THE SWEDISH WHITE STORK REINTRODUCTION PROGRAMME

A review of current achievements with implications for future management

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SUMMARY

In 1954 the last breeding attempt by the White Stork (Ciconia ciconia) in Sweden failed and the species was declared extinct from the Swedish fauna. Reasons for the extinction are thought to be a combination of issues such as habitat conversion, increased mortality and an overall decline of the European White Stork populations. Since 1989 an ongoing reintroduction programme for the White Stork has been established in Scania, southern Sweden. The aim of the reintroduction programme is to re-establish a naturally breeding population of White Storks. The approach is based on captive breeding and release of established pairs that settle and breed in the vicinity to the release sites. The White Stork is also used as a flagship species for the restoration of the Swedish wetlands that have been severely affected by drainage to the point that 90% has disappeared from the area. Today (2012) there are 34 free breeding pairs of project storks in Scania. These pairs do not migrate since they have been raised in captivity and are used to being fed year round and are hence not regarded as naturally behaving. However, it has been shown that the offspring of the introduced population are able to migrate. When these return to the breeding ground as adults they can settle and breed. The objective is to establish a migrating population parallel to the stationary population and as this migrating population continues to grow collect the stationary one. Issues that have arisen over the course of the programme have been to facilitate proper migration among the juveniles as well as the low breeding success among the free breeding population. The low reproductive success has partly been explained by the fact that the breeding storks create colonies around the release sites which has resulted in competition for food and disruptive aggression among the breeding pairs. However, the issues with migration and the low reproductive success also made management question the suitability of the reintroduced individuals to persist under Swedish conditions. The originally introduced individuals deriving from northern Africa has therefore gradually been replaced by individuals of eastern European decent. Further, the uncertain financial situation due to the programme being dependent on funding that needs to be reapplied for each year has slowed down the whole process. During the last couple of years practises have changed and captive juveniles have been released in an effort to facilitate true migration behaviour. This has resulted in a juvenile migration rate of approximately 80% since 2010. Within the next few years these individuals are expected to return from migration. The future of the programme will depend on the level of return among the migrating population, the breeding success among the reintroduced individuals as well as external factors such as the uncertain development of the other White Stork populations in Europe.

SAMMANFATTNING

1954 misslyckades det sista paret vit stork med sitt häckningsförsök i Sverige och arten förklarades utdöd ur den svenska faunan. Orsakerna för artens utdöende tros vara en kombination av olika faktorer så som habitat förändringar, ökad dödlighet samt en övergripande negativ trend hos den europeiska storkpopulationen. Sedan 1989 pågår ett återintroduceringsförsök i Skåne, södra Sverige. Syftet med projektet är att återetablera en naturligt häckande population av vit stork. Metoden går ut på att föda upp individer i fångenskap och släppa ut bildade par som kan slå sig ner och häcka i närheten av utsläppsplatsen. Den vita storken används även som en flaggskeppsart för återskapandet av de svenska våtmarker som har påverkats signifikant av utdikningar till den gränsen att 90 % av dem har försvunnit. Idag (2012) har projektet åstadkommit en häckande population på 34 par på olika platser i Skåne. Dessa par har förlorat sin instinkt att migrera på grund av sina år i fångenskap där de är vana vid att utfodras året runt och betraktas därför inte som en naturlig population. Däremot har det visat sig att deras avkomma migrerar. När dessa återvänder kan de häcka parallellt med den stationära populationen. Tanken är att en migrerande population ska växa till den storleken att den stationära kan samlas in och därmed ersätta de nu häckande individerna och därmed bygga upp ett naturligt bestånd. Problem som har uppstått under programmets gång har varit att främja ett ordentligt migreringsbeteende hos ungfåglarna samt en låg häckningsframgång hos den introducerade populationen. Den låga häckningsframgången har delvis förklarats av bildandet av kolonier kring utsläppsplatserna som har resulterat i brist på föda samt störande aggressivt beteende mellan de häckande paren. Likväl fick även problemen med migrering och häckningsframgång projektledningen att ifrågasätta hur lämpliga de introducerade individerna var att häcka under svenska förhållanden. Då den ursprungliga populationen härstammar från norra Afrika beslutades det att fasa ut dessa individer och istället importera individer från Östeuropa för vidare utsläpp. Andra problem som påverkat programmets långsiktiga planering har varit den finansiella osäkerheten som uppstått då projektet är beroende av bidragsgivare och resurser måste sökas på nytt varje år. Under den senaste par åren har förändringar gjorts inom programmet då ungfåglar födda i fångenskap har släppts ut för migrering tillsammans med de frifödda ungarna. Detta har resulterat i en ungfågelflyttning på runt 80 % per år sedan 2010. Inom de nästkommande åren förväntas de flyttande ungfåglarna återkomma. Programmets framtid kommer att påverkas av återvändandegraden hos de migrerande fåglarna, häckningsframgången hos de introducerade paren samt externa faktorer så som den generellt osäkra populationstrenden hos den vita storken i Europa.

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TABLE OF CONTENTS

1. INTRODUCTION

When a species is in decline or has become locally extinct, conservation measures such as translocations, the deliberate movement and release of animals in the wild, can be an alternative for restoring the affected population (Griffith *et al.* 1989; Wolf *et al.* 1996; Fischer & Lindenmayer 2000). A reintroduction is a form of translocation and is defined by IUCN (1998) as "an attempt to establish a species in an area which was once part of its historical range, but from which it has been extirpated or become extinct". With few exceptions, a reintroduction is a slow, complex and expensive process; ultimately many of them fail (IUCN 1998). Nevertheless, as an increasing number of species are driven to extinction, it is an attractive and potentially valuable tool for conservationists aiming to restore a species in its former range (Griffith *et al.* 1989, Wolf *et al.* 1996; IUCN 1998; Fischer & Lindenmayer 2000; van Wieren 2006).

Despite reintroductions being used at an escalated rate, there are still constraints in the amount of available background knowledge (van Wieren 2006). It is a management tool that is still developing and it is therefore important to view each programme as an experiment where the acquired knowledge must be shared, no matter the outcome, in an effort to aid future programmes (van Wieren 2006).

For reintroduction programmes to be as efficient as possible it is important to continuously review their progress (Kleiman *et al.* 2000). Understanding the history of a reintroduction is also significant for programme development (Kleiman *et al.* 2000). Further, carrying out assessments of an ongoing programme facilitates information sharing, which is beneficial for similar projects carried out elsewhere (Kleinman *et al.* 2000). For these reasons, continuous reviewing should be an established part of all ongoing reintroduction programmes (Kleiman *et al.* 2000). However, these kinds of assessments are rarely executed, often due to limited resources (Kleiman *et al.* 2000).

The number of animal translocations carried out in Sweden has increased in recent decades and the practice is now often suggested as a conservation measure in Action Plans for Endangered Species, developed by the Swedish Environmental Protection Agency (Naturvårdsverket 2008). From the late 60s and onwards a number of translocation programmes for endangered or extinct birds have been initiated in Sweden (Aronsson 2013). Some of these have managed to re-establish locally viable populations, while others are still running (Aronsson 2013). One of the most well-known reintroduction programmes in Sweden is the White Stork Reintroduction Programme, which was established in 1989 (Aronsson 2013).

1.1. AIMS AND OBJECTIVES

Since initiation, no comprehensive assessment has been carried out regarding the Swedish White Stork Reintroduction Programme. The objective of this report is to gather available information about the Swedish White Stork Reintroduction Programme as well as determining key factors that may influence the future outcome of the programme. The aim is for the report to act as a supportive measure that could aid current management in the ongoing execution of the programme. Since there are similar projects being carried out all over Western Europe, it would also be valuable information sharing that could benefit the conservation of the White Stork on a greater scale.

The main questions that will be addressed in this report are; what caused the White Stork to go extinct in Sweden? How and why did the reintroduction programme start? What are the goals of the reintroduction? What has the programme achieved? What issues have arisen during the programme? How have these issues been dealt with? What are the future plans for the programme? What factors may influence the future success of the programme?

1.2. METHODOLGY

The report is based on a comprehensive literature study of both published and unpublished materials on the Swedish White Stork Reintroduction Programme, in an effort to give an as thorough description of the programme as possible. Literature was searched in the archive of the Swedish White Stork Reintroduction Programme, in scientific databases as well as on the Internet. To supplement the review with new information, interviews were conducted with a number of concerned parties, these were individuals that have been, or still are, directly associated with the programme. The interviews were mainly conducted where there is a current knowledge gap due to a limited amount of written material. In an effort to give an objective perspective of the programme, the questions were of informative character rather than opinion oriented. The scope of the report primarily covers the biological achievements of the programme and strictly organisational matters were not addressed. Finally, a short review of contemporary reintroduction literature was carried out in an effort to establish key-factors that may influence the re-establishment of the White Stork in Sweden.

2. BACKGROUND

2.1. SPECIES DESCRIPTION

The White Stork (*Ciconia ciconia*) is a large, migrating water bird characterized by its white body, black flight-feathers and long red bill and legs (Snow & Perrins 1998). There is no distinctive sexual dimorphism which can make it difficult to separate males from females (Schulz 1998). The White Stork is an opportunistic bird feeding on most animal matter it can fit in its bill (Schulz 1998). The species prefer to forage in open habitats, mainly wetlands, wet meadows and pastures, and irrigated land (Schulz 1998). The White Stork is a social species that often breed and migrate in groups (Schulz 1998). They breed in pairs on elevated objects, in areas of good foraging habitats, where they receive a good overview of the surrounding landscape (Schulz 1998). Due to its habitat requirements and breeding preferences the White Stork has long been directly associated with human settlement (Schulz 1998).

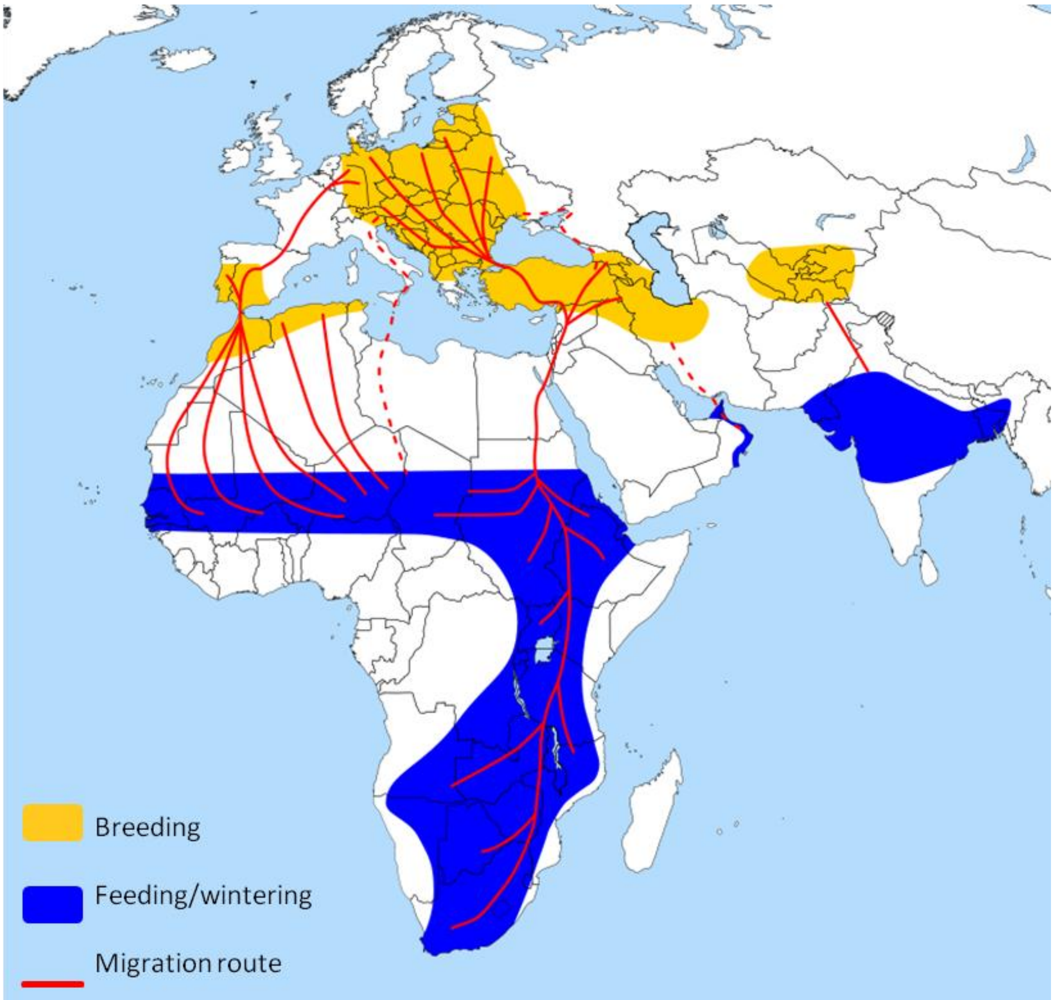


Figure 1. *The distribution of the White Stork (Ciconia ciconia), including breeding areas, wintering areas and migration route. (Source: Bamse 2007).*

2.2. DISTRIBUTION

The White Stork found in Europe (*C. c. ciconia*) has a breeding range that covers large parts of Europe, western Asia and northern Africa (Kjellén 1988), see figure 1. The species winters in Africa, south of Sahara (Kjellén 1988). As a result of its migration pattern the White Stork in Europe is divided into two sub-populations (Kjellén 1988). One migrates along an eastern path across Bosporus, Turkey, and the other migrates along a western path over Gibraltar on the Iberian Peninsula (Kjellén 1988), see figure 1. A migration divide is evident through western Germany, however this is not a strict division but contains a rather wide region where the two sub-populations overlap (Snow & Perrins 1998). Along the migration divide there are breeders from both the sub-populations and it is not uncommon that pairs are established with one individual from each of the two sub-populations (Schulz 1998). It is also possible for juveniles from the same nest to choose different migration routes (Schulz 1998).

2.3. POPULATION TRENDS

Since the early 20th century, up until only two decades ago, the White Stork has been in steady decline in the west and north-west parts of its breeding range (Schulz 1998). The initial decline is thought to be a result of the intensification of agricultural practises in western Europe, and more specifically the drainage of wetlands (Kjellén 1988). Initially the White Stork populations in eastern Europe were more stable, a result mainly due to a less extensive rate of habitat converstion in these countries (Schulz 1998).

A more recent decline, which has been evident in all parts of Europe, although at less excessive rates in the eastern parts, is explained by other factors (Schulz 1998). The most pronounced decline has been within the western population, a result manly due to continuous droughts in the wintering grounds of western Africa (Schulz 1998). A less pronounced decline has been evident in eastern Europe, which is thought to be a result of the same agricultural changes that caused the initial decline in the western population (Schulz 1998). Contributing causes of decline are suggested to be increased mortality due to collisions with overhead wires, loss of nesting-sites, poisoning from pesticide usage in the wintering areas and persecution by humans along the migration route (Schulz 1998).

After the recording of an all time low of 135 000 breeding pairs during the 4th International White Stork Census in 1984, the population trend of the White Stork in Europe turned around (Thomasen & Hötker 2006). The 5th International White Stork Census in 1994/95 revealed an increase of 23% to 166 000 breeding pairs (Thomasen & Hötker 2006). The western population displayed a much greater increase of around 75% while the eastern population had increased by 15% (Thomasen & Hötker 2006). By the 6th census in 2004/05, presented in figure 2, this increase had continued and the overall White Stork population was then estimated to consist of approximately 240 000 breeding pairs (Ådahl 2013).

