will probably stay in the local village and eat at the local restaurant. The fact that the species has a spectacular display and that it is the heaviest flying bird worldwide automatically creates publicity and interest from the public. As a consequence of this work several interested people already called and offered their land and farms to support great bustard conservation.

The social benefits are less obvious. However, introducing the great bustard is less controversial than other large species like the wild boar, the wolf, or the European bison. It is also very unlikely that the species will be disliked by the local society.

Wintering climate in northern Europe

The former Swedish great bustard population was migratory, arriving to southern Sweden in April and leaving during the autumn (Nilsson, 1858). Gadamer (1852) describes it as exceptional when a great bustard remained in Skåne, December 1842. The question is if an annual migration would be necessary for a Swedish great bustard population today? The average temperature has increased by 0.7 °C over the past 100 years. Moreover, the temperature increase is even more pronounced in the northern hemisphere including Sweden (Solomon *et al.*, 2007). As a consequence species are migrating shorter distance, an example is the grey lagged goose (*Anser anser)* and the whooper swan (*Cygnus cygnus*)

(Martin Green pers. comm.). Species which today are prone to stay in northern Europe during winter prove that the wintering possibilities in Sweden are gradually changing. However it is not only the climate that is affecting the wintering opportunities, also the food availability has increased for all species that are feeding on oil-seed rape. This happened since a new variety of oil-seed rape has been cultivated in northern Europe during the 20th century, apparently tastier to birds than the former one (Martin Green pers. comm.). Consequently bird species like the great bustard can survive mainly on oil-seed rape during winter (State of Brandenburg, 2009). The most important factor is therefore if the oil-seed rape is available and not covered by snow in the winter, out of reach for the bustards. Otherwise the great bustard is tolerant against cold weather (Langgemach, 2008).

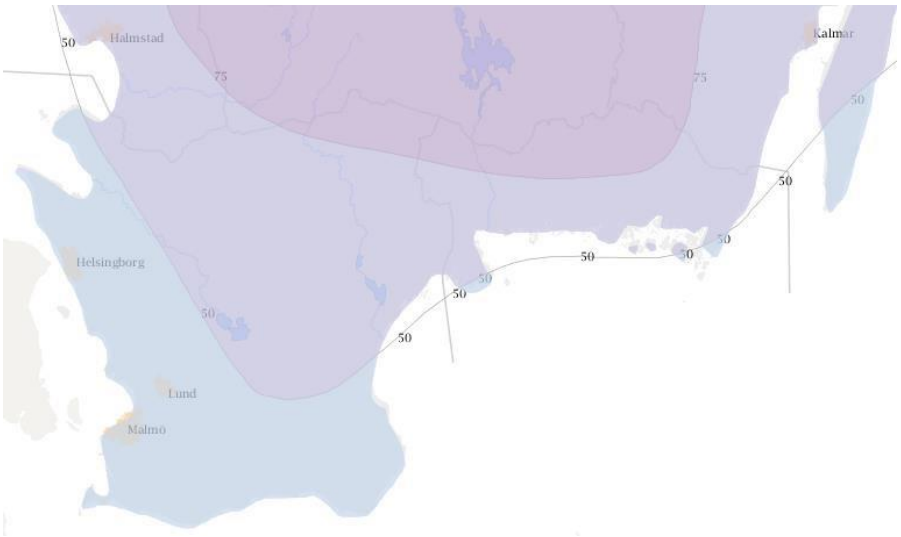

Figure 13 Days with snow cover, large areas of southern Skåne and Öland have less than 50 days of snow cover every year (1961-1990) (Map obtained from: http://opendata-catalog.smhi.se/explore/ downloaded: 13-12-2014).

The winter climate in Nennhausen in Germany is generally mild but winters in Brandenburg can have several weeks of snow (Langgemach, 2014). The annual snow cover in both Skåne and Öland lasts typically less than 50 days (Fig. 13) but vary between 12 to 53 days within the region (Table 2). Moreover, looking at the monthly mean temperature and precipitation, the wintering climate in Skåne is very similar to the climate in Nennhausen, Germany (Fig. 14). Eketorp on Öland has a slightly lower mean temperature and a few days more with precipitation during the winter season.

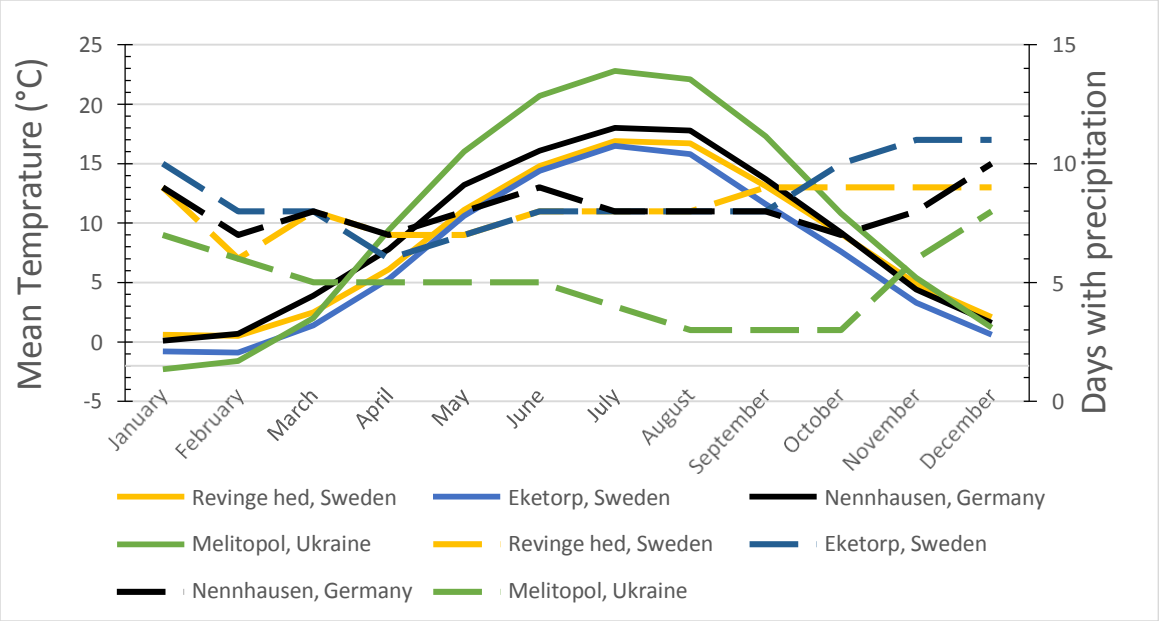

Figure 13 Monthly mean temperature (uncut lines) and mean days with precipitation (dashed lines), between the years 1961-1990 in Revinge heath (Skåne), Eketorp (Öland), Nennhausen (Germany), and Melitopol (Ukraine). (Data obtained from yr.no downloaded 26-11-2014).

However it is not the average winter that will induce migration and increase mortality but the extreme winters. The Maximum daily average temperature during the winter months is warmer in Revinge heath (Dec -0.2, Jan -1.7, Feb -1.9) (*yr.no*, 2015a) than in Nennhausen (Dec -0.6, Jan -2.2, Feb -2.1) (*yr.no*, 2015b). Considering the lack of evidence for a harsher winter climate in Skåne and that migration is very costly for large birds it would be preferable to not infer on long migration traditions for a great bustard population in Sweden. Instead making food available during extreme winters by clearing fields of oil-seed rape from snow or supplemental feeding would be a preferred option. As mentioned before the future climate in Sweden for the great bustard is predicted to become more suitable as well (Huntley, 2007). Changing a migration behavior of a population is somewhat radical but migration traditions can be flexible over time, (Sutherland, 1998). In the great bustard the migration behavior is flexible indeed, shaped by learning via mother-offspring or later in social groups (Palacín *et al.*, 2011).

Table 2 The number of measured days with snow cover depth in the locations: Falsterbo, Vomb, Kristianstad, Sandhamnen, Ölands södra udde, Segerstad (obtaind from: http://opendata-download-metobs.smhi.se/explore/?parameter=0# dowloaded 2014-11-21)

	Time period	Number of measured days with snow cover, yearly	Average Snow depth (m)
Skåne			
Falsterbo	1951-2014	12	0,05
Vomb	1961-2014	29	0,03
Kristianstad	1961-1982, 1996-2014	47	0,10
Sandhamnen	1967-1995	39	0,10
Öland			
Ölands södra udde	1951-1995	18	0,11
Segerstad	1969-1988	53	0,08

Donor population

A suitable donor population must be identified prior a reintroduction project. Earlier attempts of captive breeding in England and Russia failed but a private company in southern Spain has been able to perform captive breeding. All captive-release programs currently running are based on the collection of wild eggs (Langgemach, 2013). Only two great bustard populations in the world are large enough to sustain such a reintroduction project for several years; the Iberian and Russian populations (Burnside *et al.*, 2012). Recent findings show that the former British population is closer related to the Iberian population (Anonymous, 2013) contradicting the previous believed separation between Iberian population and the other European populations (Pitra *et al.*, 2000). This would make the Iberian population the most likely donor population. However, most of the respondents imposed that a genetic study of the former Swedish population would be desirable. A genetic study would also clarify any doubts about a donor population and confer a reintroduction project more legitimacy. For a captive breeding program not using wild eggs but captive breeding there might be more donor populations available and the need of a genetic study even greater. There is material from the former Swedish population available at "Arkivcentrum Syd" in the form of two eggs, two "skins", one montage and one montage of a skeleton and skeleton parts (Appendix III).

Breeding center

Captive breeding of wild animals is not allowed in Sweden or in the European Union without two judgments, a permission, and a dispensation. In Sweden such judgments are issued by the country administrative board (Länsstyrelsen). Normally a reintroduction of a threatened species is a legal request for an exception (*Artskyddsförordningen*, 1999).

