Reintroducing the Ural Owl (*Strix uralensis*) to Austria – Requirements for a successful comeback

Reintrodução da coruja dos Urales (*Strix uralensis*) na Áustria – requisitos para um regresso bem-sucedido

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ABSTRACT

The Ural Owl (*Strix uralensis*) became locally extinct in Austria (Europe) around 60 years ago. Since 2008 a reintroduction project for the Ural Owl takes place to re-establish the species in the Austrian woods. A renewed distribution in the Alps will establish an essential connection between the remaining populations south (Slovenia, Italy) and north (Germany, Czech Republic) of Austria and the alpine arch. Individuals that occasionally disperse between the newly established population in Austria and the ones in the neighbouring countries will ensure a genetic flow within European meta-populations, which is vital for the survival of the species in the long term. Since the start of the project and until the end of 2017, 300 owls have been released. Between 2011 and 2017 and a minimum of 58 breeding attempts in the wild could be verified with a total number of 115 owlets fledged. The average number of owlets fledged in the field was 2.6 per successful brood.

We present an overview of the most important factors for a successful reintroduction project in the three main areas of breeding, release and monitoring. Requirements for successful breeding of Ural Owls for release as well as administration and development of the breeding network are discussed. The method of release is explained and lessons learned from 9 years of experience are demonstrated. For the monitoring section, we show that the combination and interconnection of monitoring methods used, helps to re-identify birds on a regular basis and keep an eye on the development of the population in the field. Monitoring methods addressed and evaluated include the installation of nest boxes, special colour rings with inserted RFID Chips for re-identification, telemetry and establishment of a genetic monitoring system.

Keywords: Austrian Alps, monitoring methods, reintroduction, *Strix uralensis*

RESUMO

A coruja dos Urales (*Strix uralensis*) tornou-se localmente extinta na Áustria (Europa) há cerca de 60 anos. Está em curso, desde 2008, um projeto de reintrodução da coruja dos Urales para restabelecer a espécie nas florestas austríacas. Uma nova distribuição nos Alpes estabelecerá uma ligação essencial entre as populações remanescentes no sul (Eslovénia, Itália) e no norte (Alemanha, República Checa) da Áustria, e o arco alpino. Os indivíduos que migram ocasionalmente entre as populações recém-estabelecidas na Áustria e aqueles nos países vizinhos garantirão um fluxo genético entre meta-populações europeias, o que é fundamental para a sobrevivência da espécie a longo prazo. Desde o início do projeto, e até ao final de 2017, foram libertadas 300 corujas. Entre 2011 e 2017 foram verificadas 58 posturas (incluindo tentativas de reprodução mal sucedidas), tendo sido contabilizados no total 115 juvenis voadores. O número médio de juvenis voadores foi de 2,6 por ninhada bem-sucedida.

Apresentamos uma visão geral dos fatores mais importantes para o sucesso de um projeto de reintrodução, focando as três principais áreas de atuação: reprodução, libertação e monitorização. São discutidos os requisitos para o sucesso da reprodução de coruja dos Urales para liberação, bem como a administração e desenvolvimento da rede de reprodução. O método de libertação é explicado e as lições aprendidas em nove anos de experiência são demonstradas. Na componente de monitorização, mostramos que a combinação e a interligação dos métodos de monitorização utilizados ajudam a re-identificar as aves numa base regular, e permite acompanhar o desenvolvimento da população no campo. Os métodos de monitorização abordados e avaliados incluem a instalação de caixas-ninho, de anilhas coloridas especiais com chips RFID para re-identificação, telemetria e estabelecimento de um sistema de monitorização genética.