The causes of the reversed trend among the western population are the improved climatic conditions in western Africa since the middle of the 1980s and the fact that there has now been established a wintering population on the Iberian Peninsula (Schulz 1998). Open rubbish dumps together with the introduction of a fast spreading crayfish has provided the White Storks with food year round in Spain and Portugal (Schulz 1998). In Portugal alone, the number of wintering storks has increased from 1,180 in 1995 to as many as 10,000 individuals in 2008 and the numbers are still increasing (University of East Anglia 2013). This has resulted in an increased survival rate among the western population (Schulz 1998). The

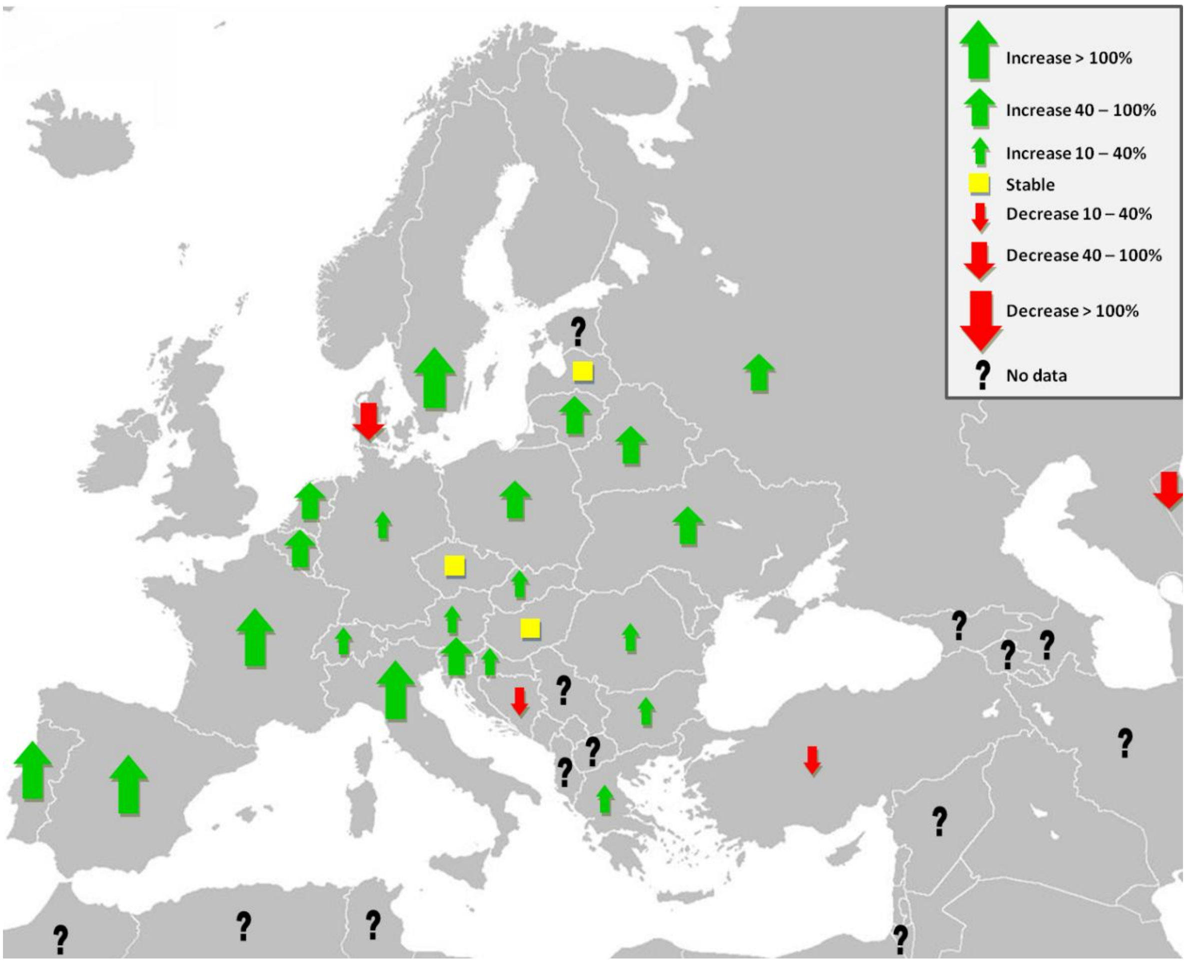


Figure 2. *The population development of the White Stork (Ciconia ciconia ciconia) between 1994/95 and 2004/05, distributed between different countries (Source: Alphaton 2012; Thomasen & Hötker 2006).*

multiple reintroduction programmes in western and northern Europe has also contributed to the increase, however many of these are only regarded as semi-wild due to the fact that they are non-migrating or only partially migrating (Schulz 1998). The reasons for the increase in eastern Europe are less obvious but are likely a result of changes in the breeding areas (Schulz 1998). In the core area of the eastern population, e.g. Poland and Ukraine, the political changes and economic uncertainties as of the 1980s are thought to have reduced the level of agricultural intensification and have possibly improved the ecological conditions for the White Stork (Schulz 1998).

2.4. REINTRODUCTION PROGRAMMES

Due to the negative development in the western and north-western range of the European White Stork population, reintroduction programmes have been established in a number of countries (Schulz 1998). These include Switzerland (1948), Belgium (1957), the Netherlands (1969), France (1970s), Germany (1970s), Italy (1985) and Sweden (1989) (Schulz 1998).

The pioneering programme, which has served as a model for the Swedish reintroduction programme, was initiated in Switzerland in 1948 (Moritzi *et al.* 2001). Initially young storks where brought to Switzerland from other European countries and soon after, a large number of storks where imported from Algeria (Moritzi *et al.* 2001). The original approach was to release juvenile birds from the main breeding facility in Altreu (Moritzi *et al.* 2001). The released individuals ended up dispersing from the release site without returning (Moritzi *et al.* 2001). As a result, the methodology was changed and instead the birds were kept in enclosures and released once they had reached sexual maturity (Moritzi *et al.* 2001). In 1960 the first free flying pair had settled and bred (Moritzi *et al.* 2001). Since the White Stork is generally not ready to breed prior to the age of three years old (Schulz 1998), the consecutive years in captivity resulted in the released birds losing their natural inclination to migrate (Moritzi *et al.* 2001). Instead, the free-breeding population spent the whole year around the breeding stations where they would receive supplementary feeding year round (Moritzi *et al.* 2001). Over the course of the programme another 23 release stations have been constructed in Switzerland (Enggist 2013). This has facilitated an establishment of a stationary, free-breeding stork population (Moritzi *et al.* 2001), regarded by Schulz (1998) as semi-wild.

Since the first release, the Swiss free-breeding population has steadily increased, first slowly with 10 breeding pairs in 1965; 16 in 1970 and 62 in 1980 (Schulz 1998) and more recently at an escalated pace (Moritzi *et al.* 2001). In 1993 the population had increased to 145 breeding pairs and over the last two decades it has more than doubled to 325 breeding pairs in 2012 (Enggist 2013).

Migration of juveniles born free was initially prevented by collecting them and re-releasing them once they reached sexual maturity (Schaub *et al.* 2004). Since 1971 juvenile migration has been allowed, which has resulted in returning individuals settling and breeding parallel to the non-migrating population (Schaub *et al.* 2004). The migrating population is steadily increasing and it is now estimated that 90-95% of the juvenile birds migrate each year, however many of the released individuals still spend all year at the breeding site (P. Enggist, pers. comm.).

The yearly reproductive success over the course of the programme averages at 1.7 fledglings per breeding pair, however the annual fluctuations are high (Moritzi *et al.* 2001). This number is very low compared to many other areas in Europe that are averaging at approximately two fledglings per breeding pairs and year (Moritzi *et al.* 2001). Since the 1980s the amount of supplementary feeding has gradually decreased and it seized entirely during the first years of the 21th Century (Enggist 2013). This has had no effect on the annual reproductive output (Enggist 2013). Instead the major influence has been that of cold and rainy weather (Enggist 2013).

As the western White Stork population increased in the 1990s there was a synchronous increase in the number of wild storks immigrating to Switzerland (Schulz 1998). It was found that these individuals exhibited differences in their behaviour, ecology and fitness compared to the project-storks (Schulz 1998). It was therefore determined in the mid-1990s to terminate the captive breeding programme and redirect management efforts elsewhere (Schulz 1998). Since there is no further release and the population is increasing it is now considered self-sustainable with an almost zero probability of extinction during the next 25 years (Schaub *et al.* 2004).

Schaub et al. (2004) suggests that management practises should be focused on increasing the adult survival; however since it is already very high this might be difficult. Almost the entire adult mortality in the breeding grounds have been determined to be caused by power-lines (Schaub & Lebreton 2004) which would mean that decreasing these would have a direct positive effect on survival (Schaub *et al.* 2004). Schaub et al. (2004) also suggests increasing reproductive output through habitat restoration to increase the chances of long term persistence. So far restoration of viable stork habitat in Switzerland has been marginal (Schaub *et al.* 2004). Improving reproductive success should be easier than increasing adult survival since there is more variation (Schaub *et al.* 2004). It is also very likely that the adult mortality will decrease rather than increase as the resident storks are phased out of the population, further promoting the improvement of other parameters (Schaub *et al.* 2004).

It has also been discovered that the rate of return among the migrating juveniles has been exceptionally low and conservation efforts are hence now focused on improving the western migration route (Schulz 2000). Focus is also on increasing awareness and education for the general public as well as for decision makers, since protecting migrating species entails cross-country commitments (Schulz 2000). Through following storks equipped with GPS-transmitters several risks for the migrating storks have been identified (Schulz 2000). For example, it was discovered that the storks that during the day forage on rubbish dumps on the Iberian Peninsula often rest at night on pylons, greatly risking electrocution (Schulz 2000). It was found that at one rubbish dump alone, the overhead power lines cause at least 1000 deaths of White Storks each year (Schulz 2000).

3. THE WHITE STORK IN SWEDEN

3.1. COLONIZATION AND EXTICTION

The White Stork is thought to have colonized Sweden during the 16th century as a result of human clearance of forests to make way for agriculture (Cavallin 1997). Due to the species dependence on open and irrigated fields for forage it has, with few exceptions, been restricted to the agricultural landscapes of the most southern part of Sweden, manly in the province of Scania (Cavallin 1997). No exact numbers are known but it has been suggested that in the 18th century the Swedish population could have consisted of as many as 5000 breeding pairs (Cavallin 1997).

It is not fully understood how the Swedish population developed during the 19th century (Nilsson 1989). However, the available literature suggests that a continuous decline was evident from the middle of the century (Nilsson 1989). In 1917, the first comprehensive recording of the Swedish stork population was carried out and by then there were only 35 active nests remaining (Nilsson 1989). After the inventory began the population slowly but steadily decreased until the breeding season of 1954, when the last breeding pair in Sweden failed to raise offspring and the species was declared extinct, see figure 3 (Nilsson 1989). As is evident in figure 3, the reproductive output was still high when monitoring began but decreased and was highly fluctuating, as the population was approaching extinction (Kjellén 1988). During the last years of breeding, the reproductive output was very low, averaging at only one fledgling per breeding pair and year during the last 10 years (Kjellén 1988).

After the last breeding attempt failed Sweden was regularly visited by the White Stork, although this never resulted in any spontaneous settlements (Jönsson 1989). Between the years 1955-1988, approximately 540 individual storks had been observed flying or resting in Sweden (Jönsson 1989). The reason for the visits never resulted in a re-colonization is believed to be because it is normally non-breeding juveniles that explore new areas and these are generally not ready for settlement (Jönsson 1989). Further, due to their gregarious nature, the White Stork prefers to settle in areas where there are already other breeding storks (Jönsson 1989). Hence, the lack of a resident stork population in Sweden was making a spontaneous establishment unlikely (Jönsson 1989).

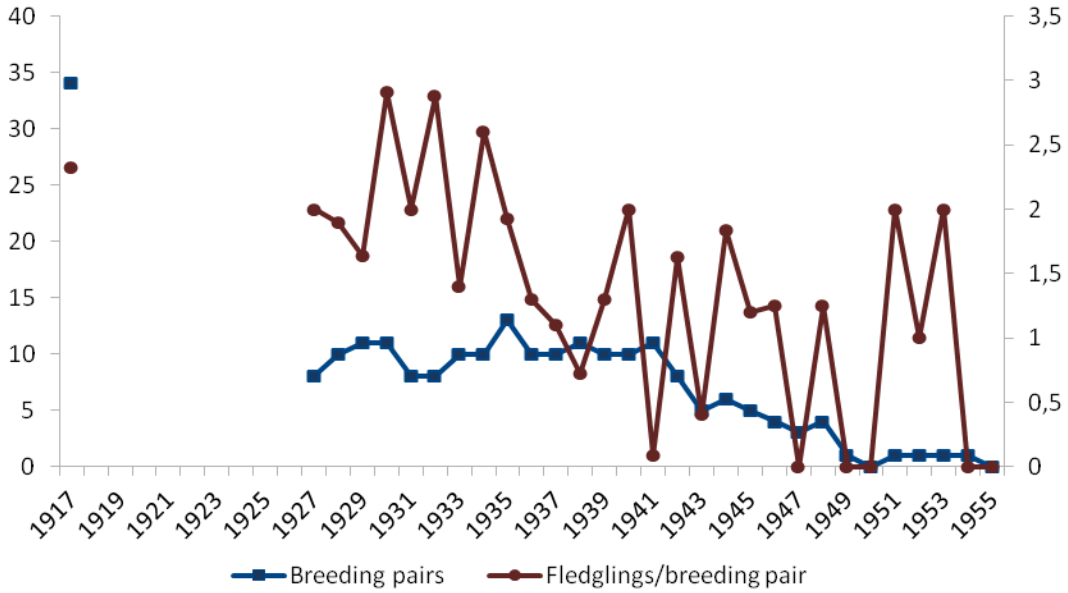


Figure 3. *The development and average reproductive success of the Swedish White Stork population in Sweden between 1917 and extinction in 1954 (Source: the Swedish White Stork Reintroduction Programme Database)*

3.2. CAUSES OF EXTINCTION

A number of different causes have been suggested to explain why the White Stork went extinct in Sweden (Kjellén 1988). Most likely it is rather a combination of factors than one factor alone that led to the species disappearance (Kjellén 1988). Climate change has earlier been suggested as a partial reason for the decline (Kjellén 1988). It is known that the nestlings are highly sensitive to cold and wet weather and often freeze to death during periods of unfavourable weather conditions (Cavallin 1993). A change in climate could therefore have had a negative impact on the reproductive success of the species (Cavallin 1993). However, Olsson (2004) studied the development of the original Swedish White Stork population in relation to climate and found no evidence to support that there would be a link between a change in climate and the decline of the population. The factors currently suggested to have had a major influence on the White Storks disappearance from the Swedish fauna are presented below.

3.2.1. Landscape changes

Similar to other parts of Europe, it is a changing landscape, and the drainage of wetlands, that is thought to be the largest contributor to the decline in the Swedish White Stork population (Larsson 1985; Kjellén 1988; Cavallin 1997; Olsson 2007; Ådahl 2013). The agricultural revolution in Sweden during the 19th century meant that the landscape, which had previously consisted of small agricultural fields in a wider landscape of meadows and wetlands, was shifted towards a reduction in meadows and increasing cultivation for fodder (Cavallin 1997). From the beginning of the 19th century to early 20th century the area of agricultural fields quadrupled and it was manly grasslands that disappeared (Cavallin 1997). The human population doubled in Sweden during the same time period, further increasing the need for cultivation (Cavallin 1997). The 19th century was also the time of extensive wetland-drainage (Cavallin 1997). Further drainage as well as straightening of rivers and lake-lowering took place on government aid in an effort to increase food-production for the increasing human population (Cavallin 1997). During the second half of the 19th century the species connected to wetlands were somewhat benefited by the adoption of water-meadows, however when artificial fertilizers were introduced in the beginning of the 20th century these were put out of practise (Cavallin 1997). Today, only a maximum of 10% of the original area of wetlands are left in Scania (Länsstyrelsen i Skåne 2007).