The most commonly used method when raising great bustards is by hatching eggs taken from a donor population (Langgemach, 2013). This method has been used in Germany, Hungary, Russia and Britain (Szabolcs, 2009). Successful breeding has happened spontaneously in captivity but more systematical breeding trials in Russia and England were unsuccessful (Langgemach, 2013). A breeding center in Spain is the only institution that have managed to successfully breed the great bustard in larger numbers through insemination (Langgemach, 2013).

The breeding information below is based on guidelines for reinforcement and reintroduction of great bustard (Langgemach, 2013) as well as experience from the German great bustard project.

Incubation

Preferably a house with three separate rooms should be dedicated to the great bustard rearing; a reception room, an incubation room, and a hatchery room. The size of the rooms should be adjusted to fit the needs and future expansion of the project. Good ventilation and a temperature around 22 – 24 °C and an air humidity of approximately 50 % is required.

Incubation lasts for approximately 24 days, during this time the eggs should be turned eight – 12 times per day and kept in a temperature of 37.4 °C with a 60 % air humidity. Moving the eggs to a hatching machine the day before hatching will keep the incubator clean. During hatching the humidity is turned up to 90 % and the temperature is kept at 37 °C. When the chicks are hatched it is important to regularly weigh and measure them. This is an important step in monitoring their condition and further development.

Raising chicks

The first 1-3 days the chicks are placed in a warm box (40x40 cm) with cellulose material and already after the second day the chicks are allowed to take a walk outside. Predators must be kept away by fencing and nets, the enclosure for the first week should be a few 100 m^2 areas. Later enclosures of several 1000 m^2 are suitable, the larger the better (Fig. 15, Appendix III). The vegetation within the enclosures needs to be suitable for the great bustard. A "stable" with floor heating and infrared lamps are needed to compensate for the lack of a mothers heat. In the German project the chicks are kept in similar age groups and they are allowed to take "daily walks", first inside and then later outside the pens. The birds are being released into the wild in-fenced areas gradually after eight to 12 weeks.

Figure 4 Breeding center in Nennhausen, Germany (Photo: Karl Fritzson).

Feeding

It is desirable that the feeding is as anonymous as possible and that the chicks are not given any food during the first 24 h. Young chicks feed mainly arthropods the first two weeks, for example commercially available crickets and arthropods collected from the local area. It is desirable that the food should resemble wild food items. From day seven small bits of herbs are gradually added to the diet: nettle (*Urtica dioica*), dill (*Anethum graveolens*), dandelion (*Taraxacum officinale*), yarrow (*Achillea millefolium*), alfalfa (*Medicago sativa*), plantain (*Plantago spec.)*, and clover (*Trifolium*). The selection of herbs can be partly changed depending on the local availability. From the age of three weeks the bustards are also given a fodder named "Lundi" manufactured by a German producer. Furthermore it is important that the protein content in the diet is not too large, the first five to six weeks up to 35 % and thereafter 20 %.

Costs

From next year the Bird center in Germany will spend 100 000 € yearly for the great bustard project. The funding covers all the daily material and staff preforming all the work, for example egg collection, hatching, rearing and release of birds, monitoring, managing enclosures, collaboration, and communication between the farmers, hunters, the local state, and the public (Langgemach, 2014).

The year 2010 the state of Niedersachsen in Germany investigated their possibilities to reintroduce the great bustard and did estimations of the costs. Startup costs including a container with equipment, an enclosure and vehicles, was estimated to 138 000 €. Purchase of 20 hectares of land would cost between 100 000 and 500 000 €. The yearly running cost is estimated to 287 000 € including costs in land of origin, three employees, running costs (station and traveling) and 10 solar powered radio transmitters. The total running costs for the project during 15 years would be 4,2 million €, not including any other unforeseen costs (Krüger, 2010)

The English project is mainly financed by 2,2 million € during five years, mainly from the EU-Life foundation (*greatbustard.org*, 2014).

A minimum financial estimation of the costs for a Swedish reintroduction project would be startup costs of 2,2 million SEK including a new house, stable, fence, nets and two vehicles. Yearly running costs is estimated to 1,2 million SEK including three fulltime employee, leasing of 10 hectares of farmland, use of two vehicles and traveling costs. Running the project for 15 years would then cost around 18 million SEK (+ 2.2 million in startup costs). Estimating the financial costs of a reintroduction project is difficult and if a part of the work can be carried out by volunteers the costs could be lower, however if more resources can be allocated the project is likely to be more successful.

Conclusion

The great bustard disappeared from Sweden during the mid-19th century, most likely due to intensive hunting and changes in agriculture practices. The negative population trend in Europe has after years of decline now been reversed due to conservation efforts. A future concern of the species is now the climate change as it is a poor colonizer with a fragmented distribution. The present study have identified 2 - 4 areas in Skåne with suitable habitat potentially large enough to harbor a great bustard population. There are also larger areas on Öland that are suitable. However, there are issues that have to be solved during a reintroduction like: predation, fragmentation of infrastructure, and habitat management. Prior to a reintroduction it would be desirable to genetically analyze which donor population that is most suitable, although the options are limited. A reintroduction would have positive socioeconomic benefits mainly through tourism effects and the negative effects are, if any, few.

Future recommendations

1. Analyze how the former Swedish population is related to today's living populations to identify a population with similar genetic variation.
2. Start the work with: allocating long term funding, finding available donor populations, and starting the process to identify and collaborate with landowners, farmers and authorities in the topical areas.
3. When a breeding program (with eggs or captive breeding) is secured practically and financially, it is time to set up a release area and imply bustard habitat conservation management. Since the great bustard is a long lived species habitat improvements can be done as the release continues.

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References

Allen, M. G. (2009). The re-identification of great bustard (Otis tarda) from Fishbourne Roman Palace, Chichester, West Sussex, as common crane (Grus grus). *Environmental Archaeology*, 14(2), pp 184–190.

Alonso, J. C., Magaña, M., Alonso, J. A., Palacín, C., Martín, C. A. & Martín, B. (2009). The Most Extreme Sexual Size Dimorphism Among Birds: Allometry, Selection, and Early Juvenile Development in the Great Bustard (Otis tarda). *The Auk*, 126(3), pp 657–665.

Alonso, J. C., Martín, E., Alonso, J. A. & Morales, M. B. (1998). Proximate and ultimate causes of natal dispersal in the great bustard Otis tarda. *Behavioral Ecology*, 9(3), pp 243–252.

Alonso, J. C., Morales, M. B. & Alonso, J. A. (2000). Partial Migration, and Lek and Nesting Area Fidelity in Female Great Bustards. *The Condor*, 102(1), pp 127–136.

Alonso, J. C., Palacín, C. & Martín, C. A. (2003). Status and recent trends of the great bustard (Otis tarda) population in the Iberian peninsula. *Biological Conservation*, 110(2), pp 185–195.

Anonymous (2013). *Life+ Project summery report "Reintroducing the great bustard to southern England" Year 3 summery* [online].

Artfakta.se. [online] (2014-11-19) (Artfakta). Available from: http://www.artfakta.se/GetSpecies.aspx?SearchType=Advanced. [Accessed 2014-11-19].

Artskyddsförordningen (1999). [online]. Available from: http://www.naturvardsverket.se/hb/Artskyddsforordningen/Lagtolkningar/Artskyddsforordningen/. [Accessed 2014-11-19].

Ash, D., Toynton, P. & Davis, S. (2005). *Management of chalk grassland on Salisbury Plain military training area*. Tilshead: Salisbury Plain Life Project. ISBN 1857168224 9781857168228.

Bengtsson, J., Ahnström, J. & WEIBULL, A.-C. (2005). The effects of organic agriculture on biodiversity and abundance: a meta-analysis. *Journal of applied ecology*, 42(2), pp 261–269.

Berlin, G. & Rosquist, G. (2014). *Här finns höga naturvärden i Skåne*. Skåne: Länsstyrelssen.

Bird Directive (2009). [online]. Available from: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0147. [Accessed 2014-12-13].

Bird life International. *The IUCN Red List of threatend species*. [online] (2013) (Otis tarda). Available from: http://maps.iucnredlist.org/map.html?id=22691900. [Accessed 2014-11-19].

Boatman, N. D., Brickle, N. W., Hart, J. D., Milsom, T. P., Morris, A. J., Murray, A. W. A., Murray, K. A. & Robertson, P. A. (2004). Evidence for the indirect effects of pesticides on farmland birds. *Ibis*, 146, pp 131–143.

Bradshaw, R. (2002). Grazing Ecology and Forest History By F.W.M. Vera: CABI Publishing, Wallingford, Oxon, UK, ISBN 085 199 442 3. *Forest Ecology and Management*, 165(s 1–3), pp 327–329.

Bravo, C. & Ponce, C. (2012). Diet of young Great Bustards Otis tarda in Spain: sexual and seasonal differences. *Bird Study*, 59(2), pp 243–251.

Breife, B. (2003). *Sällsynta fåglar i Sverige*. Stockholm: Sveriges ornitologiska fören. (Vår fågelvärld. Supplement, 0504-9520 ; 39). ISBN 91-88124-26-6 (inb.).

Britten, N. (1995). Qualitative Research: Qualitative interviews in medical research. *BMJ*, 311(6999), pp 251–253.