Palavras-chave: Alpes Austríacos, métodos de monitorização, reintrodução, *Strix uralensis*

Introduction

The Ural Owl (*Strix uralensis*) is a medium sized owl within the *Strix* genus including several subspecies with a distribution ranging from Europe to Northern Asia and Japan. In Europe there are two strongholds: one in northern and one in southern Europe. While there are still substantial populations in the Dinaric Alps and the Carpathians, in central Europe, it became locally extinct in Germany, as well as in Austria during the 20th century (Zink 2007, Zink & Probst 2009). Since the 1970s a successful reintroduction project has been carried out on the bohemian plateau in Germany and since 1995 in the Czech Republic (Bufka & Kloubec 2001, Beran 2005, Scherzinger 2006). In 2006 an expert meeting to discuss further conservation actions for the Ural Owl in Central Europe was held in Grafenau, Germany. It was decided in the meeting that the European meta-populations have to be connected in the future in order to ensure sufficient gene flow between the populations. To reach this goal, the re-establishment of the former Alpine population was considered necessary. This renewed population is supposed to establish the essential connection between the remaining populations south (Slovenia, Italy) and north (Germany, Czech Republic) of Austria and the alpine arch. Dispersing individuals between the newly established population in Austria and the ones in the neighbouring countries can bridge the distances and ensure genetic flow on the long term.

Previous to starting the reintroduction project a feasibility study was performed (Steiner 2007, Zink 2007). This study addressed former extinction risks and their current status, availability of suitable habitat and food resources, as well as the potential of bridging the genetic gap between the Central European populations. Before the start of the re-introduction project it is essential to research the reasons for the former extinction of a species to assess their current relevance (IUCN/SSC 2013). For the Ural Owl in Austria the main driving forces that lead to extinction were poaching (Zink & Scherzinger unpub. data) and due to changes in forestry the loss of massive deadwood stumps or old trees with holes in them for breeding, as it was the case in Scandinavia (Lõhmus 2003). Poaching of Ural Owls is no longer permitted in Austria (Zink & Probst 2009), nor is it of any interest to the hunters. With the establishment of protected areas, where trees are not harvested, the first steps towards minimizing the lack of nest sites for Ural Owls were taken. Furthermore the project planned to set up nest boxes in managed forests. It was also verified whether dispersal is actually sufficient to bridge the gap between subpopulations. The approximate distance between the German and the Slovenian/Italian population is about 220 km. According to data from Saurola & Francis (2004) the vast majority of Ural Owls disperse over a distance of less than 50km. About 5-10% of the surveyed individuals dispersed beyond 100 km. These individuals would be able to connect the meta-populations starting in Austria at the northern slopes of the Alps when considering only dispersal distance.

In 2008 the re-introduction project of the Ural Owl in Austria started. It is conducted by the Austrian Ornithological Centre (Veterinary University of Vienna) in cooperation with the Wienerwald Biosphere Reserve and the Dürrenstein Wilderness area. The first releases of young owls took place in 2009 and are ongoing. Reintroduction projects call for careful planning and long-term actions. In this article we outline the requirements for a successful reintroduction of the Ural Owl in Austria. This includes the setting up of a captive breeding stock with a managed studbook, the care for best release techniques, the usage of effective monitoring methods as well as the involvement of all relevant stakeholders.

Material and Methods

From the beginning of the project on, it was essential to establish a captive breeding network cooperating with many institutions in Central Europe (e.g. Zoos, wildlife parks, private institutions). The aim of the studbook was to get a gene pool from the nearest populations, without taking birds from the wild in order to avoid weakening or diminishing the neighbouring populations. To achieve this, fresh bloodlines are incorporated by receiving injured birds from nature, which cannot be released again. Agreements on this have been installed with Slovenia, Slovakia and Croatia. Another option is to receive young birds from Zoos which are keeping animals from the neighbouring populations. A main point of concern is the avoidance of imprinting through hand rearing. All birds used in the reintroduction project have to be “behaviourally intact”. Birds in the breeding network should be given adequate and best quality food in order to produce offspring with high fitness.

For a successful release several pre-conditions have to be met: The extinction risk of the species has to be lower than when it went extinct, stakeholders - for example hunters and foresters – have to be involved in the project, and a check for habitat suitability in the area of release as well as immediately around the release site is necessary. The possible impact of the reintroduced species on other species and ecosystem functions should be considered.