3.2.2. Increased mortality

As is evident in figure 3, the reproductive output in the beginning of the 20th century was still high, suggesting that habitat conversion was not the single cause of the extinction (Kjellén 1988). Population growth of White Storks is more dependent on adult survival than reproduction success (Schultz 1998). An increase in adult mortality is therefore suggested as a contributing cause that most likely had a negative effect on the Swedish stork population (Kjellén 1988). The most common cause of death for adult storks in Sweden are collisions with overhead wires, resulting in fractured wings and/or legs, or by electrocution as a result of contact with uninsulated parts of power lines (Cavallin 1997). During the 20th century an increasing number of deaths as a result of power-line collision were reported from many parts of Europe (Kjellén 1988). Despite the strong negative trend of the western population, a higher number of deaths were reported (Kjellén 1988). This was evidently not a single cause of the decline but is likely a contributing factor to fewer juveniles reaching maturity and hence compensating for the adult mortality (Kjellén 1988). Adding to this, hunting in southern Europe, Africa and the Middle East in particular, was intensified with the acquisition of more effective hunting equipment (Kjellén 1988). Further, the extensive use of pesticides to control locusts swarming in Africa, an important nutritional base for wintering storks, has also been suggested to have been a contributing cause of increased mortality among White Storks (Kjellén 1988).

3.2.3. Stochastic events

Disturbance years (from German “Störungsjahr”) take place randomly and are characterised by late or failed arrival at breeding grounds, fewer breeding pairs and a large proportion of pairs not producing any offspring at all (Kjellén 1988). Disturbance years reflect the conditions in the wintering grounds and/or along the migration route (Kjellén 1988). For example, drought in Africa can cause starvation among the wintering storks and may result in death or the individuals not being in good enough condition to return to the breeding grounds, forcing them to spend the breeding season in Africa (Kjellén 1988).

Some disturbance years are worse than others and are sometimes referred to as catastrophic years (Kjellén 1988). Such a year was 1856 when the eastern White Stork population on their way back from the wintering grounds, met severe weather conditions by the Mediterranean Sea (Cavallin 2010). This resulted in many countries along the Baltic Sea, including Sweden together with Denmark and northern Germany, suffering major declines in their respective populations (Cavallin 2010). It is often mentioned in Swedish stork literature that in the colony of Örups elm forest, the largest known stork colony in Sweden, only five individuals returned where there had been 80 pairs breeding previous years (Cavallin 2010). The Swedish White Stork population never really recovered after this event (Ådahl 2013).

3.2.4. Geographical position

Olsson (2004) discovered negative density dependence among the original Swedish population. A year after the presence of many storks would be followed by a substantial decline and after a year with few storks there would be a slight recovery, or at least a less pronounced decline (Olsson 2004). Lack of suitable habitat often result in negative density dependence, however Olsson (2004) also states that emigration can result in similar trends or intensify the consequences of habitat degradation. As a result of the strong decline of the western and north-western stork populations, many suitable nesting sites would have become empty, which could have resulted in the Swedish storks settling along the migration route instead of returning to the original breeding grounds (Olsson 2004). This suggests that the decline of the more central populations had an effect on the population in the periphery of the distribution range (Olsson 2004). It is therefore possible that the Scanian landscape was not in such bad condition that no storks could survive there, but that the Swedish population more likely was affected by the dramatic decline in the rest of Europe (Olsson 2004). That the European stork populations function in a set of meta-populations, where the core populations disperse to the more periphery areas as the populations are increasing, have further been suggested by Schulz (1998). With a current, more stable continental population, this could suggest that there are better conditions for a Swedish stork population today than during the 20th century (Olsson 2004).

3.3. INITIATING REINTRODUCTION

Before the extinction a few attempts were made to save the declining stork population in Sweden. The most well known effort was initiated in 1953, one year before the last breeding attempt failed (Malmberg 1953). Managers at a Scanian zoo had gained knowledge of the Swiss programme and hence decided to import White Storks from Denmark for captive breeding (Malmberg 1953). Over a two year period, a dozen storks where imported from a Danish zoo (Malmberg 1953). The hopes were for the captive storks to produce offspring that in their turn would be free to migrate and hopefully return (Malmberg 1953). The reintroduction attempt ended up failing early on when the only eggs laid disappeared, most likely predated on by the cranes at the zoo (Karlsson 1989). Decades later, an initiative was taken by the Scanian Hunting Society along with the Scanian Ornithological Society that together created a foundation “Storkfonden” in an effort to gather resources for a future reintroduction (Karlsson 1989). Unfortunately, due to lack of commitment, the interest in the fund faded as a reintroduction programme was initiated in Aneboda, Småland, in 1979 (Karlsson 1989).

Not being part of the White Storks original distribution range, Aneboda, displayed in figure 4, might seem as an odd choice for a reintroduction, but at the time that was where the commitment was (Karlsson 1989). In the late 1970s, enthusiasts at the independent, non-profit research institute Institutet för Vatten- och Luftvårdsforskning IVL (today IVL - Swedish Environmental Research Institute) recognized the value of the White Stork as a flagship species for the Swedish wetlands (Larsson 1992). At the time, receiving funding for restoration and creation of wetlands was difficult and it was hence regarded that the already unlikely event of a spontaneous re-colonization by the White Stork would be further impaired by the lack of suitable habitat (P-E Larsson pers. comm.). This lead the concerned people at IVL to come up with an original, and by some regarded as controversial, idea; by bringing back the White Stork to Sweden it could be used as an ambassador for the Swedish wetlands and hence speed up the process of restoration and creation, benefiting both the White Stork and all the other species linked to the same habitat (Larsson 1985).

Figure 4*. Map of Sweden, displaying the region of Scania and town of Aneboda. (Source: Lokal_Profil 2007)*

The original intention was to import eggs from Poland for hand-rearing but while all permits and financial resources had been gathered by 1978, the efforts were stopped by the Swedish Museum of Natural History (Jernelöv 2006). Since the Swedish stork population had diminished during the same time as the western population was in decline and the eastern population was stable, the Swedish population had wrongfully been presumed to belong to the western sub-population (Jernelöv 2006). Therefore management was instructed that if import should be made, it had to be from the western population (Jernelöv 2006).

Instead visits were made to the Swiss and German reintroduction programmes that were already running (P-E Larsson, pers. comm.). The main objective of the trips was to determine if the Swiss model, based on captive breeding and release, could be applied in Sweden and if the storks would be able to survive the Swedish winter (P-E Larsson, pers. comm.). Soon after the visit, in 1979, 15 White Storks, among them two sexually mature pairs, were sent as a gift from the Swiss programme to Aneboda (P-E Larsson, pers. comm.). These, along with a few individuals that had been found straying in different parts of Sweden, captured and brought to Aneboda, later served as the reproductive base of the entire reintroduced population (P-E Larsson, pers. comm.).

While still in Aneboda, research was conducted on the storks, trying to establish a good approach for the reintroduction programme (P-E Larsson, pers. comm.). It was found that the birds could winter in Sweden without any difficulties, as long as they received supplementary feeding (P-E Larsson, pers. comm.). It was also discovered that the reproductive output could be increased by using double clutch, i.e. removing the first clutch and placing it in an incubator and letting the female lay a second clutch (P-E Larsson, pers. comm.). This method was used in the start of the project, for a more rapid increase in the captive population (P-E Larsson, pers. comm.).

Since Aneboda is not part of the historical distribution range of the White Stork, the objective from the start was to find stakeholders in Scania who were willing to manage the reintroduction (P-E Larsson, pers. comm.). To find suitable receivers was estimated to take approximately 3-5 years, in reality it took almost a decade (P-E Larsson, pers. comm.).

After a survey among the Scanian municipalities in the middle of the 1980s, it was concluded that a large proportion saw the value of the White Stork in their regions and were positive to a reintroduction (P-E Larsson, pers. comm.). In the end Sjöbo municipality, where the last breeding had occurred 30 years earlier, was chosen for the establishment of the main breeding facility (J Karlsson, pers. comm.). The place was Karups Nygård, in the Kävlinge River basin, which was purchased by the Swedish Environmental Protection Agency and the tenants volunteered to care for the enclosure and the captive storks (J Karlsson, pers. comm.). Meantime, a working group consisting of representatives from IVL, the Scanian Ornithological Society, and the local branch of the Swedish Society for Nature Conservation (Naturskyddsföreningen Färs), along with WWF was created (unpubl. The Swedish White Stork Reintroduction Archive). Later, the programme was joined by the Swedish Society for Nature Conservation in Scania (SSNC Scania) who became the main executive body of the programme (unpubl. The Swedish White Stork Reintroduction Archive).

4. THE SWEDISH WHITE STORK REINTRODUCTION PROGRAMME

1989 is regarded as the official starting point for the reintroduction programme. This is when the main enclosure in Karup was inaugurated and 13 project storks where brought down from Aneboda (Cavallin 1997). Meanwhile, breeding was continued in Aneboda and the surplus was sent to Scania (P-E Larsson, pers. comm.). The first captive pair was released prior to the inauguration and settled on the roof of the enclosure (Cavallin 1997). The day after the official start, the first eggs were hatched in Scania since extinction (Cavallin 1997).

4.1. PROGRAMME AIMS AND GOALS

The ultimate goal of the reintroduction programme is to *"re-establish a viable, migrating population of White Stork in Scania"* (Ådahl 2013). For the goal to be considered met there are three major requirements (Ådahl 2013);

1. The population must be stable, it should neither increase nor decrease in the long-term.
2. The population must be naturally behaving, no individuals will be allowed to winter in the breeding area.
3. The population must not be depending on supplementary feeding, the landscape must provide enough forage during the breeding season to sustain the population.

A viable population number has long been considered to comprise of approximately 150 pairs, this estimate has been based on experiences from similar projects in Europe (Cavallin 1997; Ådahl 2013). A recent study based on the Scanian conditions has now suggested that a population of at least 100 pairs is needed for the extinction risk to be at a reasonably low level (Ådahl 2013).

4.2. CURRENT ORGANISATION AND FUNDING

Currently the programme is managed by the Swedish Society for Nature Conservation in Scania (SSNC Scania) in collaboration with the Scanian Ornithological Society (SkOF) (Ådahl 2013). The programme manager is a full time employee hired by SSCN Scania (Ådahl 2012). There is also a board of directors consisting of three representatives from each of the two organisations (Ådahl 2013) that handle the long term strategic planning of the programme (E Ådahl, pers. comm.). Further efforts carried out within the programme are executed by the approximately 40 volunteers who are working on a regular basis (Ådahl 2013).

The programme is to a large extent dependent on sponsorships and the individual sponsors have varied from year to year, e.g. nature oriented funds or government bodies. This kind of funding has been needed to be re-applied for each year (Ådahl 2012). Further financial resources are made available though individual donations, as well as members of the general public and businesses, that support the programme by becoming sponsors to individual storks (Storkprojektet 2013). To a small extent, there is also some income as a result of selling merchandise linked to the stork (Ådahl 2013). Resources, other than financial, are also made available through donations of materials, such as food for the storks (Storkprojektet 2013).

The organisation is regarded as highly cost-efficient (Ådahl 2012). For many years the budget has been stagnant at SEK550 000 (approximately EUR63 130, 2013-06-10) which is considered extremely tight with regards to the extensiveness of the programme (Ådahl 2012).

4.3. PROGRAMME METHODOLOGY

The Swedish reintroduction programme is based on the methodology established by the Swiss programme and further developed in the Netherlands (Cavallin 1997). These were pioneering projects and the Swedish programme has had the advantage of being able to adopt an already worked out methodology (Cavallin 1997). During the last ten years, methodology has been refined and is now considered highly effective (Ådahl 2013). A summary of current practices are presented in table 1. A more detailed description of these practices and what they have resulted in will be covered throughout the report.

Table 1. *A summary of the current methodology practised within the Swedish White Stork Reintroduction Programme (Source: Ådahl 2013).*

Practice	Description
Establishing pairs	Juveniles born each year are kept in enclosures for breeding, as they reach maturity they are separated from direct siblings and allowed to establish pairs.
Releasing established pairs	Pairs that have been established and have bred at least once in captivity are released in spring each year. These are not considered wild since they do not migrate.
Releasing juveniles	Juveniles born in captivity are released to join the free- born juveniles for migration.
Capturing non-migrating juveniles	The juveniles that do not migrate are captured during winter and placed in captivity where they are allowed to establish pairs.
Constructing release enclosures	To increase the distribution of the reintroduced population in Scania, release enclosures are constructed in areas of suitable habitat.
Mounting nesting platforms	Artificial nesting sites are created by mounting nesting platforms in the release areas, as well as in other localities around Scania with suitable habitat.
Ringing	All storks that are born within the reintroduction programme, along with wild immigrants are ringed. This enables the management to provide each stork with an identity and follow their movements.
Supplementary feeding	Storks that winter in Scania receive supplementary feeding during the time of the year when it is too cold for the birds to feed themselves.
Pressuring energy companies	To reduce the threat of power line collisions, energy companies are encouraged to mount power lines close to breeding areas with bird diverters.
Education and awareness	In an effort to increase the knowledge of the White Stork and its habitats as well as to promote conservation public events, lectures and guided tours are hosted each year.

5. CAPTIVE BREEDING AND RELEASE

5.1. ESTABLISHING ENCLOSURES

Over the course of the programme there have been 13 enclosures distributed over Scania. Four of these have been successively terminated, leaving the nine active enclosures presented in figure 5 in 2013. The enclosures have different functions; seven of them have the capacity to function for both breeding and release, while two are smaller with the sole purpose of release (E Ådahl, pers. comm.). The captive storks are distributed among the breeding enclosures in a systematic way to ensure efficiency, see figure 5 for details (Storkprojektet 2013). However, as the captive population has grown in size, this distribution has had to become less strict (E Ådahl, pers. comm.).

Initially many enclosures were only partially covered with roofs; this meant that the captive storks had to have their wings clipped for them not to escape (Olsson 2005). This was a very resource demanding practice (E Ådahl, pers. comm.) and in addition it was suspected that the growing juveniles, that were not allowed to practise flying, could have underdeveloped muscles and skeleton (Olsson 2005). Therefore, all enclosures now have roofs and new larger aviaries have been successively established so that after 2004, no further wing clipping has been executed within the programme (Olsson 2005).

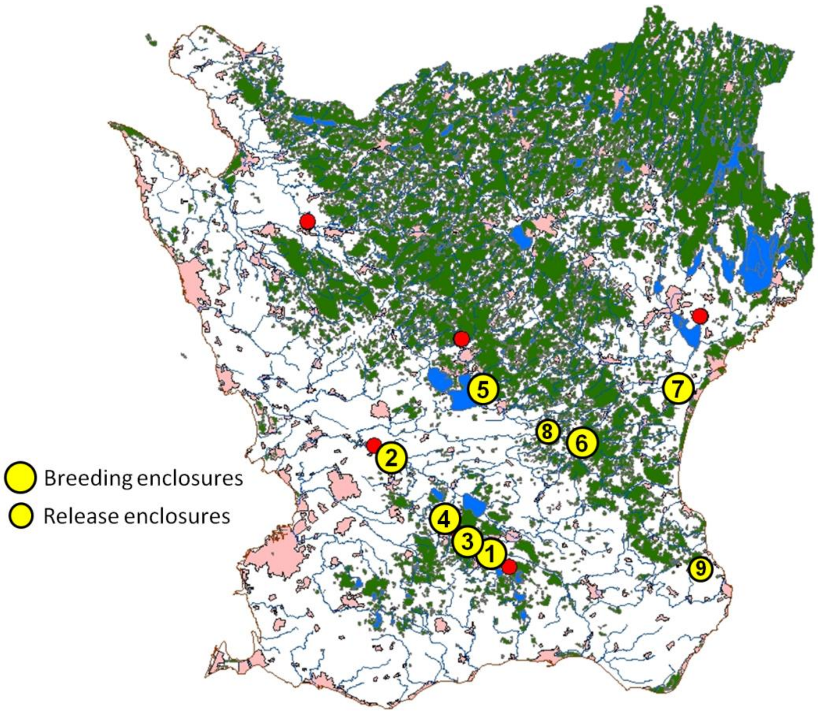


Figure 5. *The distribution of the enclosures of the Swedish White Stork Reintroduction Programme in Scania, Sweden, in order of establishment 1. Karup – pair establishment; 2. Flyinge; 3. Hemmestorp – unpaired juveniles; 4. Östra Tvet; 5. Fulltofta – injured storks not for release; 6. Stänkelösa; 7. Härnestad; 8. Tormastorp; 9. Bräkneryd. (Source: Storkprojektet)*

Since the released storks, with few exceptions, settle in direct proximity to the enclosures all the pens are constructed in areas of viable stork habitat (Ådahl 2013). Initially, the area in which it was known that the original Swedish stork population had bred was targeted (Cavallin 1997). Currently, a map of good quality breeding habitat developed by Olsson and Rogers (2009) is used as a reference when choosing the mounting sites (Ådahl 2013). The map shows that there are currently areas in the eastern part of the landscape that would be particularly good breeding sites for the re-introduced population (Olsson & Rogers 2009). In addition to viable stork habitat, a qualification for a good mounting site is the availability of volunteers in the area whom are prepared to care for the captive storks for a longer period of time (Cavallin 1997). Further, there should preferably not be any immediate threats to the released storks such as power-lines and nesting platforms need to be available or mounted in direct association with the enclosures (Cavallin 1997).