Brusewitz, G. (1999). Makten över jakten. *Populär Historia* 1999(6). Available from: http://www.popularhistoria.se/artiklar/makten-over-jakten/. [Accessed 2014-11-11].
Burnside, R. J., Carter, I., Dawes, A., Waters, D., Lock, L., Goriup, P. & Székely, T. (2012). The UK great bustard Otis tarda reintroduction trial: a 5-year progress report. *Oryx*, 46(01), pp 112–121.
Collins, K. L., Boatman, N. D., Wilcox, A. & Holland, J. M. (2003). A 5-year comparison of overwintering polyphagous predator densities within a beetle bank and two conventional hedgebanks. *Annals of Applied Biology*, 143(1), pp 63–71.
Cramp, S. (1980). *Handbook of the birds of Europe, the Middle East, and North Africa : the birds of the western Palearctic. Vol. 2, Hawks to bustards*. Oxford: Oxford Univ. Press. ISBN 0-19-857505-X.
Dal, B. (1996). *Sveriges zoologiska litteratur : en berättande översikt om svenska zoologer och deras tryckta verk 1483-1920*. Fjälkinge: Orbis pictus. ISBN 91-972886-0-8 (inb.).
Demeter, L., Fatér, I. & Szép, T. (1994). The degree and couses of destruction of endagerd great bustards nest in hungarian populations. *Ornis Hungarica*,.
Dorothee, M. (2014). Intervju about great bustard conservation in Finer broch.
Eisenberg (2008). Post relese survival.
Ekberg, B., Nilsson, L. & Sjöberg, M. (1994). *Skånes fåglar i dag och i gången tid. D. 1, Lommar till och med alkor*. Lund: Skånes ornitologiska fören. : ISBN 91-87896-17-6 (inb.).
EU (n.d.). Otis tarda fact-sheet SWIFI. EU. Available from: http://ec.europa.eu/environment/nature/natura2000/management/docs/Otis%20tarda%20factsheet%20-%20SWIFI.pdf. [Accessed 2014-12-12].
Faragó, S. (1992). Cluth size of the great bustard (Otis tarda) in Hungary. *Aquila*,.
Gadamer, H. (1852). *Angabe der im nordöstlichen Schonen vorkommenden Vögel mit besonderer Rücksicht auf die hier brütenden.* (Naumannia).
greatbustard.org. [online] (2014) (The Project | The Great Bustard Group). Available from: http://greatbustard.org/the-project/. [Accessed 2014-11-03].
grosstrappe.at. [online] (2014) (Conservation measures). Available from: http://www.grosstrappe.at/en/great-bustard/conservation-measures.html. [Accessed 2014-11-05].
Götmark, F. (2002). Predation by sparrowhawks favours early breeding and small broods in great tits. *Oecologia*, 130(1), pp 25–32.
Habitat Directive (1992). [online]. Available from: http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1424266835615&uri=CELEX:92003E003299. [Accessed 2014-12-09].
Huntley, B. (2007). *A climatic atlas of European breeding birds*. Lynx Edicions. ISBN 9788496553149.
Isakov, Y. A. (1974). Present distribution and population and status of the Great Bustard Otis tarda Linnaeus. *Journal of the Bombay Natural History Society*, 71, pp 433–44.
Janss, G. F. E. & Ferrer, M. (2000). Common Crane and Great Bustard Collision with Power Lines: Collision Rate and Risk Exposure. *Wildlife Society Bulletin*, 28(3), pp 675–680.
jordbruksverket.se. [online] (2014) (Förgröningsstöd 2015). Available from: http://www.jordbruksverket.se/amnesomraden/stod/jordbrukarstod2015/forgroningsstod2015.4.53b6e8e714255ed1fcc726f.html. [Accessed 2014-11-10].
Krüger, K.-O. (2010). *Machbarkeitsstudie Grosstrappe*. NABU Landesverband Niedersachsen.

Lane, S. J., Alonso, J. C., Alonso, J. A. & Naveso, M. A. (1999). Seasonal changes in diet and diet selection of great bustards (Otis t. tarda) in north-west Spain. *Journal of Zoology*, 247(2), pp 201–214.

Lane, S. J., Alonso, J. C. & Martín, C. A. (2001). Habitat preferences of great bustard Otistarda flocks in the arable steppes of central Spain: are potentially suitable areas unoccupied? *Journal of Applied Ecology*, 38(1), pp 193–203.

Langgemach, T. (2008). Memorium of understanding the middle-european population of great bustard German national report. Available from: http://www.cms.int/ruddy-headed-goose/en/legalinstrument/middle-european-great-bustard. [Accessed 2014-11-05].

Langgemach, T. (2013). Guidlines of reinforcemeant and reintroduction of Great bustard Otis tarda.

Langgemach, T. (2014). Intervju about the great bustard conservation in Germany and possible reintroduction to Sweden.

Langgemach, T. & Watzke, H. (2013). Naturschutz in der Agrarlandschaft am Beispiel des Schutzprogramms Grosstrappe (Otis tarda). *Julius-Kühn-Archiv*, (442), p 112.

Lansstyrelsen.se. [online] (2014) (Skanörs ljung). Available from: http://www.lansstyrelsen.se/skane/Sv/djur-och-natur/skyddad-natur/naturreservat/vellinge/skanors-ljung/Pages/_index.aspx. [Accessed 2014-10-28].

Von Linné, C. (1751). *Carl Linnaei Skånska resa, på höga öfwerhetens befallning förrättad år 1749. Med rön och anmärkningar uti oeconomien, naturalier, antiquiteter, seder, lefnads-sätt. Med tilhörige figurer. Med kongl. maj:ts allernådigste privilegio.* Stockholm. (XIV + 434 (468) s).

Magaña, M., Alonso, J. C., Alonso, J. A., Martín, C. A., Martín, B. & Palacín, C. (2011). Great Bustard (Otis tarda) nest locations in relation to leks. *Journal of Ornithology*, 152(3), pp 541–548.

Mann, M. E. (2002). ”The Little Ice age” - The Earth system: physical and chemical dimensions of global environmental change. Chichester. (Encyclopedia of Global Environmental Change).

Martín, A. C., Alonso, C. J., Alonso, A. J., Palacín, C., Magaña, M. & Martín, B. (2007). Sex-biased juvenile survival in a bird with extreme size dimorphism, the great bustard Otis tarda. *Journal of Avian Biology*, 38(3), pp 335–346.

Mathiasson, S. (1960). Faunistiskt nytt från Göteborgs Naturhistoriska Museum 1959. *Göteborgs Museum Årstryck*, pp 11–20.

Miljomal.se. [online] (2014) (Miljömålen). Available from: http://www.miljomal.se/sv/Miljomalen/. [Accessed 2014-11-16].

Morales, M. B., Alonso, J. C., Alonso, J. A. & Martín, E. (2000). Migration Patterns in Male Great Bustards (Otis tarda). *The Auk*, 117(2), pp 493–498.

Morales, M. B. & Martín, C. A. (2002). Otis tarda great bustard. *BWP Update*, 4(3), pp 217–232.

Myrdal, J. (1998). Det svenska jordbrukets historia. Available from: http://www.ksla.se/anh/amnessokning/allmant/fembandsverket/. [Accessed 2014-11-19].

nhm.ac.uk. [online] (2014) (Otis tarda). Available from: http://www.nhm.ac.uk/nature-online/species-of-the-day/biodiversity/endangered-species/otis-tarda/taxonomy/. [Accessed 2014-11-19].

Nilsson, S. (1835). *Skandinavisk Fauna del II Foglarne*. Andra upplagan. Lund.

Nilsson, S. (1858). *Skandinavisk Fauna Foglarna andra bandet*. Lund.

nordensark.se. [online] (2014) (Om nordens ark). Available from: http://www.nordensark.se/om-nordens-ark/. [Accessed 2014-01-12].

Osborne, P. E., Alonso, J. C. & Bryant, R. G. (2001). Modelling landscape-scale habitat use using GIS and remote sensing: a case study with great bustards. *Journal of Applied Ecology*, 38(2), pp 458–471.

Palacín, C., Alonso, J. C., Alonso, J. A., Magaña, M. & Martín, C. A. (2011). Cultural transmission and flexibility of partial migration patterns in a long-lived bird, the great bustard Otis tarda. *Journal of Avian Biology*, 42(4), pp 301–308.

Palacín, C., Alonso, J. C., Martín, C. A. & Alonso, J. A. (2012). The importance of traditional farmland areas for steppe birds: a case study of migrant female Great Bustards Otis tarda in Spain. *Ibis*, 154(1), pp 85–95.

Palacín, C. & Alonso López, J. C. (2008). An updated estimate of the world status and population trends of the great bustard Otis tarda. *Ardeola*, 55(1), pp 13–25.

Pitra, C., Lieckfeldt, D. & Alonso, J. C. (2000). Population subdivision in Europe's great bustard inferred from mitochondrial and nuclear DNA sequence variation. *Molecular Ecology*, 9(8), pp 1165–1170.

Pitra, C., Lieckfeldt, D., Frahnert, S. & Fickel, J. (2002). Phylogenetic relationships and ancestral areas of the bustards (Gruiformes: Otididae), inferred from mitochondrial DNA and nuclear intron sequences. *Molecular phylogenetics and evolution*, 23(1), pp 63–74.

Raab, R. (2012). National report for the great bustard MOU and action plan - Austrian National report. Available from: http://www.cms.int/ruddy-headed-goose/en/legalinstrument/middle-european-great-bustard. [Accessed 2014-11-05].

Raab, R., Kollar, H. P., Winkler, H., Faragó, S., Spakovszky, P., Raab, S. & Schütz, C. (2010). Die Bestandsentwicklung der westpannonischen Population der Gro\s strappe, Otis tarda Linnaeus 1758, von 1900 bis zum Winter 2008/2009. *Egretta*, p 74.

Raab, R., SchüTz, C., Spakovszky, P., Julius, E. & Schulze, C. H. (2012). Underground cabling and marking of power lines: conservation measures rapidly reduced mortality of West-Pannonian Great Bustards Otis tarda. *Bird Conservation International*, 22(03), pp 299–306.

rewildingeurope.com. [online] (2014) (Rewilding Europe – Making Europe a Wilder Place). Available from: http://www.rewildingeurope.com/. [Accessed 2014-12-16].