Before Ural Owls are released they have to be able to acclimatise for three weeks at the place of release. Training with live prey has to be ensured during this time period. Ural Owls in our experience have to be released between 90 and 100 days of age. Then they can rely on additionally supplied food on feeding tables (without human contact) until their hunting abilities are fully developed. When released later, the birds tend to disperse immediately and cannot be supported with food. This can lead to high mortality in released birds. After release, surplus food has to be offered immediately next to the place of release on feeding tables that are secure for the birds. This mimics parental care in the wild, which lasts until the autumn when juveniles are approximately half a year old (Scherzinger 1980). Adoption by wild couples is possible. Supporting these couples with extra food might be necessary in years with bad food conditions. It is also necessary to care for suitable and sufficient nest sites in the vicinity of release sites before releasing birds.

Concerning different monitoring methods after release, it’s important to avoid usage of single methods. Different methods can focus on various aspects (e.g. genetics, survival, reproduction). Ensure operational liability of monitoring methods on the long term (e.g. durability of nest boxes or marking techniques). We use the following monitoring methods within the reintroduction project of Ural Owls in Austria: genetic monitoring including genetic fingerprints from every bird used within the studbook and born in the project (breeding network and in the wild), nest boxes with mirror / camera, colour rings with inbuilt RFID- microchip, telemetry, acoustic recorders, observations and camera traps. Within this article we focus on the use of genetics and nest boxes. The genetic monitoring is carried out at the genetics lab of the Department of Interdisciplinary Life Sciences at the University of Vienna. We use different types of next boxes within the project. The main type used is made out of recycled dustbins provided by the city of Vienna (material is polyvinyl chloride - PVC) with a mirror on the upper inside for monitoring. Through the mirror breeding birds can be monitored with binoculars without distracting the bird. Nest boxes are controlled 3 times minimum per breeding period to assess breeding status.

The final important point for a successful reintroduction project is to create a network of partners and supporters, as well as to secure sufficient finances before the start of the project. The project was and is funded by the EU through the European Agricultural Fund for Rural Development, the federal states Lower Austria and Vienna, the Austrian State Forests and many others. For a complete list have a look at the webpage: www.habichtskauz.at.

Results

Since the start of the Ural Owl reintroduction project in Austria in 2008 a captive breeding network with an average of 50 active couples could be established. The number of active couples varies from year to year. Ural Owl couples within the breeding network are being kept in Austria, Germany, Switzerland, Italy, Czech Republic and Poland. We have data of over 100 new couple formations and information on 891 birds from twelve different European countries in our database. This database also includes the DNA-fingerprints of more than 500 individuals, which are used for genetic analysis.

Between 2009 and 2017 a total of 300 birds have been released in two different release areas (Figure 1). The number of released birds varied between 22 in 2009 and 45 in 2016 with an average of 33.3 birds per year. In the Wienerwald Biosphere Reserve 5 release sites are available, where 159 birds (females n = 71, males n= 81) were released (mean 17.6 birds per year). In the Wilderness Area Dürrenstein two release sites are available, where 141 birds were released (females n = 63, males n = 75, unknown sex n = 3) (mean 15.6 birds per year). This equals a total sex ratio of released birds of 47% females, 54% males and 0.01% birds of unknown sex.

We focus in this paper on reporting about two of our monitoring methods. With DNA fingerprints from all released birds the tracking of parenthood of offspring fledged in the wild can be determined. Since the start of the project 47 individual breeding birds could be identified either through their own feather samples or through those of their offspring. With help of the geneticist we are also able to keep track of the sex ratio – both of released and of birds born in nature. For the subpopulation in the Wienerwald Biosphere Reserve it can be shown that when accounting for released birds and birds born in nature the sex ratio is skewed towards a male surplus (females n = 103, males n = 134).

The project aimed to provide sufficient nest sites in managed forests where natural nest site availability is not always sufficient. Nest boxes were fixed in release areas as well as along potential migration corridors to facilitate gene flow. So far more than 450 nest boxes have been fixed, whereof 433 are currently in function. Through the control of nest boxes (and in some cases through the combination with telemetry) roughly 30 territories could be localised along the northern slopes of the Alps. Nest boxes are also willingly used by Tawny Owls (*Strix aluco*), with occupation rates of up to 80% in years with good food availability. The mean installation height of nest boxes is 10 m.