5.2. MANAGING THE CAPTIVE POPULATION

Distributed among the seven breeding enclosures are currently roughly 250 captive storks (Ådahl 2013). In the enclosures the White Storks are allowed to establish pairs (Ådahl 2013). The development of the captive population is presented in figure 6. As is evident in the figure, the captive breeding base was very small during the first decade of the programme but has increased considerably during the last ten years, partially due to two imports of Polish storks

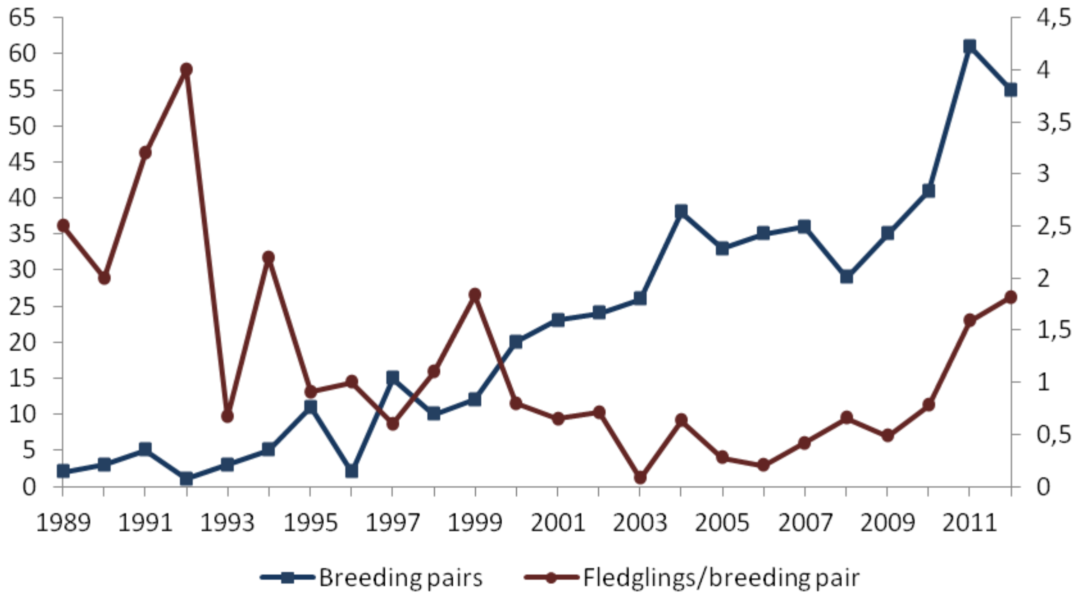


Figure 6. *The development of the captive population of the Swedish White Stork Reintroduction Programme between 1989 and 2012 (Source: the Swedish White Stork Reintroduction Programme Database).*

for captive breeding in 2004 and 2009. The Polish storks have permanent injuries and will therefore never be released but now make up the captive breeding base (Ådahl 2013); see section 10 for further information.

5.2.1. Reducing inbreeding

To reduce the chances of inbreeding close relatives in captivity are not allowed to establish pairs (Ådahl 2013). Originally direct siblings were actively broken up to reduce the chances of inbreeding (Olsson 2004). This was regarded as a stressful practise and not effective enough since the small breeding base meant that many of the birds, even though not direct siblings, were still closely related (Olsson 2004). Instead, as of 2002, management divided the birds into a larger number of groups that were based on the inbreeding coefficients between probable pairs; this resulted in a substantial decrease in the rate of inbreeding and was thought to result in healthier storks in the future, with a larger reproductive success (Olsson 2004). As management has changed, so has partially practises and currently direct siblings are once again actively separated and not allowed to establish pairs (Ådahl 2013). The import of new individuals from another source population, to serve as the captive breeding base, has also reduced the risk of inbreeding (Storkprojektet 2005).

5.2.2. Increasing reproductive output

As a result of the captive breeding population being initially small, a few issues were evident. At one point, many pairs were established despite the limited choice of mates (Cavallin 1999). When multiple pairs never managed to lay eggs, it was discovered that some pairs were made up of individuals of the same sex (Cavallin 1999). In the absence of an obvious sexual dimorphism, DNA testing is needed to separate males from females (Cavallin 1999). Therefore management had to have the captive storks DNA tested in an effort to prevent the pairing of individuals of the same sexes (Cavallin 1999). Currently, blood samples are sent to South Africa for analysis; however this is rather resource demanding (E Ådahl, pers. comm.). It was also discovered that eggs laid by some pairs never hatched, these were generally unfertilized, suggesting that males pair up prior to reaching maturity (SkOF 1995). As the captive population has increased and the sexes are determined these problems have to a great extent been mitigated (E Ådahl, pers. comm.).

Often the breeding success among captive storks is much lower compared to the free-breeding storks, a result manly due to the young age and hence inexperience among the captive breeders (Cavallin & Ådahl 2012). However, this does not apply to the large proportion of captive storks that is made up by the older, injured storks that were imported from Poland (Cavallin & Ådahl 2012). The injured storks will never be released and it has therefore been possible to significantly increase the reproductive output, over the last few years, through a number of management alterations (Cavallin & Ådahl 2012). The changes included (Cavallin & Ådahl 2012);

- Distributing the breeding pairs among the enclosures in a way that better suits the juvenile production.
- Reconstructing nesting platforms to better accommodate the large number of injured storks that cannot fly.
- Increasing the amount of nesting material for the captive storks.
- Providing the storks with more food and of greater variety.
- Better damage control for unexpected events to prevent chick's from dying due to rain and cold.
- Better predator-control, mainly preventing crows from entering the enclosures that could otherwise feed on eggs or chick's.

Increasing the reproductive output in captivity has allowed for the possibility to release juveniles for migration while still being able to keep enough individuals for further breeding and release (Cavallin & Ådahl 2012).

5.3. RELEASE

When the captive pairs have bred at least once in captivity, the management of the project is able to release them (Ådahl 2013). The release of established pairs is conducted in March and April each year, coinciding with the time when the White Stork would naturally return from migration (Ådahl 2013). The strategy has been to create colonies around the enclosures since these are mounted in areas of suitable stork habitat and since White Storks are social birds that tend to breed and migrate in groups (Cavallin 1993). However, the adjacent settlement of the storks is also a limiting factor as to how many pairs that can be released from each enclosure (Ådahl 2013).

Approximately 10 new pairs are released each year (E Ådahl, pers. comm.). Around 60% of the released pairs end up breeding together in the wild the same season (Olsson 2002). Pairs that split sometimes pair up to breed with other individuals (Olsson 2002). Others are killed shortly after release, e.g. due to the collision with over head wires, or spend the breeding season free without pairing up to breed (Olsson 2002).

6. THE FREE-BREEDING POPULATION

Today the main distribution area, where the majority of the White Storks in Sweden breed, is in the drainage area of Klingaväl- and Kävlinge Rivers, see figure 7 (Ådahl 2012). The free-breeding project-storks are not considered wild since they do not behave in a natural way, i.e. they do not migrate (Ådahl 2013). However they do produce offspring that can migrate, this will be discussed further in section 9.

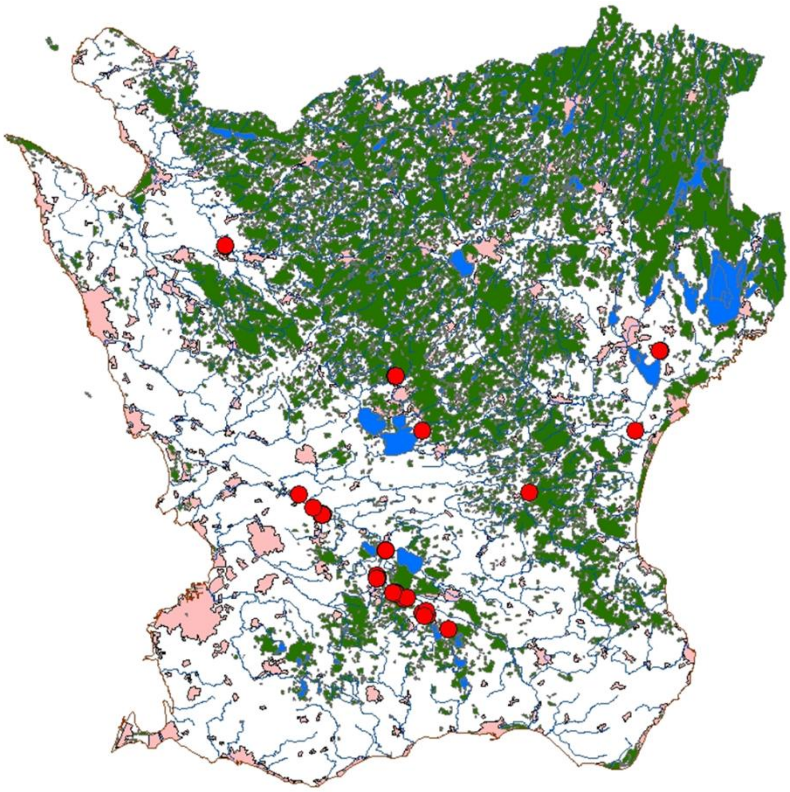


Figure 7. *The current distribution of the free-breeding White Stork population in Scania, Sweden. The majority of the breeding pairs are distributed in the Kävling- and Klingaväl River basin. (Source: Storkprojektet)*

The development of the free-breeding population is presented in figure 8. As mentioned earlier, the first free breeding attempt in Scania since extinction was in 1989, the same year as the programme was established in the area. In 2012, there were 34 free-breeding pairs in Sweden; this equals an increase of an average 1.4 breeding pairs per year. However, as is also evident in figure 8, the number of free-breeding pairs was higher from 2007 until 2009, than in 2012. Nevertheless, as can also be noted in figure 8 the breeding success during these years was very low, which made management suspect negative density dependence among the reintroduced population (Ådahl 2010). The low breeding success will be discussed further in section 7 of this report.

6.1. MANAGING THE FREE-BREEDING POPULATION

6.1.1. Supplementary feeding

During winter the stationary project-storks are fed by the management at the enclosure sites (Ådahl 2013). The cold is not an issue for the birds and some of them are even able to partly feed themselves during this time (Cavallin 1997). For the project to be successful, a natural breeding population must be established, this means that only organized feeding by the management is allowed during times when the birds are unable to feed themselves, i.e. during the winter (Cavallin 1997). All other feeding, by the public or during periods of available natural forage, especially during breeding, is strictly prohibited (Cavallin 1997). Despite this it is known that feeding during the breeding season has occurred in the past (Olsson 2007). Prior to all the enclosures being mounted with roofs free-breeding pairs were also able to fly into the enclosures and feed on the food made available for the captive storks, despite efforts to control this (Pleym 1995). Since all the enclosures are now covered, this is no longer an issue (E Ådahl, pers. comm.).

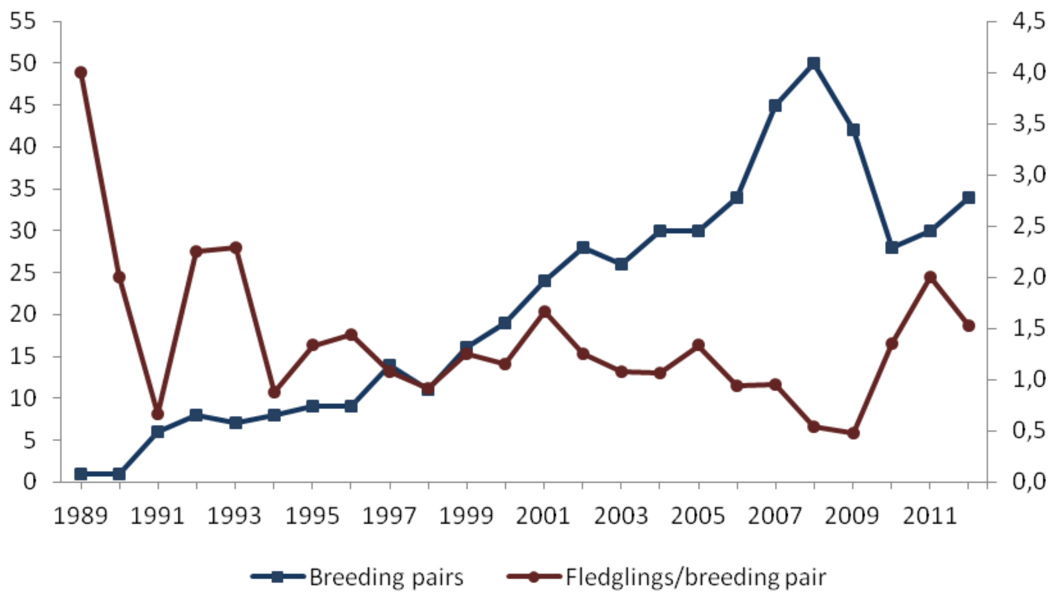


Figure 8. *The development of the free-breeding White Stork population in Scania, Sweden, 1989-2012 (Source: the Swedish White Stork Reintroduction Programme Database).*

6.1.2. Reducing mortality

As mentioned earlier, the most common direct cause of death for free-flying White Storks in Scania is collisions with, or electrocution by, power lines (Ådahl 2010). Many individuals where the fate is unknown are thought to have been killed this way (Ådahl 2010). An important task for the management of the reintroduction is to reduce this mortality-risk (Ådahl 2010). This can be done by burying the power lines underground or by mounting them with bird diverters; however this is in the hands of the electricity companies (Ådahl 2010). Therefore, management are actively encouraging energy companies to install diverters in the close vicinity of breeding sites (Ådahl 2013).

6.1.3. Ringing

All storks that are born in the reintroduction programme, along with wild immigrants, are ringed (Ådahl 2013). This enables the management to provide each stork with an identity and follow their movements (Ådahl 2013). Rings with engraved numbers are fitted on the right leg while the left is fixed with three rings of different colours (Ådahl 2013). The colour code is read out as the number on the official ring and therefore provides a possibility for the bird to be identified even if it is seen at a distance (Ådahl 2013). Prior to 2009, an aluminium ring from the Swedish Ringing Centre was used (Ådahl 2013). These have been replaced by black composite rings with white engravings called ELSA-rings (Ådahl 2013).

6.1.4. Increasing the distribution

In an effort to increase the distribution of the White Stork in Scania, mobile enclosures were tested in areas where there are not enough resources to build and maintain a permanent enclosure (Olsson 2002). The mobile enclosures were moved to the area where the release was to take place and the birds were kept there for a few weeks, to acclimatize prior to release (Olsson 2002). This method turned out to be ineffective since the released pairs chose to fly off and settle in other areas and the practise was discontinued (Olsson 2003). The reason for the lack of settlement was thought to be the absence of other breeding storks close to the mobile enclosures (Olsson 2003).