Rocha, P., Morales, M. B. & Moreira, F. (2013). Nest site habitat selection and nesting performance of the Great Bustard Otis tarda in southern Portugal: Implications for conservation. *Bird Conservation International*, 23(3), pp 323–336.

RSPB (2010). *Reintroducing the great bustard Otis tarda to southern England - Life application*. The Royal Society for the Protection of Birds.

Samzelius, H. (1915). Anteckningar om Svenska väldets skogs och jaktväsen. Stockholm. *Jägeristaten.*,.

Sastre, P., Ponce, C., Palacín, C., Martín, C. A. & Alonso, J. C. (2009). Disturbances to great bustards (Otis tarda) in central Spain: human activities, bird responses and management implications. *European Journal of Wildlife Research*, 55(4), pp 425–432.

Shrubb, M. (2011). Some thoughts on the historical status of the Great Bustard in Britain. *British Birds*, 104(4), p 180.

Solomon, S., Intergovernmental Panel on Climate Change. & Working Group I. (2007). *Climate change 2007: the physical science basis : contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge; New York: Cambridge University Press. ISBN 9780521880091 0521880092 9780521705967 0521705967.

State of Brandenburg (2009). The great Bustard - the Brandenburg ostrich. Brandenburg state conservation bird centre. Available from: www.lugv.brandenburg.de. [Accessed 2014-10-30].

Streich, W. J., Pitra, C., Litzbarski, H. & Quassier, C. (1996). Zur Populationsdynamik der Grosstrappe (Otis t. tarda L., 1758)–eine Computersimulation. *Natursch. Landschaftspfl. Brandenburg*, 5, pp 91–94.

Sutherland, W. J. (1998). Evidence for Flexibility and Constraint in Migration Systems. *Journal of Avian Biology*, 29(4), pp 441–446.

Svenning, J.-C. (2002). A review of natural vegetation openness in north-western Europe. *Biological Conservation*, 104(2), pp 133–148.

Svensson, L., Zetterström, D., Mullarney, K. & Grant, P. J. (2009). *Fågelguiden*. Bonnier fakta. ISBN 9174240390.

Synes, N. W. & Osborne, P. E. (2011). Choice of predictor variables as a source of uncertainty in continental-scale species distribution modelling under climate change. *Global Ecology and Biogeography*, 20(6), pp 904–914.

Szabolcs, N. (2009). International single species action plan for the western Palearctic population of great bustard, Otis tarda tarda.

Taylor, A. (2011). Great bustard managemeant guidlines. Available from: http://greatbustard.org/life_project/. [Accessed 2014-11-05].

Tuneld, E. (1793). *Geographie öfver konungariket Swerige samt därunder hörande länder - Göthaland, nemligen Öster- Göthland, Småland, Öland, Gottland, Wester-Göthland, Wärmeland, Dal, Bohus län, Skåne, Halland och Blekinge.* Sjunde upplagan. Stockholm: Anders J. Nordström.

Tyrberg, T. (2008). Pleistocene birds of the Palearctic. [online],. Available from: http://web.telia.com/~u11502098/pleistocene.html. [Accessed 2015-06-01].

Vera, F. W. M. (2000). *Grazing Ecology and Forest History*. CABI. ISBN 9781845933067.

Vinge, M. (1969). *Historisk Statistik för Sverige*. 2. ed Stockholm: Statistiska cetralbyrån. (1).

Wallengren, H. D. J. (1854). Brützonen der Vögel innerhalb Skandinavien. *Naumannia*.

Watzke, H. (2007a). Reproduction and causes of mortality in the breeding area of great bustard in the Saratov region of Russia. *Bustard Studies*, 6, pp 53–64.

Watzke, H. (2007b). Results from satellite telemetry of Great Bustards in the Saratov region of Russia. *Bustard Studies*, 6, pp 83–98.

yr.no. [online] (2015a) (Været som var Revingehed). Available from: http://www.yr.no/sted/Sverige/Skåne/Revingehed/statistikk.html?fbRefresh=20150209T1845. [Accessed 2015-02-09].

yr.no. [online] (2015b) (Været som var Nennhausen). Available from: http://www.yr.no/sted/Tyskland/Brandenburg/Nennhausen/statistikk.html?fbRefresh=20150209T1845. [Accessed 2015-02-09].

Appendix I

Interview notes:

	1. Vad har du själv för kunskap om stortrapp?	2. Möjliga effekter av en återintroduktion av stortrapp för biologisk mångfald?	3. Möjliga effekter av en återintroduktion av stortrapp för ekonomisk utveckling?	4. Möjliga effekter av en återintroduktion av stortrapp för samhället?	5. Vad skulle en återintroduktion till Sverige kunna betyda för arten?	6. Vilka anledningar kan man se till att stortrappen dog ut i Sverige?	7. Vilka problem kan en återintroduktion av stortrapp föra med sig?	8. Om möjligt, var i Sverige anser du att en återintroduktion av stortrapp skulle lämpa sig bäst?	9. Vilka åtgärder krävs för att vi skulle kunna lyckas med en återintroduktion ?	10. Anser du att en återintroduktion av Stortrapp är ett bra förslag?	Övrigt
Staffan Ulfstarand (25/9)	Ingen specialkunskap om stortrapp, men har sett den	Introduktion är angelägen, många jordbruksfåglar minskar t.ex. Sånglärkan en återintroduktion av stortrapp skulle gynna även andra arter så positivt för biologisk mångfald	Väldigt liten ekonomisk utveckling, kanske lite turism, det är en skygg fågel, men Sverige har ett ansvar för naturskydd och artbevarande	inget	det skulle öka artens utbredningsområde positivt för arten	Vet ej förutom generella förändringar i jordbruk, antagligen jakt, har aldrig varit talrik	inga för samhället	Skåne eller Ölands alvar, Revinge hed militärt övningsfält, Vombs ängar, Ravlunda eller Rinkaby, Skanörs ljung? Åhus-stenshuvud, stödmatning under vinterhalvåret inget hinder eller att arten inte har funnits på Öland tidigare		Ingen annan art är så aktuell eller värdefull för en återintroduktion som stortrapp	
Claes Andrén (7/10)	Ingen specialkunskap om stortrapp, har sett den	Stortrappen i sig kommer inte hjälpa någon men åtgärder som görs för att gynna stortrappen kan gynna andra arter, lämna kant-zoner etc. andra exempel är vitryggig hackspett, större ekbock som står för symbol för sina ekosystem.	eko-turism användningen av landskapet kan förändras	Genom turism, gömslen foto, I Finland används flyttbara gömslen på ett 50-tal ställen för att komma nära vilda djur björn?	En återintroduktion av arten skulle kräva att man kommer upp i en viss populationsstorlek, hur stor behöver en population vara?	Det beror troligen på förändringar i landskapet	Svårt att se problem, eventuellt om de skulle påverka grödor för mycket, kanske problem med naturvårdsverket?	Ölands alvar, till stor del oförändrat endast grundvatten nivån har sänkts delvis, Skåne har förändrats ett helt annat landskap idag än under 1700- 1800 talet steppliknande med öppen sandjord och näringsfattigt. De områden där trappen påträffades sist är kanske inte måste vara lämpligast? Kristianstad, Åhus är kanske mindre betat än Revinge hed, olika skjutfält?	Nordens ark kan gärna tänka sig att hjälpa till med utsättning det är bra om det finns ett åtgärdsprogram för arten eller kanske man kan göra ett pilot-projekt	Om det finns lämplig miljö att sätta ut dem i.	
Christer Larsson (6/10)	Har länge funderat på uppfödning av stortrapp	Inte om ”business as usual” men vid eventuella restaureringar i landskapet JA	Inte för jakten men för turismen så skulle det kunna finnas möjligheter	Positivt, men kan inte se negativa sidor	Marginellt små områden jämfört med andra områden inom utbredningsområdet till exempel Ungern	En kombination av jakt och förändringar i jordbruket, Kanske klimatförändringar?	Inte många problem för samhället	Ölands alvar är där jag har tänkt mig, kanske områden i Skåne Ravlunda Revinge hed. Halland, gotland? En besprutad åker måste ha färre insekter än alvaret…	Vi föder gärna upp trappar här vi har 70ha betesmark, Insamlade ägg-> ingen inprägling av föräldrarna kan leda till problem, föräldrauppfödda alltid bättre olika signaler för olika te.x. predatorer överförs.	Ja om det finns lämplig miljö att sätta ut dem i.	