The network supporting the return of the Ural Owl to Austria consists of a cooperation of 21 zoos all over Europe, the involvement of 13 institutions also being part of the breeding network. A lot of time has gone into organizing volunteers who check nest boxes during the breeding season. Currently 60-70 people are involved every year and each of them surveys between one and 50 nest boxes for the project.

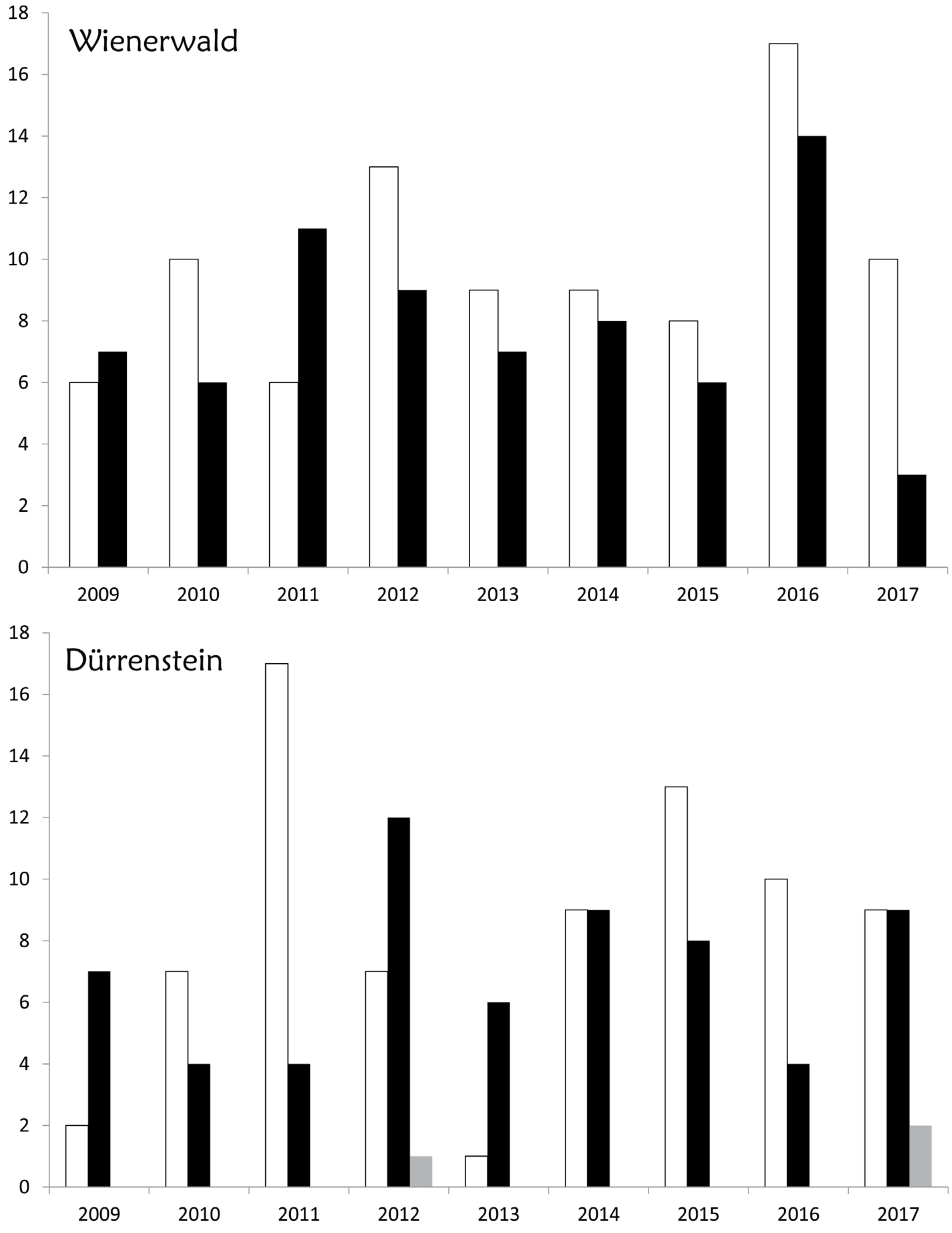
So are we successful with re-introducing the Ural Owl to Austria? Between the first release of birds and the end of 2017 we obtained the following results. All together we found 27 different breeding pairs, at least 58 broods could be recorded, out of which 44 broods were definitely successful. 115 owlets fledged successfully equalling 1.98 chicks for all broods and 2.61 chicks per successful brood.