In recent years, the programme has established a large enough captive production that further enclosures for breeding are no longer needed (Cavallin, in press). Instead focus has been shifted to constructing smaller enclosures only for release, an idea derived from a stork-project in Baden-Württemberg, Germany (Cavallin, in press). After successfully breeding in the larger enclosures, adult pairs are moved in fall to the release enclosures where they have nesting platforms and a view of the release site, to prepare for breeding and acclimatize to their new surroundings (Cavallin, in press). These enclosures can hold up to ten individuals that are later released in spring (Ådahl 2013). Upon release, juveniles are brought to the enclosures to serve as decoy for the adult pairs to settle and breed in the area of release (Ådahl 2013). Once the pairs have settled freely to breed, the juveniles are brought back to the breeding enclosures (Ådahl 2013). The same procedure will be repeated over a two to three year time period, until a local population has been established and the release enclosure will then be dismounted (Ådahl 2013). This method is regarded as an important step in increasing the distribution of free-breeding storks in Scania (Cavallin, in press).

6.2. IMMIGRATION

In addition to producing migrating offspring, the free-breeding storks serve as decoy for the wild birds that visit Sweden, which may result in more storks settling (Ådahl 2013). As a result of this, part of the breeding population consists of wild individuals that have settled along with the project-storks (Cavallin, in press). The wild birds provide new, valuable genes to the introduced population, it is also suggested that these individuals of wild descent can promote migration among the project-storks (Cavallin & Ådahl 2012). This immigration of wild storks is considered an important part of the programme and a necessity for a future re-establishment in Sweden (Cavallin 1997).

During the course of the programme, 13 wild storks have settled in Sweden (Cavallin, in press). The origin of the immigrated storks is generally unknown, due to the fact that most of them are not ringed (Cavallin 1997). However, most likely they derive from eastern Europe (Olsson 2006). The first spontaneous settlement since the extinction paired up with a project-stork in 1991 (Cavallin 1997). In 1996, the first totally wild pair bred in Scania, unfortunately they failed, however it was still regarded as a milestone within the programme (Nilsson 1996) since it proved that the presence of White Storks in the area serves as a magnet for other White Storks and increases the chances of spontaneous colonization (Cavallin 1997). This can be further strengthened by the fact that there was no spontaneous colonization during the 35 years when the stork was absent from the area (Jönsson 1989).

The immigration of wild storks has shown that being raised in captivity is not the only factor that influences the adult storks to change their behaviour and winter in Sweden (Cavallin &

Ådahl 2012). The large captive population along with the free-breeding, stationary, storks make out a powerful social magnet that may influence wild storks to change their natural migration behaviour (Cavallin & Ådahl 2012). Out of the 13 wild storks that have settled to breed with the project-storks in Scania until 2012, the majority have stayed behind instead of migrating (Cavallin, in press). The supplementary feeding is not thought to be the cause of the problem since this is initiated well beyond time of migration (Cavallin & Ådahl 2012).

7. BREEDING SUCCESS

During the course of the programme, the average breeding success per year for the free-breeding storks is only 1.2 fledglings per breeding pair. However, this number has fluctuated considerably, see figure 8. In 2012 the breeding success was 1.5 fledglings per breeding pair. Many populations in other parts of Europe generally have a higher breeding success, ranging from 1.6 to 2 fledglings per breeding pair (Olsson 2005). It has been suggested that a production of two offspring per pair and year is needed to keep the Swedish White Stork population stable (Kjellén 1988). This will however be dependent on the survival rate of the adult individuals (Kjellén 1988). Migrating stork populations often have an annual adult survival rate of 75-90% whereas for the juveniles it is much lower at 15-20% per year (Olsson 2005). A higher annual survival rate, as in the Swedish population, with an annual adult survival of 85-90% (Cavallin, in press), can therefore compensate somewhat for poor reproductive success (Olsson 2005). This has further been suggested in the reintroduced population in Switzerland, Schaub et al. (2004) found that despite a juvenile production of only 1.65 offspring per year, the Swiss population could be stable due to the low mortality.

7.1. INFLUENCES OF BREEDING SUCCESS

There are a number of different factors that have been suggested as an explanation for the poor breeding result among the reintroduced population. These are explained in detail below.

7.1.1. Inexperience

It is known that inexperienced White Storks are poor breeders, as they grow older their reproductive success increases and usually peaks at 10 years of age and generally stays high until they are in their 20s (Kjellén 1988). Young, inexperienced pairs are more likely to terminate a breeding attempt and since the pairs released from the enclosures are generally young and have not bred freely before, this can result in a lower breeding success (Olsson 2005).

7.1.2. Habitat quality

Reproductive success is also dependent on good quality habitat, i.e. good forage availability (Kjellén 1988). Wetlands, pastures and hay fields are the most important foraging habitats for the White Stork in Scania during the breeding season (Olsson & Ådahl 2007). The breeding pairs usually forage within a one kilometre radius from the nesting site (Olsson & Ådahl 2007). However they often move three to five kilometres away and occasionally as far as 15 kilometres (Olsson & Ådahl 2007). Based on the premises that the storks usually use the good habitats for foraging, the optimal habitat for the breeding storks should be when a lot of these habitats are available around the nesting site (Olsson & Ådahl 2007). Without the availability of enough forage the storks will not be able to provide enough feed for all their chicks (Cavallin 1997). The number of fledging offspring produced is therefore a measure of the quality of the habitat (Cavallin 1997).

7.1.3. Weather conditions

The most common explanation for a breeding season with low reproductive success is the weather. Rainy weather in May and June has a great impact on the reproductive success of White Storks (Olsson 2002). Short, intense periods of rain are the most harmful (Kjellén 1988).This is due to the fact that newly hatched nestlings are very sensitive to getting wet and cold; if they do they often freeze to death (Olsson 2002). The more rainy days during this period, the fewer fledging young are ultimately produced (Ådahl 2001). Another sensitive period arises when the juveniles are older, bigger and in the need of a larger amount of feeding, which makes it hard for the parents to protect them from unfavourable weather conditions (Schaub *et al.* 2004). Poor weather conditions can therefore result in some pairs having their whole clutch dying and some only being able to raise a lower number of surviving offspring (Olsson 2002). Dry weather has also been suggested to have a negative influence on breeding success since it can result in food shortages, as a result of wetlands and meadows drying out (Olsson 2005). Extreme winds can also result in nests being destroyed or abandoned further reducing reproductive output (Olsson 2005).

7.1.4. Social interactions and density-dependence

Disrupting social interactions are also suggested to cause poor breeding results (Olsson 2004). Crowding may result in disturbing aggression among breeding storks and the destruction of nests (Ådahl & Olsson 2009).

In 2009, after several consecutive years of exceptionally poor breeding results, it was investigated whether there might be negative density-dependence affecting the largest colonies (Ådahl 2010). In the three largest colonies the number of breeding pairs had increased over the time of the programme while the number of fledglings per breeding pair had decreased (Ådahl 2010). It was determined that pairs nesting in colonies consisting of 6-10 pairs failed more often and produced fewer fledglings than did solitary pairs breeding in areas of only 1-2 pairs (Ådahl 2010). It was suggested that the competition for food was too high in the larger colonies and interaction between individual birds resulted in the destruction of eggs or death of chicks (Ådahl 2010). This sort of negative density dependence among White Storks has also been found in Switzerland (Schaub *et al.* 2004) and France (Barbraud *et al.* 1999).

As a result of the negative density dependence among the free-breeding population, 32 adults were caught early in 2010 from the three largest colonies and placed in captivity (Cavallin & Ådahl 2011). The effect was positive with an increased reproductive success the following two breeding seasons, as is evident in figure 8, suggesting that reduced competition would decrease conflicts in the larger colonies and increase local food availability (Cavallin & Ådahl 2012). However, weather conditions were also favourable both these breeding seasons which could potentially have had a positive effect on the breeding success (Cavallin & Ådahl 2012). Monitoring during the next coming years will determine if this is the case (Cavallin & Ådahl 2012).

7.1.5. Genetic heritage

Olsson (2007) suggested that there may be genetic reasons for why the reintroduced stork population has a poor reproductive output. In a study on the genetic origin and success of the reintroduced White Stork population in Sweden, Olsson (2007) discovered that the storks that derive from the founding Algerian population have a lower reproductive success than storks that derive from immigrated or introduced individuals from the "correct" sub-population, i.e. the east migrating population, defined in the study as the native population. Pairs with some native ancestry produced more than twice as many offspring than purely Algerian pairs (Olsson 2007). Factors that were not suggested to have a significant impact on the reproductive success were age, inbreeding, kinship and whether the pairs had been raised in captivity or not, while supplementary feeding during breeding season and dry weather increased reproductive output (Olsson 2007). These findings led Olsson (2007) to conclude that there must be a genetic difference between the Algerian storks and the native storks (Olsson 2007). According to Olsson (2007) this difference could be a result of the captive Algerian storks going through a bottleneck effect, due to the low number of founding individuals. However, Olsson (2007) states that these effects would then be obvious as inbreeding effects. Since inbreeding did not seem to influence the reproductive output Olsson (2007) instead suggested that the difference could be a result of the Algerian storks possessing local adaptations that are not suitable for breeding under northern European conditions. Olsson (2007) proposed that these adaptations could be foraging habits, thermo-regulatory abilities or timing of breeding, e.g. the reintroduced storks in Sweden initiate breeding earlier than storks in Poland, but this may also be a result of the fact that the Swedish storks are stationary. If the Algerian storks possess local adaptations or not are only speculations and a common-garden experiment would be needed to confirm if there are actually any local adaptations making the Algerian less suitable for breeding in Sweden (Olsson 2007).

7.1.6. Lack of natural selection and inbreeding

A problem with the originally introduced population is that it has spent many generations in captivity where there is a lack of natural selection (Olsson 2005). As mentioned before, in the wild only 15-20% of the birds survive to become breeders, it is most likely a very strong force for natural selection working on such a population favouring migration and foraging abilities (Olsson 2005). When the individual birds grow up in captivity and hence do not need to experience the dangers of migration, most of them survive to adulthood (Olsson 2005). A high survival rate is evidently desirable when building up a new population fast (Olsson 2005). However, in captivity properties that may not be favourable for a life in the wild might be kept in the population, making them less suitable once released, which might be a further reason for the poor breeding results (Olsson 2005).

There are other issues with the original introduced population, first of all the founding population only consisted of 15 individuals imported from Switzerland and only around half of these actually bred (Olsson 2005). This means that the re-introduced population has a low genetic diversity, which does not necessarily have to result in any problems for the reintroduced population, although it is desirable to have as much genetic diversity as possible (Olsson 2005). Despite Olsson (2007) not finding inbreeding to have an influence on reproductive output, it has been previously recorded that some of the laid eggs did not hatch, a problem that can be the result of inbreeding (Olsson 2005). A higher hatch rate could result in more surviving fledglings which would be positive for the programme (Olsson 2005).

Efforts to mitigate the suggested genetic problems among the reintroduced population will be discussed in section 10.

8. DISPERSAL

It has been recorded that a few project-storks from the Swedish reintroduction programme have settled in areas outside of Sweden (Cavallin, in press). Since 2004 a pair of project-storks have been breeding in Denmark, these do not migrate and are fed by a Danish stork organisation (Cavallin, in press). In 2012 another Swedish project-stork settled in Denmark, where it paired up with a wild stork (Cavallin, in press). Two project-storks have also been confirmed to have settled in Germany, one has been breeding with a wild stork since 1998, and wintering in Germany and another has spent its time in Germany since 2008 and further bred there with a wild stork in 2012 (Cavallin, in press).

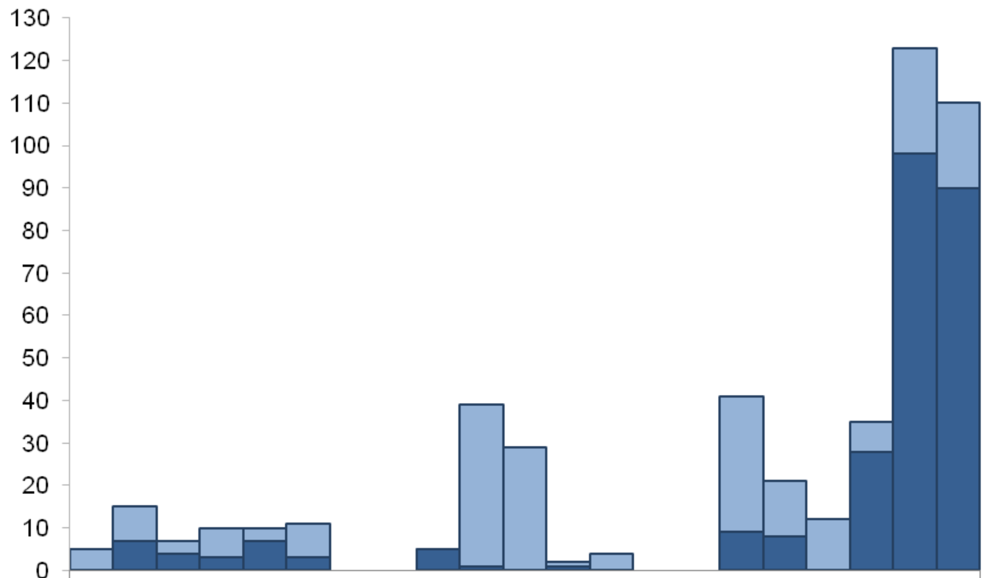
Failed breeding one year can result in pairs changing their breeding site the following breeding season (Ådahl 2013). Conflict in the breeding area, along with the quality of the habitat, can therefore influence the White Stork’s tendency to disperse (Ådahl 2013). As a result, management are actively trying to prevent this kind of dispersal by reducing the colonies and hence the negative density dependence, promoting establishment among good quality habitat and encouraging habitat improvements (Ådahl 2013).

9. MIGRATION

One of the greatest obstacles to overcome within the programme has been to facilitate migration among the reintroduced storks (Ådahl 2012). The establishment of true migration behaviour is a vital part of the programme since supplementary feeding during winter will be discontinued once the programme has been terminated; migration will then be a necessity for survival (Olsson 2007). Further, proper migration behaviour is needed for the population to be considered natural, which is the ultimate goal of the reintroduction programme (Ådahl 2013).

9.1. JUVENILE MIGRATION

The result of juvenile migration is presented in figure 9 where the numbers of juveniles free to migrate and the number of juveniles that actually have migrated are displayed. Juvenile



	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12
Juveniles free to migrate	5	15	7	10	10	11	0	0	5	39	29	2	4	0	0	41	21	12	35	123	110
Juveniles migrating	0	7	4	3	7	3	0	0	5	1	0	1	0	0	0	9	8	0	28	98	90
Migration rate (%)	0	47	57	30	70	27	-	-	100	30	0	50	0	-	-	22	38	0	80	80	82

Figure 9*. Juvenile migration of the reintroduced White Stork in Scania, Sweden, between the years 1992 and 2012 (Source: the Swedish White Stork Reintroduction Programme Database).*

migration was actively prevented in the beginning of the programme by collecting all juveniles born freely and placing them in enclosures until adulthood (Cavallin 1997). This was done partly to increase the captive breeding basis and partly because of the known dangers of migration made it unlikely that the migrating juveniles would survive and return (Cavallin 1997). To test if the juveniles' migration behaviour was still intact after generations in captivity the first juveniles were allowed to migrate in 1992 (Cavallin 1997). However, the five individuals free upon migration all chose to winter in the breeding grounds (Cavallin 1997). Nevertheless, the following year seven out of 15 juveniles free ended up migrating, proving that despite generations of captive breeding the instinct to migrate still remained (Cavallin 1997). The juveniles were continuously allowed to migrate until 1998 when it was once again chosen to prevent further migration. This was due to the fact that few took the chance and only one had returned, an individual migrating in 1994 and returned in 1997 (unpubl. The Swedish White Stork Reintroduction Programme Archive 2009). The five individuals migrating in 2000 were individuals that had been released as a result of inbreeding and they all ended up migrating (unpubl. The Swedish White Stork Reintroduction Programme Archive 2009).