Torsten Langgemach (14/10)	Responsible for the bird center in Germany has been working with the great bustard project for 15 years.	The great bustard is an umbrella species many other farmland-birds will benefit from the conservation of great bustard, here we have seen an increase of 18 different bird species	The farmers are will get a more stable income when they can rely on subsidies, they are not as dependent on the weather, The tourism increases because of the great bustard. Here in the center we have more than 2000 visitors each year mainly during the display season. It is a unique feature, the local people are not so interested but people from further away come and hunters come as well to see the bird. Guided tours, accommodation and a restaurants as well.		Yes a reintroduction in Sweden would be positive for the species we don´t know what will happen in the future and it in the future the some of the current populations/range could be endangered than we could translocate birds from Sweden, the climate change will affect the species range and already the great bustard are disappearing in south Spain.	I don´t know, Hunting? Otherwise the same reasons as here. Reintroduction of the little owl in th50´s they still have problems	For the bustard predation is the main problem here, But there is not any big conflict between farmers and bustard or other negative aspects, Swans can be a problem		Open landscape, mown meadows, grassland, Pasture is not the main areas very extensive grazing otherwise it will not be used by bustards.	Yes, it would be positive for the great bustard, who knows in the future we might need to translocate bustards from Sweden to Germany?	
Martin Green (20/10)	Ingen expert på stortrapp	Kan vara svårt att få till extensivt jordbruk åkermark, men naturvårdsåtgärder för stortrapp skulle kunna gynna biologisk mångfald, den skulle bli en symbolart för gräsmarker.	Bönderna skulle kunna få mer bidrag för marker som är skötta för stortrapp, Turism?	Det är ju ett jaktbart vilt, men det är ju om det skulle bli många stortrappar	En etablerad stam i Sverige skulle innebära en förstärkning av beståndet	Vet ej, Jakt, förändringar i markanvändning, försämring för rovdjur/bytesdjur, idag finns det mer rovdjur så en jakt på räv skulle nog behövas	Restriktioner i markanvändning, Vilket avelsmaterial ska man använda sig av, stannande eller flyttande population?	Skjutfälten i Skåne, trapparna behöver högre gräs som kan skydda boet, Sydöstra Öland, på alvaret finns det gott om insekter som gräshoppor, skulle tro att stortrapp skulle trivas där de östra delarna av Öland är mer ostörda och glest befolkade i jämförelse med västra, snödrevet på vintern kan dock bli ganska stort både på Öland och i Skåne.	Det måste finnas gräsmark och odlingslandskap nära varandra, vad kommer lantbrukarna att få ut av detta? I lärkprojektet är de flesta lantbrukarna intresserade, även i storkprojektet	Jag är skeptisk, finns möjligheterna? Just den här arten kommer längre ner på min lista över arter som jag skulle se insatser för spec. om pengarna som används ställs mot andra projekt, Att rädda en art i sig är inte så stort mervärde men att rädda en art som medför förbättrad livsmiljö för andra arter vilket skulle kunna vara fallet för stortrappen. t.ex. Vitryggig hackspett.	
Petter Haldén (24/10)	Ingen specialkunskap om stortrapp, har sett den två gånger en gång i Spanien, Mongoliet på gränsen till Sibirien har också sett stortrappshabitat i kina	Beror på hur man sköter miljön som stortrappen ska återföras till. Om man förbättrar miljön för stortrappen så kommer nog många insekter och växter gynnas, bland fåglar så tror jag framförallt att det är fältpiplärkan som skulle gynnas!	Turism, att få se stortrapp är sevärt och kommer att locka besökare, existerande exempel är tranorna i Hornborgasjön eller sångsvan vid Tysslingen	Besöksnäringen skulle kunna öka	Det är positivt, viktigt att man återinför trappar från rätt population	Jag har ingen uppfattning men om jag skulle gissa så tror jag att jakt var den främsta anledningen med tanke dåliga tider och att folk blev tvungna att utvandra till Amerika, om man inte har mat på bordet och det står 16kg kött på åkern så	Predation kan bli ett stort problem för trappen, inte så mycket problem för jordbruket men om bönderna blir tvungna att "krångla" så vill de bli få ekonomisk ersättning eftersom det tar av deras tid.	Skjutfälten i Skåne, trapparna behöver högre gräs som kan skydda boet, Syd östra Öland, på alvaret finns det gott om insekter bland annat trumgräshoppan, skulle tro att stortrapp skulle trivas där de östra delarna av Öland är mer ostörda och	Viktigt med bra kontakt med brukarna redan från början så blir de en del av projektet, samt att det finns föda åt ungkycklingar	Kul och bra idé, lätt att engagera folk när det är en spektakulär art!	

						jagar man det. Om den finns kvar i t.ex. Tyskland så tror jag inte jordbruket är den främsta orsaken.		glest befolkade i jämförelse med västra, snödrevet på vintern kan dock bli ganska stort både på Öland och i Skåne.			
	1. Vad har du själv för kunskap om stortrapp?	2. Möjliga effekter av en återintroduktion av stortrapp för biologisk mångfald?	3. Möjliga effekter av en återintroduktion av stortrapp för ekonomisk utveckling?	4. Möjliga effekter av en återintroduktion av stortrapp för samhället?	5. Vad skulle en återintroduktion till Sverige kunna betyda för arten?	6. Vilka anledningar kan man se till att stortrappen dog ut i Sverige?	7. Vilka problem kan en återintroduktion av stortrapp föra med sig?	8. Om möjligt, var i Sverige anser du att en återintroduktion av stortrapp skulle lämpa sig bäst?	9. Vilka åtgärder krävs för att vi skulle kunna lyckas med en återintroduktion?	10. Anser du att en återintroduktion av Stortrapp är ett bra förslag?	Övrigt
Martin Tjernberg (29/10)	Jag har begränsad kunskap av stortrapp. Jag har dock sett den i Mellaneuropa. Ur sprungligen är det en stäppfågel, finns numera i stor utsträckning i jordbruks miljöer. Kan ha problem med kollisioner, vägar/ledningar.	Alla arter som dog ut efter 1850 är med på svenskarödlistan. Jag har svårt att se att stortrapp skulle konkurrera medandra arter, och mer biologisk mångfald är positivt	Fågelskådare kommer att "vallfärda" för att se fåglarna, även "vanliga" natur-intresserade människor. Det ta kan gynna den lokala näringen i området runt ev. återintroduktionsplatser. Stortrappen blir ett flaggskepp för kommun/landskap (reklampelare).	Det kommer att kosta en hel del att återinföra stortrappen eftersom ett sådant projekt kommer att ta tid innan det blir "självgående". Jämför medstorkprojektet som startade 1989 och först nu börjar ge nöjaktig effekt. Även projekt pilgrimsfalk tog lång tid innan det gav önskvärd effekt. Efter ev. lyckad introduktion måste förmodligen åtgärder kontinuerligt ske, t.ex. åtgärder för vinteröverlevnad (utfodring), vilket kostar.	Även om populationen i Sverige inte skulle kunna bli speciellt stor, så är det positivt för artens överlevnad om den finns i flera delpopulationer.	Jakt skulle kunna vara en anledning, även om jag inte vet om man på 1800-talet jagade denna art. Förr (1800-talet) sköt man emellertid "allt" eftersom det ofta var brist på föda för befolkningen. Arter som decimerades kraftigt under senare delen av 1800-talet p.g.a. jakt var t.ex. grågås, gråtrut, dubbelbeckasin. Rationalisering i jordbruk (Skåne) bidrog troligen också till trappens försvinnande.	Frågan är vem som kan betala - blir kanske det största problemet? Kanske en stiftelse skulle kunna fungera - jag tror att man har det i fallet med storkprojektet. Det är högst osannolikt att naturvårdsverket skulle avsätta medel. Däremot kan naturvårdsorganisationer möjligen bidra med en del? Stortrappen var, vad jag förstår, en flyttfågel i Sverige. Detta kan bli ett problem. En lyckad återintroduktion tror jag förutsätter att fåglarna blir stannfåglar. Detta medför i sin tur att vinterutfodring, tidvis även snöplogning av fält med lämplig föda, blir nödvändigt (kostar).	Ölands alvar med omgivande jordbruksmark förefaller för mig vara lämpligaste område. Kanske skjutfälten i Skåne – har tidigare inte ens tänkt på dem som lämpliga områden … men hur blir det i så fall med militärövningarna, helikopter? Tolererar arten sådan störning? Stora slättbygder, i Västra-götland t.ex.? Tror dock att återintroduktion har bättre förutsättningar att lyckas ju längre söderut den sker (vinterförhållanden).	Behöver man göra några åtgärder i jordbruket? I så fall är det vinterutfodring, odling av raps, eller att ploga snötäckta fält vid svåra vinterförhållanden som blir nödvändigt. Det blir med stor sannolikhet nödvändigt med volontärer, eftersom jag har svårt att tro att medel avsätts från staten till återintroduktion. Någon/några få avlönade personer (koordinatorer) måste dock finnas. Samarbete med trapp-projekt i Mellaneuropa/ England nödvändigt.	Är det möjligt? Efter din presentation av artens ekologi i Mellaneuropa får jag ändra på min tidigare uppfattning, eftersom arten tydligen inte behöver jättestora öppna arealer? En återintroduktion får inte medföra att medel avsatta till hotade arter (ÅGP) minskar eller dras in. Om det går att finansiellt (stiftelse el. dyl.) ordna en återintroduktion så har jag personligen inga invändningar mot förslaget.	
Jan Hultgren (6/11)	Begränsad vet att den har funnits i Skåne tidigare och att den tycker om raps	vet inte, den biologiska mångfalden som finns idag har ju klarat sig utan stortrapp	För lantbruket ser jag ingen vinning om det inte finns möjlighet för jakt så kan det finnas intresse speciell från större gods och gårdar som vårdar sina viltstammar	Jag är ingen fågelexpert men fån naturvårdshåll så har jag inte hört någonting om stortrapp däremot stork och storkprojektet har det pratats mycket om	Ur ett fågelperspektiv så måste ju en återintroduktion vara positiv en liten population får antagligen ett starkt skydd…	jakt, Förändring i jordbruket kanske? Stora förändringar redan i början av 1800-talet med enskiftesdelning men även på 1860-talet	Eftersom den äter raps så skulle den kunna medföra skador på rapsodlingen eftersom det är en viktig gröda i Skåne om den får allmän utbredning ett exempel är vitkindad gås som idag är		Finns det intresse från jordbrukar-håll? Idag är det på gång med nya förgröningsområden "ekotjänst" områden sprutning och gödslingsfria zoner även inom konventionellt lantbruk, enskilda	Nej det tycker jag inte vi har klarat oss utan den i över 150 år och den har försvunnit ur folks medvetande till skillnad från storken, det finns nog inget större intresse från	Betesskador på raps varierar beroende på år men det kritiska är om djuren betar av tillväxtpun