Discussion

The reintroduction of any species has to be considered carefully, both before and during the implementation. Preceding considerations of the Ural Owl reintroduction were the following: From a European conservation perspective, the population of the species has been slightly increasing both in the northern and southern sub-populations during recent years (Bird Life International 2017). However, the former distribution range in Austria has not been autonomously recolonized for many decades, even though

Figure 1 - Annual number of released birds for the two release areas Biosphere Reserve "Wienerwald" and Wilderness Area "Dürrenstein" (white = males, black = females, grey = sex unknown).

Figura 1 - Número de aves libertadas anualmente na Reserva da Biosfera de Wienerwald e na Área Selvagem de Dürrenstein (branco = machos, preto = fêmeas, cinzento = sexo indeterminado).



healthy population strongholds are known to exist south and east of Austria. A reintroduced population in Austria would not only cover the former distribution area, it also can facilitate gene flow between northern and southern sub-populations. In our project, the species also acts as a flagship species for illustrating the importance of forest ecosystems. From an ecological point of view, the impacts of a reintroduced predator have to be considered. Korpimäki & Hakkarainen (2012) stated that the occurrence of the Ural Owl has a negative impact on smaller owls such as the Boreal Owl (*Aegolius funereus*) in coniferous forests. On the other hand Vrezec & Tome (2004) found that in Slovenia Boreal Owls profit from the presence of Ural Owls, when Tawny Owls (*Strix aluco*) are present in the same ecosystem. Due to the complexity of ecosystems it is difficult to have a complete view on all species interactions. Since the Ural Owl used to be part of the Austrian forest ecosystem, we assume that it will again take its place within this forest owl guild.

For the implementation of reintroductions, careful planning and learning from the experiences others already made, helps to avoid mistakes and increases the chances of success. Based on our experience with the reintroduction of the Ural Owl in Austria, we recommend the establishment of a captive breeding network including a managed studbook, the identification and use of the best release techniques, the usage of effective monitoring methods as well as the involvement of all relevant stakeholders.

Using birds for release that are born within a captive breeding network poses the advantage that no remaining populations in the wild are threatened by removal of birds for the reintroduction somewhere else. In the reintroduction of Ural Owls it became obvious that knowing the date of birth and therefore the age of released birds is crucial for their survival after release. When birds are born within a breeding network, this data is known. Keeping a well-managed studbook is crucial to allow the organization of breeding pairs to enhance genetic variability and avoid inbreeding. Extensive research of the genetic origin of birds within the breeding network is highly recommended in order to consider the "best" genetic origin of founder birds (Scherzinger 2014). Refrain from hand-raising chicks to avoid imprinting and miss-behaviour at later life stages especially during their reproduction.

Of all influencing factors on the success of release, the time of release is the most important to consider. Scherzinger (2007) recommended releasing Ural Owls with about 100 days of age. Through telemetry and intensive monitoring of feeding stations with camera traps we could improve this recommendation. Hence, we recommend releasing Ural Owls at the age of 90 to 100 days before their dispersal phase starts and birds cannot profit from surplus food provided after release. When Ural Owl couples are already present, adoption by wild breeding pairs could be observed. We recommend using only young birds, since older birds are already accustomed to dead food and have not developed hunting skills during growing up.

It is necessary to set up a genetic monitoring program for every reintroduction program. Only through a comprehensive monitoring of genetic origins of birds genetic variance in released birds as well as in the newly established population can be followed. Also genetic monitoring allows to manage for a balanced sex ratio in released birds. Release has to occur continuously to ensure proper demographic development. Do not release more than 8-10 birds per release site as this may lead to intraspecific competition amongst juveniles after release. Limit competition among birds and therefore do not release where couples have already settled and reproduce, except if surplus feeding can be provided and therefore adoption is made possible.