In 2001, management once again allowed for juvenile migration, since the juvenile group was considered to be a large enough, consisting of almost 40 individuals (Olsson 2002). However, few individuals took the chance and as a result of the poor attempts of migration in 2001 and later also in 2002 led to the decision to once again collect the juveniles and not letting them migrate during the following years (Olsson 2003).

As from 2007 no further collection has been made and all juveniles born free have been allowed to migrate. The migration in 2007 and 2008 is thought to have consisted of many more individuals than what is evident in figure 9; however these are the numbers that have been confirmed by ring findings along the migration route (Ådahl & Olsson 2009). There was no migration in 2009 which was probably due to the small juvenile-group (Ådahl 2010). The juvenile batch of 12 individuals was small in relation to the approximately 80 stationary storks in Scania at that time (Ådahl 2010).

In 2010 practises changed, juveniles born in captivity were released upon migration time to join the juveniles born free in an effort to increase the numbers to a large enough group that would potentially facilitate proper migration (Cavallin & Ådahl 2011). Experience suggested that there is a greater chance for the juvenile population to migrate the larger it is, perhaps to decrease the social magnet or because of an increased likelihood that there would be an individual bold enough to initiate and others would follow (Cavallin & Ådahl 2011). The change in practise was considered a great success as the number of migrating juveniles increased rapidly and has been stable at approximately 80% the last three years (Cavallin & Ådahl 2012).

9.2. INFLUENCES ON MIGRATION BEHAVIOUR

Despite the extensive knowledge available about the White Stork its migration behaviour is still not fully understood (Ådahl & Olsson 2009). What route the storks choose and their behaviour are influenced by a number of different factors such as genetics, social factors, topography, available resting places and weather conditions (van den Bossche *et al.* 2002). The factors suggested to influence the reintroduced storks in Scania will be discussed below.

9.2.1. Genetic factors

Due to the poor migration attempts it was suggested by Olsson (2007) that there might be genetic factors affecting the introduced population’s inclination to migrate. In the study on the genetic origin and success of the reintroduced storks Olsson (2007) also studied a potential link between heritage among the storks and migration. It was suggested that the storks with Algerian heritage were less inclined to migrate than individuals with “wild” ancestry (Olsson 2007). Olsson (2007) considered all the free-flying individuals present in Scania during at least one migration season to have had the chance to migrate, these were then analysed depending on their level of Algerian ancestry. The analysis did not include the wild immigrants that were presumed to have migrated prior to settling in Sweden (Olsson 2007). Olsson (2007) concluded that there was a significant difference in the ancestry of the individuals that had migrated during the course of the programme and that birds with partly “wild” origin were more inclined to do so. This conclusion has received some criticism. Cavallin and Ådahl (2012) claims that the project-storks that had migrated during the 90s, where most of them were of 100% Algerian heritage, were left out of the analysis and hence the result does not reflect the true conditions. This has been rejected by Olsson (pers. comm.) since the analysis included all known cases of migration from the programmes own database as well as all ring findings from the Swedish ringing centre. It is however worth mentioning that the stationary storks that have spent years in captivity was included in the study (Olsson 2007) while it has long been known that these do not migrate, and should not be expected to, due to reasons mentioned earlier (e.g. Cavallin 1997; Olsson 2006).

9.2.2. Social factors

Instead (Cavallin & Ådahl 2012) states that since the White Stork is a soaring bird that migrates in larger groups during daytime, they should not be dependent on any inherited migration mechanisms similar to those of passerines that migrate alone during darkness. They suggest that social interactions, topography and the guidance of experienced individuals have the largest influence on the White Storks migration behaviour (Cavallin & Ådahl 2012).

In a study on the intentional displacement and delay of juvenile White Storks, Chernestov et al. (2004) found a significant variation in migration pattern among the treated storks. The result suggested that since all the storks flew south, although in varying direction, there should be, to some degree, an inherent inclination to migrate among White Storks (Cherenstov *et al.* 2004). However, finding the correct migration route was greatly dependent on the encountering of other migrating storks (Cherenstov *et al.* 2004). They further concluded that due to the dependence on other conspecifics, first time migrating storks are not forced to rely on their inherent orientation mechanism (Chernestov *et al.* 2004). This would suggest that the selection pressure on these mechanisms are relatively low, at least compared to other migrating species that are highly dependent on such innate mechanisms (Cherenstov *et al.* 2004). This would have resulted in the fact that, when forced to migrate by themselves, many juvenile White Storks are not able to orient themselves correctly (Cherenstov *et al.* 2004). This would suggest that the migration of the juvenile storks in the Swedish reintroduction programme has been hindered by the lack of experienced individuals in the area (Cavallin & Ådahl 2012). Further, the increasing level of juvenile migration in the Swiss programme mentioned earlier would suggest that an increasing wild population of experienced migrating storks would provide much needed help for the juveniles during their first migration (Olsson 2003). Adding to this, it is also thought that the social magnetism that the stationary storks exuberate on the juvenile is preventing migration (Cavallin & Ådahl 2012). If the juvenile batch is small in comparison to the stationary population it is deemed unlikely that these inexperienced individuals would branch out by themselves (Cavallin & Ådahl 2012). Hence, a larger juvenile group would reduce the effect of the stationary population and increase chances of departure (Cavallin & Ådahl 2012).

9.2.3. Environmental factors

It has also been suggested that the Baltic Sea acts as a barrier for the White Storks, further impairing the initiation of migration (Cavallin 1993). The stork population in Scania is on the edge of the distribution area and need to cross the Baltic Sea to reach the continent (Cavallin 1993). This is considered and obstacle that makes it harder for storks to pass since they are soaring birds, relying on thermal winds when flying longer distances and these are not created over water (Cavallin 1993). Another fact that suggests that the Baltic Sea poses an obstacle for White Storks is the fact that there up until recently was a breeding population on the mainland of Denmark despite the breeding conditions not being better there than in Scania (Cavallin 1993). This would further suggest that the availability of experienced pull is important to initiate migration (Ådahl & Olsson 2009).

Further, environmental factors such as bad weather can also influence the migration behaviour of White Storks (van den Bossche et al. 2002). It is known that storks need good weather and thermal conditions to migrate (van den Bossche et al. 2002). Rainy weather can for example be unfavourable for the storks and they may postpone initiation of migration (Cherestov *et al.* 2004). This was also evident among the Swedish storks in 2001 (Olsson 2002). The free juveniles, along with a couple of wild storks that had joined the programme, gathered and prepared to move (Olsson 2002). However, the weather conditions in August and September that year were poor with only four days in September where it did not rain (Olsson 2002). The migration was initiated in late September but all but one of the juveniles turned around and flew back when they reached the Baltic Sea (Olsson 2002).

9.3. MIGRATION ROUTE

It is not only the questions of whether the reintroduced population will migrate at all but also where to they will migrate, that has been widely discussed. As mentioned before, it had been presumed that the now extinct Swedish White Stork population had followed the western flyway since they declined along with the western population (Cavallin 2010). However, it has been concluded that the original Swedish population would have belonged to the eastern population (Cavallin 2010). Due to extensive ringing in Denmark it has been found that 90% of the Danish population migrated along the eastern route, making it highly likely that the Swedish stork population did the same (Cavallin 2010). Adding to this is the fact that the Swedish population was hit hard by the catastrophic year of 1856, an event that only affected the eastern population (Cavallin 2010).

Due to the severe drought in western Sahel and the resulting decline of the western European population, the eastern flyway has long been regarded as the more safe option for migration (Ådahl 2001). The hope is for the storks belonging to the programme to migrate to East- and South Africa like the original population, however it is not known if these habits may change (Cavallin 1997). The migration pattern in Denmark has partially changed since the 1980s and prior to extinction in 2008, more and more individuals chose to travel along the western route (Cavallin 2011). As the western population grew in numbers, the chances for the Danish storks to encounter westward moving storks increased and as a result an increasing number of individuals chose that way (Cavallin 2011). By 2011, five of the offspring's from the Swedish project-storks in Denmark that had migrated chose the western migration route and none flew along the eastern (Cavallin & Ådahl 2011).

Out of the project-storks that have migrated from Sweden it is often not fully known where these have migrated to, due to the fact that they have often not been reported (E Ådahl, pers. comm.). However, one juvenile stork that initiated migration in 2003 but was only reported to reach Germany, was further spotted in 2004 together with a larger group of storks in Gibraltar continuing towards western Africa (Olsson 2005). With this reporting, that juvenile stork became the first from the Swedish stork project, which with absolute knowledge, completed a full migration (Olsson 2005).

As the number of migrating juveniles has increased in recent years, so have the reports on their whereabouts. In 2011, the majority of the migrating juveniles where later reported from rubbish dumps on the Iberian Peninsula (Cavallin & Ådahl 2012). In 2012, the migrating juveniles left Sweden in two different batches; the first one got an early start and was later reported to have joined experienced individuals along the eastern flyway (Cavallin, in press). Some of these juveniles were later reported from Israel (Cavallin, in press). The second batch migrated a month later and was reported from central Germany suggesting they instead chose the western flyway (Cavallin, in press).

9.3.1. GPS-STUDY

To examine the actual migration path of the project-storks two individuals were mounted with GPS transmitters in 2010 (Cavallin & Ådahl 2011). The individuals were chosen based on their background to be as representative of the available project-storks as possible (Cavallin & Ådahl 2011). One with 100% Algerian father and wild mother that was born free and the other born in captivity with 75% Algerian father and mother from the imported Polish storks (Cavallin & Ådahl 2011). The captive individual was chosen to display that juveniles born in captivity can move as long as they are released during certain premises (Cavallin & Ådahl 2011). These included (Cavallin & Ådahl 2011);

1. Fully flight ready.
2. At least 4 weeks prior to expected migration start.
3. No stationary storks around, however preferably wild storks that can act as a pull for the inexperienced storks.

The two juveniles migrated in different groups, the one born in captivity in the end of July made its way along the eastern route all the way to South Africa, while the juvenile born free left in the end of August and flew along the western route and settled on a rubbish dump in Catalonia (Cavallin & Ådahl 2011). Contact was later lost with the stork that flew to South Africa and it was presumed dead (Cavallin & Ådahl 2011) while the other returned to the breeding grounds in 2012 and has since wintered in Sweden (Cavallin, in press).

9.4. RETURN

Once the juveniles have migrated, it will be at least three years before they return to breed (Cavallin 1993). Due to the low number of migrating juveniles so far, the numbers of returning birds have been very few. Considering the fact that the normal return rate is very low, approximately 15% (Cavallin 1997) and that so far not that many individuals have migrated, it is not surprising. Since the migration rate has increased in the last few years it can be expected that there would be some degree of return during the next coming years (Ådahl 2013).

However, there are already a few recorded cases of return. An adult male that migrated in 1994 and returned in 1997, has been migrating continuously until he died in 2012, while his female has remained stationary (Cavallin, in press). It is not known to where he has been migrating since no report of sightings has been made, due to his early arrival in March each year it has been presumed that he has been one of the many storks wintering on the Iberian Peninsula (Cavallin, in press). One juvenile migrating in 2008 returned as an adult but did not breed in 2012, during the winter 2012/2013 that individual wintered along with the stationary storks (Cavallin, in press).

It is not only a question if the migrating individual will survive to return but also the question of them actually choosing their birthplace and not settling somewhere else. For ringed chicks in Denmark the average distance for breeding from the birth site was 115 kilometres and out of 343 ringed individuals only 4 returned to the place of birth while 75% chose to settle in Germany (Cavallin 1997). If there are available breeding sites along the way back from migration there is a chance that the returning storks will chose to settle there instead (Ådahl 2013).

As the returning population increases the hope is that a migrating population will be established parallel to the stationary one (Ådahl 2013). The ambition is for the migrating population to fully replace the stationary storks in the future (Ådahl 2013).

10. CHANGING THE REINTRODUCED POPULATION

The current high survival rate among the reintroduced population is not natural since the population does not migrate and is hence not subjected to the dangers and high mortality of a natural migrating population (Olsson 2007). Olsson (2007) concluded that the reproductive success of the Algerian storks was not large enough to make up a stable population once proper migration habits have been established. As a result, it was decided to import storks from the "correct" sub-population, i.e. from eastern Europe (Storkprojektet 2005). By importing storks from Poland a number of different effects were suggested that would benefit the reintroduced population;

1. It would speed up the process of establishing a naturally behaving population, by increasing the reproductive base and therefore the reproductive output (Storkprojektet 2005). With more juveniles produced, this could also help facilitate migration (Olsson 2003).
2. It was thought that the Polish storks would be more genetically suited to breed under Scanian conditions, which would increase breeding success (Storkprojektet 2005). New genetic material could also reduce the level of inbreeding (Storkprojektet 2005).
3. It was suggested that the Polish storks perhaps would be more inclined to migrate (Storkprojektet 2005).

The first batch of White Storks were imported in 2004, manly from the Polish Poznan Zoo, and consisted of 40 individuals (Olsson 2005). All the storks imported were originally born in the wild and of no known relation to each other (Olsson 2005). These individuals had been injured or orphaned prior to being handed in to the zoo (Olsson 2005). As a result, most of them had permanent injuries preventing them from being released in the wild (Olsson 2005). All were however of reproductive capacity and the juveniles of these individuals would be released in the future (Olsson 2005). In 2009 a second import of Polish storks was executed, this time only 19 individuals but they were regarded to be in a better condition than the previous group (Ådahl 2010). However, these too were not able to use for release but were kept for captive breeding (Ådahl 2010).

Since it had been determined that the Algerian storks would not be able to make up a stable population due to the poor reproductive success it was determined to no longer breed individuals of Algerian heritage in captivity (Olsson 2006). The first year the eggs of the pure Algerian pairs were pecked, resulting in them not hatching and being of minimal intrusion for the birds (Olsson 2006). As the Polish storks began to produce eggs, management instead exchanged the eggs and let the Algerian pair's foster Polish eggs (Olsson & Ådahl 2008).

Free-breeding pairs with a large part Algerian ancestry had their eggs exchanged with eggs laid by the captive Polish storks (Olsson & Ådahl 2008). These captive pairs laid new eggs which they were allowed to keep and the eggs from the Algerian storks were destroyed (Olsson & Ådahl 2008). However, there were not enough eggs to distribute to all the Algerian couples and some had their eggs destroyed without any replacement (Olsson & Ådahl 2008). It was determined that the batches that were exchanged had as much of a survival chance as the ones that were left alone (Olsson & Ådahl 2008).

Because management decided to no longer breed the Algerian storks, during 2007 and 2008 approximately a total of 50 captive storks of Algerian heritage were euthanized (Ådahl 2013). The free-breeding storks of Algerian ancestry where kept as foster parents to Polish eggs (Olsson & Ådahl 2008). However, in 2010, when a reduction of the free population was initiated due to negative density dependence, all free-breeding storks of 100% Algerian heritage were collected and placed in captivity (E Ådahl, pers. comm.). This meant that the egg exchange of free breeding pairs could be discontinued in 2011 (Cavallin & Ådahl 2012).

11. PUBLIC AWERNESS AND EDUCATION

A large part of the programme is focused on raising awareness about the project, the White Stork and its habitat (Ådahl 2013). The White Stork serves as a practical example of the effects modern agricultural practises have had on our environment (Ådahl 2012). A good example of the educational value of the White Stork is that, when in 2011, after a guided tour a school class decided to donate half of their earnings from a Christmas Market to the programme (Cavallin & Ådahl 2012).