							väldigt talrik jämfört med tidigare		lantbrukare måste tänka på kollektivet innan man sätter ut någon vild art t.ex. vildsvin...	medlemmar i LRF över lag förutom enskilda mark o godsägare, det är klart att en mindre population som i Tyskland 150 på fåglar kommer inte orsaka något större problem men om den blir talrik så kan det bli konflikter.	kten på plantan.
Helena Lager (24/11)	Har sett arten i Ungern och Spanien i häckningsmiljö, (ornitolog) men har annars inga specifika stortrappskunska per	Stortrappen betar och äter insekter, positivt för mångfalden, tror ej att den skulle konkurrera med vanliga betesdjur, Åtgärder för stortrapp skulle definitivt gynna många andra hotade arter, åtgärder i torra öppna miljöer kommer att behövas vare sig vi har stortrapp eller ej.	Det är en intressant fågel finns möjligheter för turism både fågelskådare och vanliga människor, framförallt på kort sikt. Men det är alltid svårt att ta betalt för naturen.	Inte många, förutom att det kan ge ett ökat intresse för djur och växter, naturen och det är alltid lovvärt.	Tidigare population var en randpopulation och var därmed inte så betydande, områden här är inte lika stora som t.ex. Pustan eller Spanien men en återintroduktion här skulle förhoppningsvis vara positiv.	Kan för lite om detta, men gissningsvis så är den förändrade markanvändningen av stor betydelse/orsak	I så fall är det skador på grödor (raps) annars tror jag inte att det finns andra problem.	Områden som finns kvar i Skåne där den fanns tidigare, På Öland har den inte funnits vilket gör det mer tveksamt att införa den här, och nödvändigt det är inte gynnsamt för mycket liv när det blir en hård vinter. Svårt att hitta mat på backen.	Det krävs en god kunskap om stortrappens ekologi, gräsmarkerna behöver nog inte några åtgärder, i så fall är det jordbruksmarkerna, kanske sprutfria zoner eller speciella grödor som trappen behöver.	Jag är kluven, idén är "galen och kul" men det finns så många andra arter som vi behöver jobba med och ekonomin är begränsad, men om det finns ett bra underlag så kan ju "mytomspunna arter" kan väcka intresse för naturvården.	Det finns gott om gräshoppor i framförallt fuktmarker na, vi har jobbat och kommer fortsätta att arbeta med predatorko ntroll några år till. Alvaret har också en del vadare men inte lika många.
Mikael Svensson (25/11)	Har sett stortrapp i centrala Spanien i torra sandiga stäppliknande områden men även i Österrike. Jobbat med svensk fågelatlas och hotade arter bl.a. Fjällgås	Det är en paraplyart, arealkrävande både växter, insekter och fåglar skulle gynnas av en miljö lämplig för stortrapp, men det kans vara svårt att hitta tillräckligt stora områden eller att ha råd att betala för åtgärder för stortrapp, i vilken skala behövs åtgärder?	Tveksamt, eko-turism är det i så fall, ett uppfödningscenter skulle kunna ta emot besökare men frågan är om det kommer bli någon större turism attraktion. Det är svårt att ta betalt för naturen.	Svårt att bedöma, stork har funnits kvar i folks medvetande även om den slutade häcka här för ca 60 år sedan men stortrappen har varit försvunnen länge och det kommer att behövas mycket "propaganda" i så fall för att allmänheten ska vara stolta över stortrapparna.	Var går gränsen för naturvårdsutsättning ar, vilka risker finns? En isolerad population i Sverige är nog av mindre betydelse idag, men om populationen kan övervintra eller flytta till Tyskland/polen så ökar konnektiviteten och betydelsen av en svensk population. Dock så är Östersjön ett effektivt spridningshinder.	Plantering av tall, strukturomvandling i jordbruket, slumpartade händelser kan också ha spelat in eftersom stortrapp är en art med låg fekunditet och dessutom flyttande, Alla stora fågelarter ökar idag och det beror främst på att jakten har minskat, jakt kan ha spelat in, befolkningsökningen under 1800-talet var stor och svåra tider, amerikautvandringen, det måste ha ökat utnyttjandet av omgivande miljön.	För att jobba med utsättning så måste arten vara skyddad, det kan bli problem om arten rör sig utanför de områden som man har tänkt sig.	Framförallt östra Skåne från Bromölla till Kivik, främst trakterna kring Rinkaby, Revinge skjutfält är stort och en möjlighet sen så är områden från Löberöd och Vollsjö mer varierande med småjordbruk vilket skulle kunna passa stortrapp, storkarna i storkprojektet hittar dit spontat, Efter det så tror jag Öland med östra jordbruket-gräsmarkerna och alvaret skulle vara en möjlighet, Ravlunda och Kabusa är kanske möjligt men inte ett	Sandlife är ett pågående projekt där man återställer sandmarker, liknande åtgärder behövs troligen för stortrapp, hur är det med utbredningen av skog, finns samlade öppna arealer i tillräcklig omfattning, öppna upp diken, svensk naturvård behöver arbeta i en större skala med riktade intensifierade åtgärder.	Det är en resurs och prioriteringsfråga, stortrappen är en paraplyart och skulle ha positiv inverkan men jag vill inte att ett stortrappsprojekt tar pengar från andra pågående naturvårds projekt/insatser, under kommande 5-års period så försvinner mer än hälften av pengarna till miljöstödet ca:1 miljard, rådgivningen till	

								förstahandsval. Hur är insektsfenologin jämfört med stortrappens behov av föda, sammanfaller "biomasstoppen" med häckning, kläckning av kycklingar.		lantbrukarna från länsstyrelsen försvinner osv...	
	1. Vad har du själv för kunskap om stortrapp?	2. Möjliga effekter av en återintroduktion av stortrapp för biologisk mångfald?	3. Möjliga effekter av en återintroduktion av stortrapp för ekonomisk utveckling?	4. Möjliga effekter av en återintroduktion av stortrapp för samhället?	5. Vad skulle en återintroduktion till Sverige kunna betyda för arten?	6. Vilka anledningar kan man se till att stortrappen dog ut i Sverige?	7. Vilka problem kan en återintroduktion av stortrapp föra med sig?	8. Om möjligt, var i Sverige anser du att en återintroduktion av stortrapp skulle lämpa sig bäst?	9. Vilka åtgärder krävs för att vi skulle kunna lyckas med en återintroduktion?	10. Anser du att en återintroduktion av Stortrapp är ett bra förslag?	Övrigt
David Waters (24/11)	Started to help out in great bustard captive breeding project when I was 13, much later I formed the great bustard group 1998, currently director of the reintroduction project in UK (Life project) and I have experience of the species from several countries ie. Russia, Spain, Austria, Germany, Hungary I have seen great bustards in -40 to +40.	The great bustard is an fascinating species and several other species benefit from conservation work with great bustards, only in our 7ha release area we have had 7-8 other threatened bird-species nesting.	Our project receives more than 10.000 visitors each year and when we started a local stakeholders made great bustard beer and great bustard cheese and Jewelry to support us, most of our work is performed by volunteers sometimes driving an hour to get here, the interest is very big here in the UK.	The great bustard is indeed a symbol for the region here, schools have it on their symbols and the county flag of Wiltshire is now a golden great bustard, recently a string quartet dedicated their work to the great bustard and so on…	the prediction is that the range of great bustard will move northwards and in that sense it´s positive	In UK the reasons for extinction is believed to be hunting, plantation of hedges restricting the bustards land use, also changes in agriculture like actively weeding and the corn drill, the great bustard is not the king of grassland it is a myth, it thrives usually in a mosaic of agriculture fields and has a strong preference to nest in or close to bare soil. Often in a wheat field or similar crops.	Not any problems really, the major concern from the farmers has been that it will be many birdwatchers coming but so far that has not been the case and we also have a hide where you can see "wild" Great bustards.	Hard for me to answer but large areas of grassland is not essential rather stripes of grassland within farmland is more important. Conservation measures for great bustard will benefit many other species as well.	A mosaic of agriculture fields, pasture herb rich grassland, during autumn early winter and spring.	I love the idea, the more great bustard the better, however it is important to consider the IUCN- guidelines, they are generally good.	
Hans Cronert (8/12)	Jag har sett arten i Spanien på två lokaler en i Extremadura där det är mer traditionellt jordbruk med trädesmarker och extensiva betesmarker och en väster om Mallaga som är ett modernare jordbruksområde.	Rent objektivt så blir det ju en art till och precis som storken så skulle det bli en symbolart. I detta fall för öppna, torrare landskap och gräsmarker . Stortrappen skulle belysa behovet av naturvård. Jag har uppfattningen när det gäller andra arter som vitrygg eller mellanspett så ställs högre krav på miljöerna kvalitet här i Sverige än i t.ex. Polen/Tyskland eftersom	Stortrappen skulle vara positivt för besöksnäringen i vattenriket och vara ännu en attraktion bland tranor och storkar	Att införa stortrapp skulle kunna innebära en begränsning av exploaterings möjligheterna i vissa delar av området bl.a. För framtida byggnationer eller markanvändning	Jag tror att populationerna här kommer att vara marginella i jämförelse med Spanien, Ungern, men det är återigen en gissning.	Jag vet egentligen inte men jag kan tänka mig att den var förföljd, ett attraktivt vilt att jaga. Sedan så har landskapsförändringarna varit stora. I samband med skiftet flyttades gårdarna ut från byarna ut i landskapet och de ostörda ytorna minskade, landskapet är mer fragmenterat, bl. a. har skyddsplantering med	Det vet jag inte men om det blir problem med skador så regleras det av viltskaderegleringen precis som tranor och gäss.	Jag känner inte till trappen och inte det svenska landskapet tillräckligt bra men kan tänka mig Östra Skåne eller möjligen sydvästra Skåne (om det inte är för tätbefolkat), Öland med alvaret är ostört men det behövs andra miljöer också	Jag har ingen klar bild över vad som behöver göras för att klargöra förutsättningar för utplantering i Sverige men tänker mig att en landskapsanalys får göras av vilka arealer av grödor som finns och behövs, för att utifrån denna försöka bedöma om det svenska landskapet	Jag tycker att det är intressant och det skulle sätta fokus på naturvård i odlingslandskapet .	Det finns nog markägare tycker det här är spännande och andra som är mer skeptiska