When choosing monitoring methods for reintroduction projects these methods should monitor all important aspects (i.e. survival/mortality of released birds, dispersal, pair formation, reproduction, genetics, food sources and availability of nest sites) to enable an evaluation of the project. We recommend securing staff, equipment and finances on the long-term when choosing monitoring methods and balancing outcome and costs, especially when using expensive techniques like telemetry or sound recording. Do not underestimate the value of simple techniques like behavioural observation.

With help of the geneticist we are able to keep track of the sex ratio – both of released and of birds born in nature. This is essential to trace demographic development of the growing but still fragile population. Finally knowledge about sex distribution helps to decide where to release the next females/males in order to try to balance sex ratios.

Another valuable monitoring method used in the project are nest boxes. We decided to use nest boxes made from materials that do not decay in order to safeguard their long-term existence. The function of wooden nest boxes expires usually after 10-15 years and maintenance can be time consuming. It can happen that the material in wooden nest boxes spills out through cracks that develop between the wooden boards. This can lead to owls not using the nest box when it is completely empty when all nesting material has spilled out or to the failure of breeding attempts due to an insufficient amount of nesting material. Boxes made out of PVC are long lasting and easy to maintain. Fixing a mirror in the nest box enables controls from the ground without disturbing the bird. Considering the aggressive behaviour of females during rearing period, we fix nest boxes in heavily used recreation areas above 10-15m. Thus we have never had any attacks so far. Monitoring through nest boxes is useful to find territories when a species distribution is scarce. It might be argued that birds which are reared in nest boxes in captivity will only breed again in nest boxes in the wild. However, we have already verified territories with birds breeding in natural cavities. This was possible by the use of telemetry or the periodic reporting of sightings from interested people within territories.

In less than a decade it was possible to build up two new population nuclei of about 15 couples each. We know that a high proportion of adults kept their territory for several and up to 9 years. We could show that reproduction parameters equal those of well-known populations e.g. in Finland median 1986-2007 =2.19 / successful brood (Saurola 2009), in Sweden 2.15 (Lundberg & Westman 1984). Even though we know through radio tracking that we lose 10-20% of released birds during their first year (Kohl & Leditznig 2014), we are still lacking sufficient knowledge about adult mortality. Possible mortality risks for Ural Owls include traffic collisions, illegal persecution, electrocution, predation (through Golden Eagles (*Aquila chrysaetos*), foxes (*Vulpes vulpes*) and most probably Eurasian Eagle-owls (*Bubo bubo*)) and collision with fences, glass or aerial cable. In how far rodenticides and genetic isolation can be a risk for the newly established population is not clear yet. However, we assume that genetic isolation is not an immediate risk, since we were able to verify a couple of long distance movements (Kohl & Leditznig 2014). They show us that gene flow to and from adjacent subpopulations is definitely possible.

As it is already well known for Ural Owl populations in Finland and Sweden (Brommer, Pietiäinen et al. 2002, Brommer, Pietiäinen et al. 2002, Sundell, Huitu et al. 2004) we also observed a strong dependence of the reproductive outcome and mice/vole years. In our area mice gradation almost exclusively depends on beech mast seeding. The events of mast seeding seem to occur more often (maybe due to climate change). However, mice/vole gradations are not as regular as observed in more northern areas. If we compare the number of released birds versus those fledged in nature we can expect a balance soon. This will be a signal to lower release activity and focus on the monitoring of further population development.

Conclusions

Our vision to re-establish the Ural Owl in the Alps has almost become true. Through a strong network of zoo-collaborations it was possible to release noteworthy numbers of young owls within a relatively short period of time. We implemented successful release techniques and could prove pair formations and reproduction in the wild. The monitoring methods we chose helped to follow population development and to evaluate the re-introduction process. Reproductive data in the recovered habitat are good and mortality seems to be acceptable. Via long distance dispersal we could prove cross linking of populations. Last but not least a lucky choice of project partners secured funds needed to carry out the project. Stakeholders involved approve of the project and support the return of the Ural Owl. In the future we will focus on further monitoring the population development, broaden the genetic basis by releasing rare genetic lineages, thus increasing the quality of released birds, but reduce the quantity of releases when appropriate.

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