Approximately ten public events linked to the programme are arranged each year in different areas of Scania (Ådahl 2013). Adding to this are around 20 lectures and private tours held each year which, in addition to information spreading, provides an income for the programme (Ådahl 2013). The public can also gain knowledge about the programme by visiting the different captive breeding sites (Storkprojektet 2013). At three of the larger enclosures there are information signs about the programme and the White Stork in general (Storkprojektet 2013). Further, at Fulltofta a pavilion is under construction that will increase the management’s ability to cater for large guided tours and where the visitors will have a good view over the surrounding wetlands and breeding storks (E Ådahl, pers. comm.). In Fulltofta there is also a stork-shop with the sales of programme oriented merchandise, however due to resource constraints, this is only opened sporadically (E Ådahl, pers. comm.). Previously there was a proper visitors centre with an open shop by the main enclosure in Karup, this was at times estimated to have around 10 000 visitors each year (unpubl. The Swedish White Stork Reintroduction Achieve). However, the visitor centre in Karup had to be shut down as no one could manage it anymore (unpubl. The Swedish White Stork Reintroduction Achieve).

11.1. THE WHITE STORK AS A FLAGSHIP SPECIES

The presence of White Storks in the landscape of southern Sweden is of more importance than for conservation alone. Because it is an area that is characterised by many centuries of manipulation, manly by agricultural practises, environmental management is often partly focused on the cultural history of the area (Karlsson 1989). The White Stork is for many people a given element of such a cultural landscape (Cavallin 1997). The view of the stork in Sweden has been of the same character as in many other countries, historically people have mounted old cartwheels on their roofs in the hope of having a stork pair settling on their property (Cavallin 1997). Having a stork on your property was not only said to bring good luck but it was also believed to prevent your house from catching fire (Cavallin 19997). The public appreciation of the White Stork makes it a good candidate to promote habitat restoration (Cavallin 1997).

The great value of the White Stork has credited the programme with extensive media coverage (Ådahl 2012). In 2011 alone, the programme was covered in approximately 20 different newspaper articles, appeared in the radio at five different occasions and received four news reports in both regional and national television (Ådahl 2012). The programme is regarded to be the most well-covered conservation initiative in Sweden, further increasing the value of the White Stork as an ambassador for the regions wetlands (Ådahl 2012).

11.1.1. Habitat restoration

For the goal of a self-sustainable White Stork population in Sweden to become reality, efforts must be made to restore the species habitats (Cavallin 1997; Olsson & Rogers 2009). In many European countries the White Stork is used as a flagship species for the preservation of these ecosystems (Thomsen & Hötker 2006) and so too in Sweden (Cavallin 1997). Preserving and restoring the grass- and wetlands that the White Stork is depending on would ultimately result in beneficial outcomes for other species linked to these ecosystems (Olsson & Ådahl 2007).

The most urgent need for protection, creation and restoration of wetlands in Sweden occurs in the region of Scania, due to the historical drainage being much more extensive in this area (Andersson 2009). Scania is also the main region in Sweden for amphibians, where all of them are dependent on wetlands and most of them are endangered (Andersson 2009). The climate and soils are different in Scania compared to the rest of Sweden which means that some of the species, dependent on the Scanian wetlands, are not present in any other areas of Sweden (Andersson 2009). This makes the wetlands conservation in this region of even greater importance (Andersson 2009). The first possibility to receive government funds for wetlands creation was established in 1989 (Länsstyrelsen i Skåne Län 2007). Since 2001, most of the financial support for the creation of wetlands on an estate are provided by the EU and it is with few exceptions on the initiative of the landowner (Länsstyrelsen i Skåne Län 2007).

No active restoration of habitat is executed within the programme (E Ådahl, pers. comm.). Instead, the White Stork is used to encourage landowners and governments to restore degraded habitats, as well as reduce the chances of further degradation (Cavallin 1997). For example, the public are encouraged to create platforms for nesting and install them on their estates, with instructions provided by the management (Cavallin 1997). It is however added that there needs to be proper feeding grounds surrounding the estates and landowners are recommended to create these if there are none available (Cavallin 1997).

Restoration efforts benefiting the White Stork in Sweden have so far been limited due to the lack of knowledge of the distribution of potentially viable stork habitats (Olsson & Rogers 2009). In an effort to direct management efforts Olsson & Rogers (2009) developed a predictive habitat model for the White Stork in Scania. The model identified current, unoccupied suitable habitat for breeding White Storks as well as habitats that with modest restoration efforts could become suitable stork habitat in the future (Olsson & Rogers 2009). A resulting map is used in the Strategic Plan for Wetlands in Scania, that provides land owners that are interested in aiding the conservation of the White Stork, with a map of suggested restoration areas (Länsstyrelsen i Skåne Län 2007). The County Administrative Board in Scania has also decided to prioritise the White Stork (E Ådahl, pers. comm.). They are currently planning to offer landowners the highest level of financial compensation for creation and restoration of habitats within a five kilometre radius of a nesting site (E Ådahl, pers. comm.).

12. FUTURE

12.1. REVISED DEVLOPMENT PLAN

The revised development plan from 2013 follows the original development plan from 2005 (Ådahl 2013). In 2005 it was estimated that if following an expected prognosis the programme would be able to initiate termination around year 2013 (Storkprojektet 2005). The original plan estimated that with important measures executed, including the import and release of the Polish storks, the further establishment of breeding and release enclosures and the allowing for migration among juveniles would result in 125 breeding pair, where of 100 producing migrating offspring by 2013 (Storkprojektet 2005). However, the development of the programme was highly deviant from the expected prognosis (Ådahl 2013). Reasons for this outcome have been suggested to be a result of (Ådahl 2013);

- The breeding population was reduced as a result of the euthanization of the Algerian storks.
- The Polish storks could, due to their injuries, not be released until they had produced sexually mature offspring in 2012 instead of 2006 which was expected.
- The number of released individuals was lower than what was suggested in the prognosis.
- Using Algerian storks as foster parents for Polish eggs was not as effective as had been accounted for.
- The reproductive success in the colonies reduced as they grew larger.
- The free-breeding population was reduced due to the collection of pairs in the colonies.

In the newly adopted development plan a new working strategy has been proposed where, as of 2013, the programme will be working in stages of three years and after each completed stage the accomplishments will be evaluated in relation to the goals and budget of the programme (Ådahl 2013). If the stage is determined successful the programme will continue with the next three-year stage or if it is highly divergent to the plan the management will consider terminating the programme (Ådahl 2013). Stage I (2013-2015) and II (2016-2018) are described in table 2 (Ådahl 2013).

Table 2. *The next two stages in the development plan for the Swedish White Stork reintroduction programme (Source: Ådahl 2013).*

Stage **Time period**	**I** **2013-2015**	**II** **2016-2018**
Yearly actions (year 1-2)	Approximately 30 new juveniles are kept for breeding	
Yearly actions (year 1-3)	At least 2 new release enclosures are constructed At least 10 new established pairs are released At least 1 new power line is mounted with bird diverters	At least 2 new release enclosures are constructed At least 15 new established pairs are released At least 1 new power line is mounted with bird diverters
Goals	A population of 60 free breeding pairs, whereof; - 15 spontaneously established migrating pairs - 200 migrating juveniles Juveniles are no longer needed to be kept for breeding	A population of 120 free breeding pairs, whereof; - 50 spontaneously established migrating pairs - 220 migrating juveniles

According to the development plan the most important management actions during the initial two stages will be (Ådahl 2013);

- Constructing a larger number of release enclosures.
- Continuing the release of established pairs.
- Continuing the release of a large part of the captive born juveniles.
- Reducing the captive reproductive base.
- Capturing non-migrating juveniles.
- Initiate collection of the stationary storks.
- Initiate the deconstruction of permanent enclosures.
- Increasing the number of nesting platforms.
- Continue pressuring the electrical companies to mount bird diverters or bury power-lines close to breeding areas.

A prognosis has been developed based on the proposed management strategy and if it is followed the Swedish stork population could consist of approximately 120 free breeding pairs by 2018 (Ådahl 2013). According to this development, there would be around 70 stationary pairs, 50 migrating pairs along with approximately 220 migrating juveniles each year and roughly 30 breeding pairs left in captivity (Ådahl 2013). If the development follows the prognosis the goal of 100 migrating pairs could met by 2023 (Ådahl 2013).

12.2. INCREASED FUNDING

An important concern within the programme is the lack of continuity and inability to plan for longer time period as a result of financing that needs to be reapplied for each year (Ådahl 2012). In 2011 a working group was assembled to find new sponsors and develop ways of increasing the self-financing, e.g. by producing merchandise linked to the stork (Ådahl 2012). The ambition is to make the financing more stable in the long term and hence increase the working pace and efficiency of the programme during the next three years (Ådahl 2012).

For the programme to be able to evolve and for the goal to be reached an increase in funding is required (Ådahl 2012). The current management position is for 100% and it is regarded that a further position of 25% is needed for development of tourism opportunities and educational activities (Ådahl 2012). Further, the low number of release enclosures has been and still is a limiting factor that has slowed down the establishment of a free-breeding population (Ådahl 2012). If the development of the reintroduced population should be able to follow the prognosis more release enclosures must be mounted (Ådahl 2012). These are expensive and to be able to follow the suggested prognosis an increase in funding over the next few years will be essential (Ådahl 2013).

12.3. PROGRAMME TERMINATION

Four criterions are listed that need to be fulfilled for the initiation of programme termination (Ådahl 2013);

1. There must be a steady migration rate of at least 50 adult pairs.
2. All juveniles must migrate.
3. The return rate of juveniles to breed must be at least 20 percent.
4. The return rate of adult breeders must be at least 80 percent.

Early termination can be initiated if the programme is regarded unsuccessful or unlikely to succeed due to a highly divergent outcome in relation to the prognosis (Ådahl 2013).

12.4. FUTURE THREATS

12.4.1. DIRECT THREATS

There are a number of different factors that have been identified that might have a direct influence on the outcome of the programme (Ådahl 2013). As mentioned before, juveniles that do not migrate are collected and put in enclosures. If the rate of migration in juveniles is constantly too low, lower than a three year average of 75 percent, the number of juveniles in captivity will increase and hence delay the time plan of the programme (Ådahl 2013). An increased number of birds in the enclosures will act as a stronger social magnet for the free-flying storks and may hence further inhibit migration among the free storks (Ådahl 2013). In an effort to counteract this, attempts can be made to release the captive juveniles the following year and test if they move with the juveniles born that year (Ådahl 2013). Further, for the programme to be successful there needs to be a large enough establishment of migrating breeding pairs (Ådahl 2013). If the return rate, alternatively the immigration rate, is lower than a 20 percent rate of return there is no chance of establishing a natural population (Ådahl 2013). Actions may also be taken for the collection of stationary birds before the population reaches 50 migrating pairs if it turns out that returning storks chose to stay in the breeding area instead of migrating the following fall (Ådahl 2013). The number of individuals kept in enclosures should be minimized as well as distributed to as few sites as possible in an effort to keep the attraction to these storks as small as possible (Ådahl 2013).

All these issues are determined to have a strong influence of the future of the programme and may therefore result in early termination (Ådahl 2013). It is estimated that there will be enough data to consider the effect of these factors within the next three years (Ådahl 2013).

12.4.2. Indirect threats

The current positive trend of the overall European population is likely beneficial for the Swedish population (Schulz 1998). However, the future of both the western and the eastern populations are uncertain (Schulz 1998). The increases of the breeding populations in Spain and Portugal, along with the establishment of a wintering population on the Iberian Peninsula are partially the reason for why the White Stork population has been increasing in western

Europe (Schulz 1998). However, EU regulations on garbage handling will result in the discontinuance of these kinds of rubbish dumps (Cavallin and Ådahl 2012). This might have negative effects on the western European stork population, since it is likely to cause a change in distribution and migratory behaviour (University of East Anglia 2013). Further, the climatic conditions in western Africa might once again become unfavourable with droughts having a severe impact on the west-migrating populations (Schulz 1998).

It is also expected that the agricultural practises will change in eastern Europe as a result of more of these countries joining the European Union (Schulz 1998). A rationalisation of the agriculture is likely to have a negative effect on the eastern stork population similar to that experienced in the western population during the last century (Schulz 1998). Figure 10 displays the number of breeding pairs divided between countries after the 6th International White Stork Census in 2004/05. As is evident in the figure, the largest populations of White Stork in Europe are present in the eastern and south-western parts. These populations are

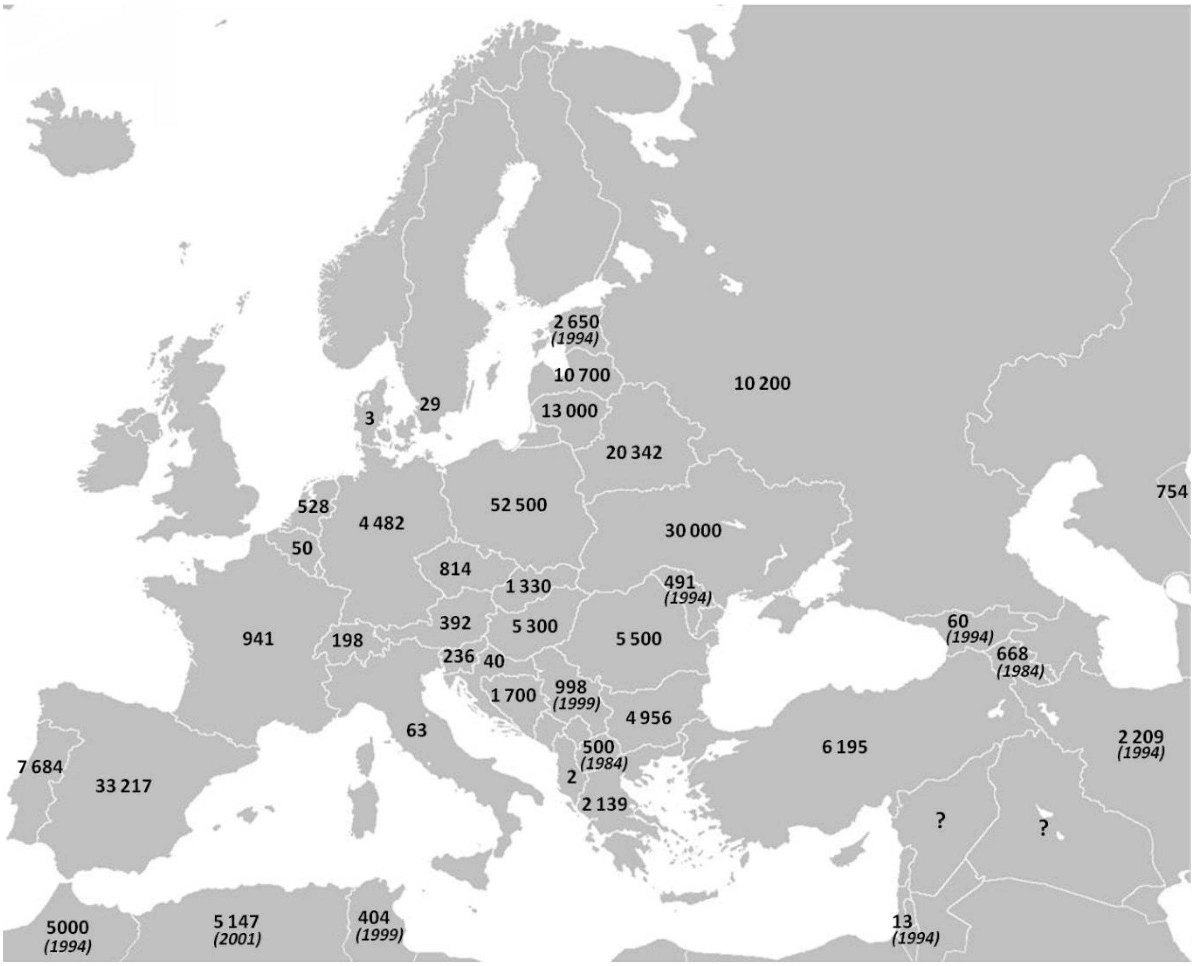


Figure 10. *The number of breeding pairs of White Stork distributed by country, if nothing else is stated, the number is from 2004/05. (Source: Alphaton 2012; Thomasen & Hötker2006).*

thought to serve as core populations, allowing for dispersal into more peripheral areas after episodes of population decline (Schulz 1998). Changing conditions in these core areas would ultimately have a detrimental effect on the entire species (Schulz 1998). Since the largest populations are found in eastern Europe this might have severe consequences for the White Stork (Schulz 1998).