		vi har en lägre produktion (lägre temperatur och kortare somrar) i Sverige. Det är viktigt att fundera över om födotillgången på insekter är tillräcklig.				tall skett på många platser. Idag är odlingen mer intensiv och vi har t.ex. bevattning och salladsodling med duk. Vi har inte kvar mosaiklandskapet och systemet med flera års träda ibland upp till 20 år. Jag vet inte hur stora ostörda områden som trapparna behöver men i Spanien så kom vi trapparna ganska nära (några hundra meter).			passar för trappen idag.		
Richard Ottvall (22/10)	Vid intervjun med Richard så följdes inte intervjufrågorna, därför så är intervjun i en sammanhängande text.	Jag varit med i ett lona-projekt sedan 2007 som främsta arbetat med predatorkontroll av kråkfåglar på Öland. Vid en återintroduktion av stortrapp så skulle det kunna finnas synergieffekter med åtgärder för vadarna. I lona-projektet så har vi sedan 2007 decimerat kråkfåglarna med 80-90% i områden på Öland, vi har även satt igen diken för att skapa våtmarker. När rävskabben kom till Öland för några år sedan så minskade predationen på vadarna drastiskt och fler häckningar lyckades, nu håller rävpopulationen på att återetablera sig och från att det hade skjutits 10 rävar skjuts det idag 100 till 150 rävar Rödspoven har ökat från 36 par till 64 par i sjömarkerna i år. Tidigare fanns ej korp pga. jakt och man fick pengar för skinn och kråkfötter, kanske kan man öka jakttrycket närmare häckningssäsongen istället för den normala jaktperioden? I projektet så lägger jägarna varje år ner över 1000-timmar frivilligt och är väldigt entusiastiska över att hjälpa till, dock ej Ottenby kungsgård. Röjning av buskmark ingår i skötselplanen för Alvaret men är tyvärr eftersatt. Idag så finns det Ängshöksrutor som finansieras av länsstyrelsen genom LEADER som är EU-finansierat, kanske kan det bli liknande trapprutor?									

Appendix II

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Skala 1:304473

Figure 5 Four localities in Skåne with potential for the great bustard. (Map modified from viss.lansstyrelsen.se; downloaded 2014-11-20).

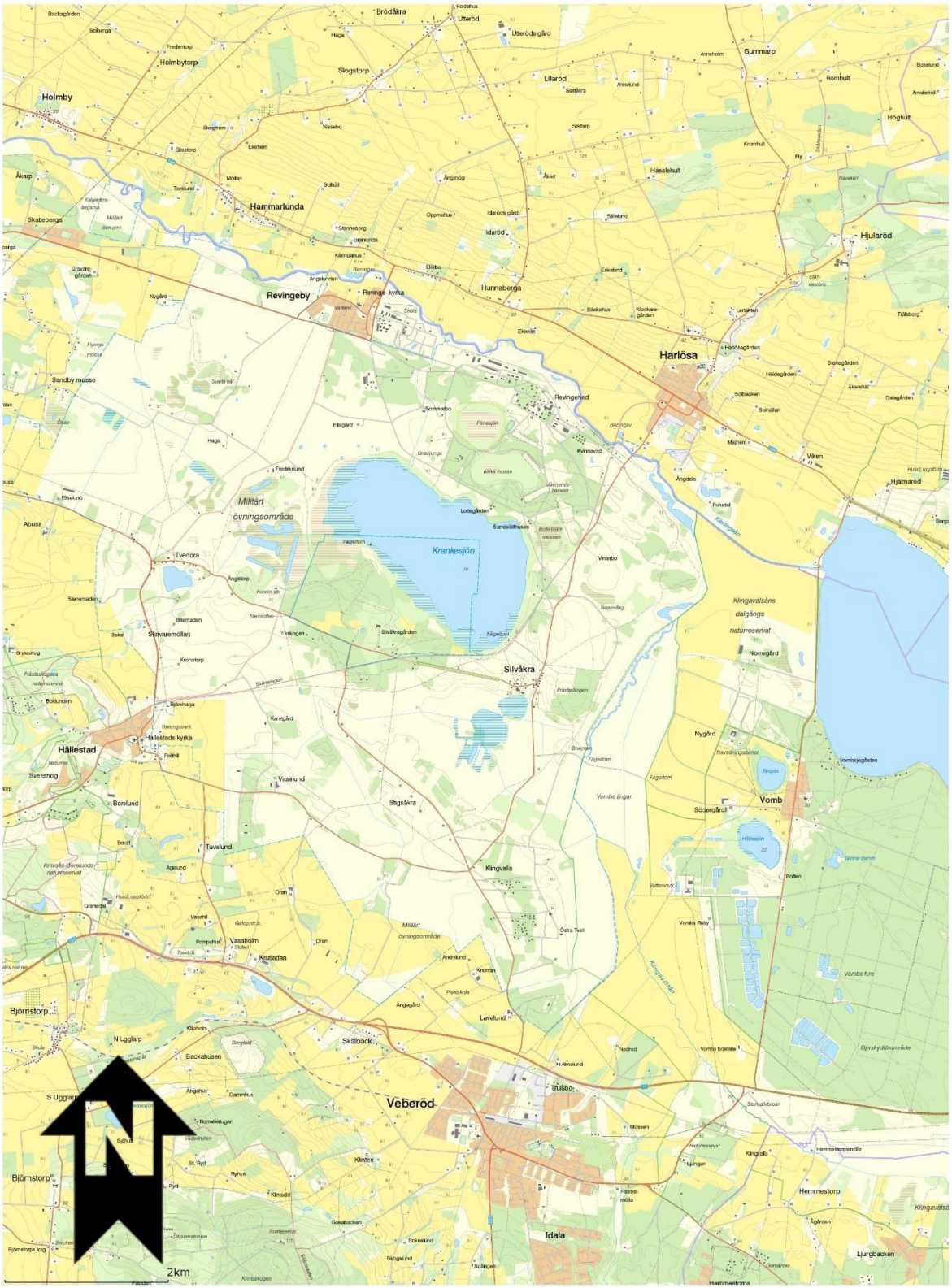

Figure 6 "Revinge heath" (Map modified from viss.lansstyrelsen.se; downloaded 2014-11-20).

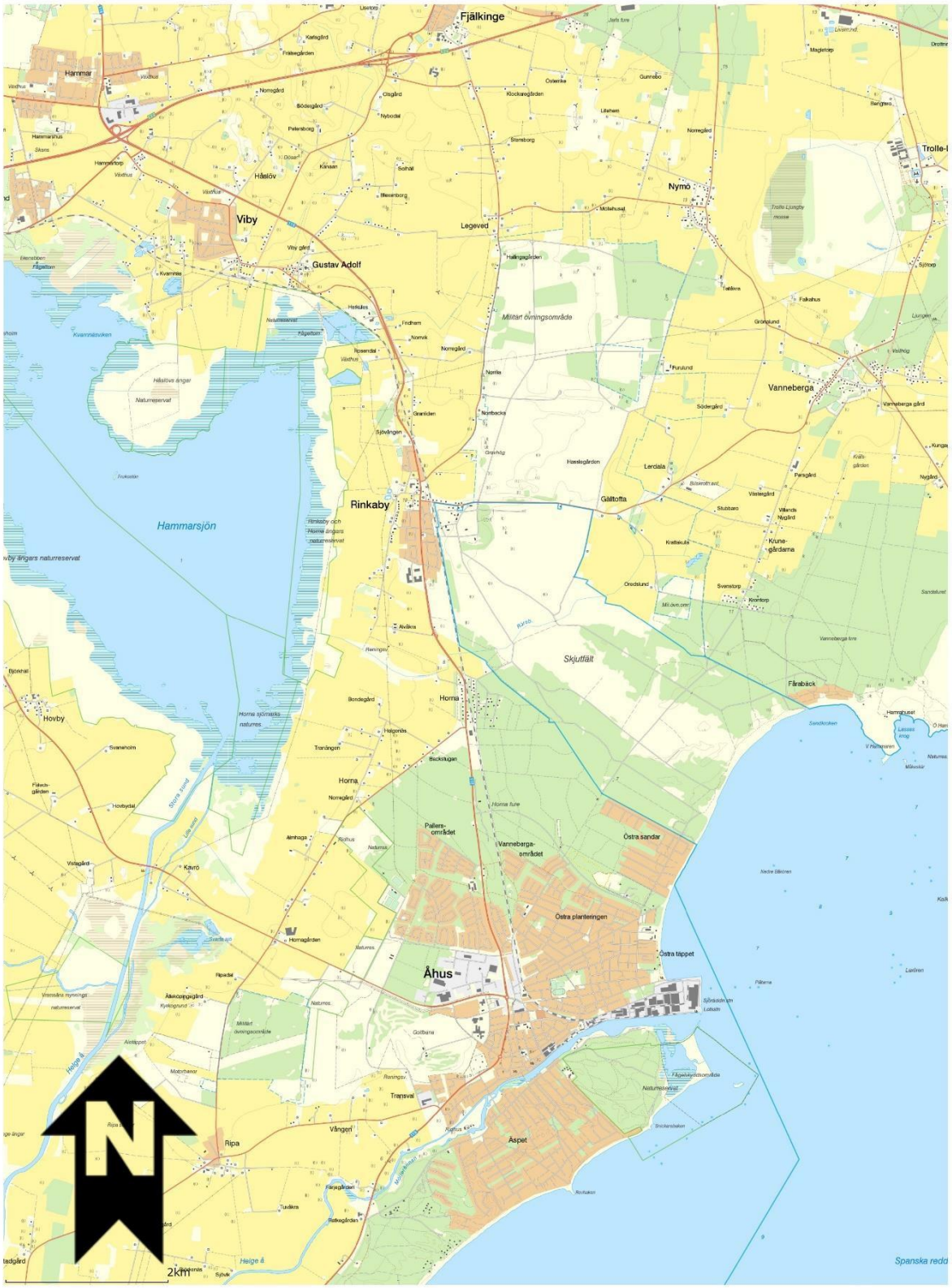

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Figure 7 "Rinkaby skjutfält"(Map modified from viss.lansstyrelsen.se; downloaded 2014-11-20).

Figure 8 "Ravlunda skjutfält" (Map modified from viss.lansstyrelsen.se; downloaded 2014-11-20).

Figure 9 "Kabusa skjutfält"(Map modified from viss.lansstyrelsen.se; downloaded 2014-11-20).

Appendix III

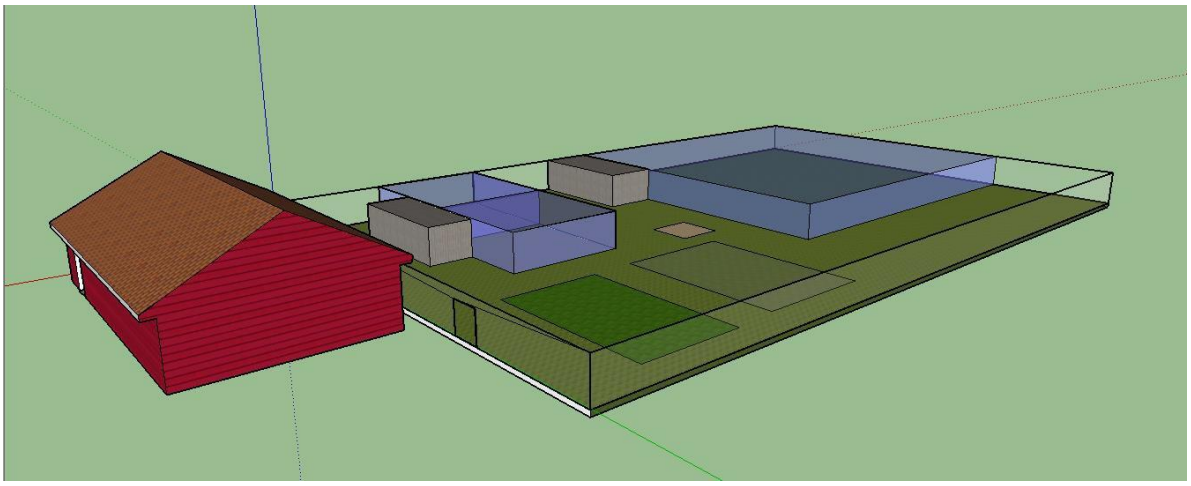

Figure 10 A 3D-example of a captive rearing facility for the great bustard (Animation: Karl Fritzson).

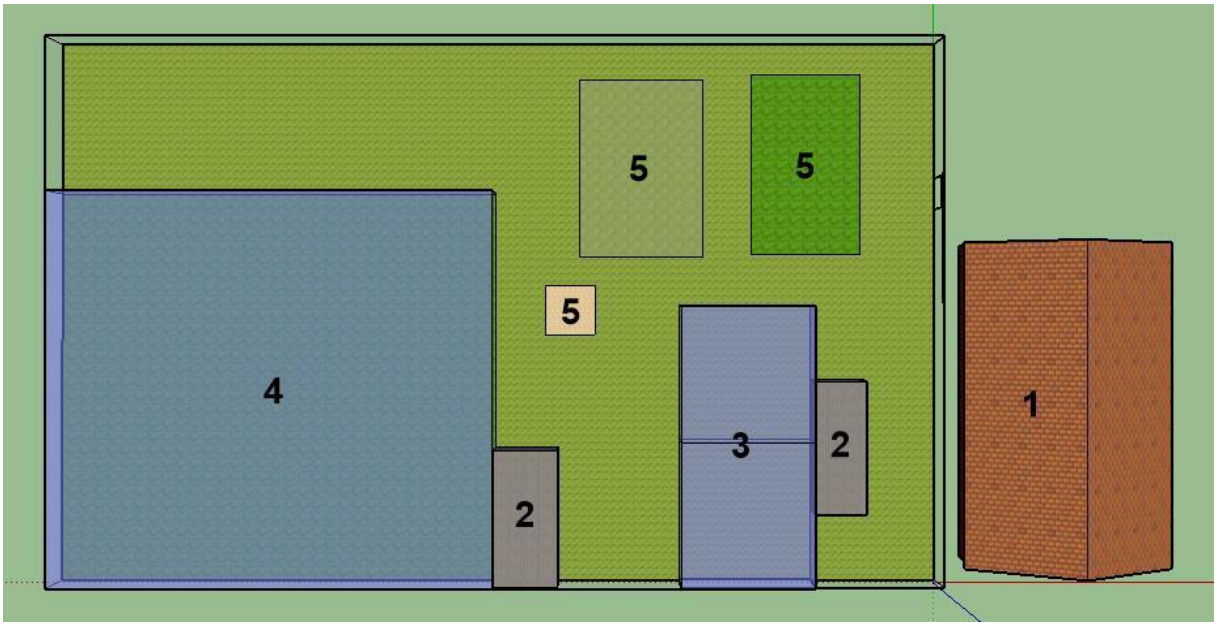

Figure 11 An example of how an captive rearing center can be disposed: 1 A house with three rooms for reception, incubation and hatching; 2 A stable with infrared heating for the chicks up to eight weeks old; 3 Net covered areas for young chicks during the first week; 4 larger net covered area as the chicks grow older; 5 Areas with cultivated crops for the great bustards i.e. sand, Oil-seed rape and Alfalfa (Animation: Karl Fritzson)

Stortrappar (*Otis tarda*) i Svenska samlingar	
Evolutionsmuseet, Uppsala Universitet, Norbyvägen 16, 752 36 Uppsala	
1 juv. hane	juni 1876, Kugeun Steppen, inköpt av shülter
1 Adult hona	Wolga, Ryssland, årtal okänt, inköpt.
1 Adult hane	Sarepta vid Volga, 1870
Biologiska museet i Oskarshamn	
1 individ	Donation från 1860-talet
Fågelmuseet i Jönköpings stadspark	
1 Adult hane	Sarepta (Wolga) 30/4 1908
Per Brahegymnasiet i Jönköping	
1 Adult hane	Sarepta Volga 8/5 1881 G Kolthoff.
Arkivcenter Syd, Porfyrvägen 20, 224 78 Lund	
2 ägg	Ursprung Sverige (Åhus)
flera ägg	Ursprung Ryssland, Tyskland, Okänt
2 skinn	Ursprung Sverige (Åhus)
1 montage	Ursprung Sverige (Åhus)
1 monterat skelett	Ursprung Sverige (Åhus)
Skelettdelar	Ursprung Sverige (Åhus)
Naturhistoriska Riksmuseet Frescativägen 40, 114 18 Stockholm	
2 hanar	NRM 534860 från Nederluleå 1833, NRM 535866 Östergötland Veckelstad, Östra Husby 7/9 1928 V. Alexandersson
2 individer	Paykulls resp. Grills gamla samlingar (slutet av 1700-tal-början1800-tal), troligen ej svenska
1 ägg	Ska vara insamlat i Åhus år 1888
Göteborgs Naturhistoriska museum Musiumvägen 10, 402 35 Göteborg	
1 hona	Insamlad i Sverige, Halland, Frillesås socken 9/3 1890
1 hona	Insamlad i Sydspanien 16/9 1875
1 Adult hane	Södra Ryssland
1 ägg	Insamlad i Sverige, Åhus 1862
Bohusläns museum Museigatan 1, 451 19 Uddevalla	
1 Adult hane	Gammal hane. Kihls ägor, Tjörn, Bohuslän 1877, Ljungman A.C.

SENASTE UTGIVNA NUMMER

2014:6 Utvärdering av lockmedel för mark-levande predatorer under midvinter-månader i Norrbottens inland.
Författare: Martin Johansson

2014:7 Role of cervids and wild boar on the presence of tick-borne encephalitis virus in Sweden.
Författare: Carmelo Gómez Martínez

2014:8 Full Circle: Upstream and downstream migration of Atlantic salmon (*Salmo salar*) in the northern Swedish river Vindelälven.
Författare: Raven Grandy-Rashap

2014:9 Nyckeltal för älg och fodertillgång på tall Pinus sylvestris och rönn Sorbus aucuparia.
Författare: Mikael Åkerblom Andersson

2014:10 Rissepareringens effekter på viltets nyttjandegrad av GROT.
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2014:11 Fysiska strukturer i Umeälvens gamla älvfåra och dess inverkan på laxsmoltens utvandringsframgång.
Författare: Viktoria Tegenfeldt

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Författare: Joanna Fahlén

2014:13 Comparison of tree cavity abundance and characteristics in managed and unmanaged Swedish boreal forest.
Författare: Sophie Michon

2014:14 Habitat modeling for rustic bunting (Emberiza rustica) territories in boreal Sweden
Författare: Emil Larsson

2014:15 The Secret Role of Elephants - Mediators of habitat scale and within-habitat scale predation risk
Författare: Urza Flezar

2014:16 Movement ecology of Golden eagles (Aquila crysaetos) and risks associated with wind farm development
Författare: Rebecka Hedfors

2015:1 GIS-based modelling to predict potential habitats for black stork (Ciconia nigra) in Sweden
Författare: Malin Sörhammar

2015:2 The repulsive shrub – Impact of an invasive shrub on habitat selection by African large herbivores
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