13. INTERNATIONAL PERSPECTIVE

Due to the fact that the species is increasing, has a large distribution range and the great size of the total population the IUCN Red List of Threatened Species listed the White Stork as Least Concern in 2004, after having been listed as Near Threatened in 1988 (BirdLife International 2013). However, being a migrating species it is listed in Annex 1, in the European Union Birds Directive (European Commission 2013). A migratory species is often more vulnerable as a result of travelling over vast distances and numerous countries (AEWA 2006). Migrating waterbirds are generally of even more threat since they depend on the wetlands that are prone to degradation by human actions (AEWA 2006). The European Union's Birds Directive recognizes that the future of the European migratory species is a common responsibility, where international collaboration between the Member States is essential for the long-term persistence of these species (European Commission 2013). Further, due to the uncertainties of the future conditions for the European White Stork populations, the need of active conservation measures to ensure the species persistence is evident (Schulz 1998). International cooperation will be essential in an effort to reduce the mortality caused by power lines, pesticide usage and persecution along the migration route (Schulz 1998).

Further, for the White Stork in Sweden would be likely benefited by collaboration between the areas around the Baltic Sea (Ådahl 2013). This would especially be of value with Denmark since the extinction in early 21st Century now mean that there is a gap in the distribution of the continental population and Sweden (Ådahl 2013).

14. INFLUENCES ON REINTRODUCTION SUCCESS

Due to the fact that a lot of resources are invested in reintroduction programmes, it is important to have knowledge of the factors that may influence the outcome of these programmes (Fischer & Lindemayer 2000). Factors that are often listed as having a large influence on the outcome of reintroduction programmes are; habitat quality at release site (Griffith *et al.* 1989; Fischer & Lindenmayer 2000; van Wieren 2006); the identification and removal of initial cause of extinction (Griffith et al 1989; Fischer & Lindenmayer 2000); the geographical location of the reintroduction (core vs. periphery of a species distribution range) (Griffith et al 1989; Wolf et al. 1996); the number of released animals (Griffith *et al.* 1989; Fischer & Lindenmayer 2000; van Wieren 2006); genetic diversity and local adaptations of the released population (Leberg 1993; Vergeer et al. 2008); whether the released individuals are wild caught or captive bred (Griffith et al. 1989; Fischer & Lindenmayer 2000; van Wieren 2006); as well as long term financial, political and public support (Sazzarin & Barbault 1996). These factors and how they may influence a reintroduction programme are presented further below.

14.1. HABITAT QUALITY AT RELEASE SITE

In studies where the result of translocations was analysed it was shown that the most important factor influencing the success of a translocation is the availability of viable habitat (Griffith *et al.* 1989; Fischer & Lindenmayer 2000). The landscape needs to have a large enough carrying capacity to maintain a viable population size and secure self-sustainability in the future (van Wieren 2006). Griffith et al. (1989) states that in the absence of adequate habitat quality reintroductions are unlikely to succeed despite of other factors such as how many individuals that are released. It is therefore important to fully comprehend the ecological requirements of the introduced species as well as ensuring that the needed habitat is identified, adequate and secured in the future (Griffith *et al.* 1989; van Wieren 2006).

14.2. IDENTIFING AND REMOVING ORIGINAL CAUSE OF DECLINE

Further, according to Griffith et al. (1989) the likelihood for a reintroduction programme to be successful is greatly increased if the cause of extinction is fully understood and eliminated. Fischer & Lindenmayer (2000) found in their review that out of the reintroduction programmes studied that had defined the cause of the decline but had been unable to remove it, all of them failed. Nevertheless, understanding and removing the initial cause of decline did not necessarily ensure success (Fischer & Lindenmayer 2000).

14.3. REINTRODUCTION LOCATION

Studies have shown that translocation into the periphery of a species historical range are more likely to be unsuccessful than translocations into the core of the species range (Griffith *et al.* 1989; Wolf *et al.* 1996). Wolf *et al.* 1996 states that releases of a species in the periphery of its historical range should only be considered when the factors that caused the decline is eliminated in the periphery but still active in the core areas. Further, they state that a reintroduction into the periphery can only be successful when the habitat quality is better in that area than in the core area (Wolf *et al.* 1996).

14.4. NUMBER OF RELEASED ANIMALS

Having a small founding population makes the reintroduced population vulnerable towards inbreeding, demographic stochastisity and fluctuating environmental factors (van Wieren 2006). It is therefore beneficial for the reestablishment if the reintroduction is carried out at a fast rate and from a large number of founders (van Wieren 2006). Fischer and Lindenmayer (2000) suggest that a minimal of 100 individuals is needed for a reintroduction to be successful. However, Wolf et al. (1996) states that the number of released individuals that are needed for a reestablishment is species- and case specific. Evidence also suggests that above a certain threshold increasing the number of released individuals will not necessarily improve the success rate (Wolf *et al.* 1996).

14.5. GENETICS AND LOCAL ADAPTATIONS

When reintroducing a population it is desirable to make sure that the population has as high genetic diversity as possible (Leberg 1993; Vergeer *et al.* 2008). A low genetic variation could ultimately reduce the populations' ability to adapt to changing environmental factors as well as influencing the growth rate of that population (Leberg 1993). A way of increasing the genetic variability among an introduced population is by using individuals from the same subspecies but from different areas (Leberg 1993). However, despite the chances of the progeny of individuals from multiple genetic sources being likely to have higher fitness, there are also chances of such an outbreeding resulting in negative effects due to outbreeding depression (Leberg 1993).

14.6. CAPTIVE REARED OR WILD CAUGHT INDIVIDUALS

A higher success rate has been confirmed among reintroduction programmes using wild-caught animals (Griffith et al 1989; Fischer & Lindenmayer 2000; van Wieren 2006). Many generations of captive breeding before release can result in unfavourable traits once the individuals are released (van Wieren 2006). Increased tameness, change in behaviour, genetic drift and inbreeding are some suggestions on phenotypic and genetic changes that might occur in a captive population (van Wieren 2006). To make sure that the re-established population do not suffer from negative traits as a result of captive breeding, monitoring will be required even past termination of a reintroduction programme (Sazzarin & Barbault 1996).

14.7. LONG-TERM POLITICAL AND FINANCIAL SUPPORT

As stated in the introduction, reintroductions are with few exceptions a long-term commitment and they are dependent on continuing financial as well as political support (IUCN 1998; van Wieren 2006). The initiators of reintroduction programmes are usually NGOs that aim to protect and restore biodiversity (Sazzarin & Barbault 1996). These are usually dependent on sponsorships which make them obliged to execute their programmes as resource efficient as possible (Sazzarin & Barbault 1996). This reduces the ability for the managers to invest part of their efforts into scientific research and hence limits the understating of the factors that may have influenced the extinction and the future population viability (Sazzarin & Barbault 1996). Financial and political concerns are sometimes deemed greater than any other, since without proper support it is not possible to tackle other issues and the programme is much likely to result in failure (Sazzarin & Barbault 1996; van Wieren 2006).

15. DISCUSSION

In this section I will discuss some of the major issues that have arisen during the course of the programme. I will also try to apply the factors that may influence the outcome of a reintroduction to the Swedish White Stork Reintroduction Programme in an attempt to direct management efforts in the future.

15.1. PROGRAMME ISSUES

Most of the issues that have arisen during the course of the programme have been problems that are often associated with reintroductions, further promoting a good understanding of the factors that influences reintroductions before initiating such a complex project. The most important concerns will be discussed in the following sections.

15.1.1. Low release rate

It is recommended for a reintroduction programme that entails captive breeding to be executed at a fast rate to reduce the negative impacts that captive breeding might have on the re-established population. Similar to the Swiss reintroduction programme the Swedish White Stork Reintroduction has had a slow start. The rate at which individuals have been released has been low, first due to a small captive breeding base and later due to density dependent factors reducing the ability to release a large number of individuals at the same release sites. Since the released individuals do not behave in a natural way and it is expected that these will be collected as a migrating population is established, the number of released pairs might not be of a great importance to the future success of the programme. However, due to the tendency of White Storks to settle and breed in areas where there are already other breeding pairs present, more established pairs will need to be released in new localities to promote colonization in these areas. The increase in reproductive output among the captive storks has allowed for a more rapid release of established pairs over the next coming years. Today, the major hindrance to carry out the programme at a faster rate is instead the lack of resources that delay the establishment of new enclosures and hence places of release.

15.1.2. Financial insecurities

When the decision was made to initiate the reintroduction programme in Scania, little consideration was given to the long-term financing of the programme (J Karlsson, pers. comm.). If this had been properly accounted for, it is very likely that the programme never would have been initiated (J Karlsson, pers. comm.). Still the lack of continuity and uncertainty that arises when the programme is dependent on donations and re-applying for funding each year is the major issue that slows down the entire programme. The suggested development of the programme during the next five years will require a substantially increased budget and if these funds are not gathered it will further slow down the process. With a more secure financial situation the process to increase the distribution of the reintroduced population could be accelerated, something that is desirable in regards to captive breeding.

15.1.3. The origin of the reintroduced population

One of the largest issues that have been affecting the entire programme has been the question whether the originally introduced birds were poorly adapted to Swedish conditions or not. During the course of the programme both establishing correct migration behaviour and the reproductive success of the reintroduced individuals have been major issues that have influenced the development of the programme. The origin of the reintroduced storks has been suggested to have had a negative influence on both the individual's ability to migrate and the low reproductive success of the reintroduced population. It is always desirable to reintroduce individuals from as closely related populations as possible to reduce the chances of local adaptations that may be harmful or lacking in the new area. Opinions differ whether the storks of Algerian heritage were suitable or not for a reintroduction in Sweden. However, the Swiss programme did also find differences between the reintroduced individuals and wild immigrants and hence discontinued the captive breeding programme. Whether these differences were due to the heritage of the reintroduced individuals or the fact that they have been bred for many generations in captivity is not fully understood. The decision was still made to cease the usage of the individuals of Algerian heritage for breeding and instead use individuals from the eastern migrating population. Since the birds deriving from the imported Polish individuals only were made available for release recently this decision further slowed down the process, however if the new individuals are better suited to persist under Swedish conditions this will have a positive effect on programme in the future.

15.2. FUTURE MANAGMENT

The development of the programme during the coming three years will be of critical importance for the future of the programme. In 2014 the first major return of juveniles ready to settle and breed is expected. If this return is absent it is questionable whether the programme will result in a natural, self-sustaining population of migrating storks. On the other hand, if they do return at a satisfactory level management practises will need to focus on providing optimal conditions for the establishment of a naturally behaving, stable population. Below I will discuss factors that will be of significant importance for the re-establishment of White Storks in Sweden.

15.2.1. Habitat restoration

Habitat restoration is important for the re-establishment of the White Stork population in Sweden due to multiple aspects. First of all it is the major cause of the original decline that has been active in the breeding area. Since it has been suggested that a reintroduction can only be successful if the initial cause of decline is eliminated efforts must be made to increase the habitat quality by restoring wetlands and other habitat the stork is dependent on. Further, since Sweden is at the periphery of the distribution range it is suggested that the availability of suitable habitat is of even greater importance than for areas in the core of the distribution range and if the programme is going to result in a re-establishment this must be kept in mind.

Habitat quality also influences the breeding success, which has so far been below the level suggested for a stable White Stork population. Increasing the amount of viable habitat would likely have a positive effect on the reproductive success. The reproductive output must be high enough and/or the mortality low enough for the population to be able to withstand breeding seasons of unfavourable weather conditions and stochastic events such as disturbance years. The current survival rate of adult storks is high which means that it can compensate for the low annual reproductive success. However, as the population of migrating individuals increases the annual mortality is also likely to increase. Therefore, it is important to increase the reproductive output. Increasing habitat quality would further reduce the impacts of negative density dependence since there would be more food available for the breeding storks.

Increasing the reproductive success by restoring habitat would also reduce the chances of dispersal among the reintroduced storks. It has been noted that individuals that have failed to breed in one area can choose to settle in a new area the following breeding season. The same applies for juveniles returning from the wintering areas that might settle in a free area on their way back. Since Sweden is at the periphery of the species distribution range, chances are that the storks will choose to settle in vacant habitats further south, especially since the historical population decline has made these places available for colonization. Therefore it is of even greater importance for a future, stable stork population in Sweden, that good and viable habitat is made available. Reducing dispersal is important not only because it is negative for the programme itself to lose individuals but also since these individuals are not behaving in a natural way and might be of a lower fitness than wild individuals. The few individuals that have dispersed to Denmark and Germany so far remain stationary in the areas that they have settled in, this is not desirable for the overall White Stork population in Europe. Providing optimal habitat and breeding conditions for the reintroduced storks will be important to reduce this kind of dispersal.

15.2.2. International collaboration

As the juveniles of the Swedish programme are now migrating at a larger rate it is important to consider the factors that influence the species re-establishment outside of the country's borders. Not only will the dangers of migration increase the mortality rate of the Swedish population but the future development of the overall European population will also likely affect the persistence of a Swedish stork population. Further, since adult survival among White Storks has a greater effect on population growth than do reproductive success, efforts should be directed to maintain or increase the survival rate. Since the Swedish stork population is now migrating along both migration routes, the future development of both the eastern and the western populations will be important for the Swedish storks. Management need to aim towards reducing the threats of migration. If the decline was a result of the decline further South in Europe then an increase like the one that has been evident during the last few decades will have eliminated that factor. However, much imply that this increase is not secured. It is believed that there might be a future threat to both the eastern and the western European population. In this case conservation measures must be applied at a larger scale with international collaboration to be able to secure the future of the White Stork population both in Sweden, and the rest of Europe.

16. CONCLUSION

While the programme started off slow, as can be expected by such an ambitious undertaking, progress in recent years has brought the re- establishment of a Swedish stork population within reach. Programme methodology has been polished as new knowledge has been acquired, increasing the effectiveness of the project.

However, despite the encouraging progress of the programme during the last few years, there are still uncertainties regarding the establishment of a naturally behaving White Stork population in Sweden. The large-scale juvenile migration during the last few years has opened up for the possibility of establishing a migrating population parallel to the stationary one. However, this will require that the high level of juvenile migration is continued and preferably increased. It will also depend on the juvenile survival and return as adults, along with the settlement in the reintroduction area and their continued migration behaviour as adult breeders. For this, management need to provide good enough breeding sites, with good quality habitat and minimal disturbance due to crowding, to limit the dispersal and settlement in other areas. This will entail increasing the distribution of the breeding storks and will ultimately require more resources to be invested in the programme.

It may be debatable whether it is the right approach to initiate a reintroduction programme when the majority of the conditions influencing the species persistence have not changed since extinction. However, without the programme it is unlikely that there would be any breeding White Storks present in Scania at present. It is only recently that the White Stork went extinct in Denmark, despite an overall positive trend of the species in many other parts of Europe. This suggests that a positive development is not enough, or at has at least not been extensive enough until present, for the White Stork to spread to the more peripheral areas of its historical breeding range. With the uncertainties of the future development of the species in its core areas, there is a need for the Swedish population to be viable without depending on immigration. The conditions in the breeding areas must be improved so that the reproductive output is large enough to sustain a migrating population where the adult mortality will be higher than at present. Further the breeding success must be large enough for the population to be able to persist despite years of unfavourable weather conditions and disturbance years caused by poor conditions in the wintering grounds or along the migration route. Management must also work on a wider scale, with international collaboration, in an effort to reduce the threats along the migration routes and secure the Swedish White Stork population in the future.

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