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Parental Hacking—An Alternative Reintroduction Method for the White-Tailed Sea Eagle (*Haliaeetus albicilla*)

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Abstract: In an age of rewilding and dramatic declines in biodiversity, we are developing a new way to reintroduce raptors: parental hacking. The principle behind it is similar to traditional hacking, where the birds are released without contact with adult conspecifics. In parental hacking, our method, the parents feed their own offspring until the end of the post-fledgling dependency period. Our programme aims to reintroduce the white-tailed sea eagle (*Haliaeetus albicilla*) to the Upper Rhône Basin in France. It started in 2022 and will continue until 2030, with the release of 80 young eagles. We describe the method used in 2022, followed by the improvements made in 2023, and finally compare the two years. The young eagles were raised in aviaries at the reintroduction site by their captive-born parents in the Aigles du Léman Park (Haute-Savoie, France). In 2022, two young females and two young males were released as soon as they were able to fly at the age of three months, but they often ended up on the ground due to a lack of flying ability and attacks from wild black kites (*Milvus migrans*) defending their territory. Therefore, the young eagles were returned to their parents' aviary before being released a second time at five months in August 2022. One month after release, one male was already 50 km from the reintroduction site, while the other three stayed close to the park. In 2023, five young females and five young males were released at five months. This came after four weeks in a large training aviary to learn how to fly, perch, and fish. The behaviour of the young eagles after release varied greatly between individuals. Overall, 4 out of 10 young eagles travelled long distances and did not return to the reintroduction site to feed within a month, while the other 6 chose to stay close (within 20 km) to the reintroduction site.

Keywords: biodiversity restoration; captive breeding; conservation; European sea eagle; Leman Lake; raptor programme; rewilding; species management

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1. Introduction

Following the loss of biodiversity caused by extreme human population growth and the urbanisation of our planet, mankind has attempted to make up for its mistakes with reintroduction programmes [1–4]. In 18th century Europe, raptors suffered particularly from hunting but also from other human activities [5–9]. Today, almost 35 species of birds of prey in Europe have an unfavourable conservation status [10,11], although raptors are among the animals benefiting from the highest number of conservation programmes [12–16].

In Britain and Ireland, the estimated range of the white-tailed sea eagle (hereinafter "sea eagle" only) during the fifth century was 110,250 km^2. At this period, the population size was 800–1400 pairs of sea eagles, declining to 150 by 1800 in the same area [17].

According to Yalden [18], sea eagles were present in the lowland of southern Britain during the Roman and Anglo-Saxon periods. In continental Europe, the sea eagle was once found throughout mainland France, in Corsica, along the entire Mediterranean coast, and in Switzerland [19,20]. The last known pair in mainland France nested in 1892 in the commune of Thonon-les-bains (Haute-Savoie, France), which gives our reintroduction project a high heritage value and making it part of the great rewilding movement initiated in Europe.

Reintroduction is defined by the International Union for the Conservation of Nature (IUCN) as "the attempt to reestablish a species in an area that was once part of its historical range, but from which it has been extirpated" [21]. Most raptor reintroduction projects have used the traditional hacking technique of releasing juvenile raptors without contact with adult conspecifics, which was developed as a falconry method to give young birds freedom while they learn to fly and hunt [22–28], while others have used the fostering technique [29–32]. In both techniques of raptor reintroduction, the birds imprint upon their natal area (natal philopatry) and many return to the desired area years later, as described by in Morandini and Ferrer [33]. This imprinting occurs between fledging and their independence of parental care, which coincides with the autumn departure.

Fostering involves placing young raptors into the nest of a wild pair which care for them. Typically, this is carried out during the first third of the nestling's development, and before the chicks develop fear responses. Alternatively, some have fostered well-developed young eagles that can feed themselves and regulate their body temperature. The birds learn to fly and hunt while under the care of their foster parents [26,34–38]. In this rearing technique, captive-bred juveniles are released into wild nests where they are reared by the adults with the existing young. This is the case for the lesser spotted eagle (*Aquila pomarina)*, sea eagle (*Haliaetus albicilla)*, bearded vulture (*Gypaetus barbatus)*, eagle owl (*Bubo bubo),* and burrowing owl (*Athene cunicularia*) [29–31,39–46].

Several sea eagle reintroduction programmes are currently underway in Europe. Almost all of them use the hacking technique with young eagles taken from Norwegian nests. This technique has been tested on large raptors with excellent results [12,32,47,48]. Fentzloff [29–31] bred sea eagles in captivity. He had 8 pairs that produced at least 25 young eagles, 20 of which were released into the wild in the Czech Republic, but he also placed almost-fledged individuals in nests in Schleswig–Holstein (northern Germany). Altman [22] also described modified hacking techniques via the successful release of a captive-bred juvenile bald eagle (*Haliaeetus leucocephalus*) in the summer of 1981. The eagle was fed in an enclosure until it was 14.5 weeks old and began flying immediately after release. The eagle remained close to the reintroduction site for 39 days, hunted successfully (with a 50% success rate), and appeared to behave normally until it moved from the study area.

We aim to reintroduce sea eagles to the Upper Rhône Basin (Haute-Savoie, France), from where they disappeared from 130 years ago. We have chosen a new reintroduction method and are developing this technique to make it more effective and ethically acceptable. This will be the first time in Europe that a wildlife park has carried out a complete reintroduction programme for sea eagles, from pair formation to monitoring the eaglet into the wild. We have chosen to breed them in captivity in the aviaries of Les Aigles du Léman, which is also the reintroduction site. Most reintroduction programmes use either wild eaglets harvested from a robust and healthy donor population or captive-born eaglets. Young eagles remain at the release site for a few weeks, being isolated from any parental or human contact before the artificial nest aviary is opened and they are allowed to fledge. During the post-fledge dependency period, they become accustomed to the area, and become independent. They also disperse at an age comparable to that at which parent-reared birds do so.

We first define the principle of parental hacking and the assumptions on which our programme is based. Then, we describe the method used on four young eagles reintroduced in 2022. After this, we outline the modifications made in 2023 based on our observations during the first year and the reintroduction of 10 sea eagles in 2023. Finally, we present and discuss the results from 2022 and 2023 and suggest improvements for 2024.

2. Methods

The breeding pairs of sea eagles for this reintroduction programme originated from several European zoos (Puy Du Fou France, Amnéville Zoo France, Veldhoven Zoo Nederland, Almaati Zoo Kazakhstan). They remained in captivity while their offspring were released into the wild. The young birds were released from the site where they were reared and therefore did not experience the stress of transport or nest change associated with translocation. Young eagles were only handled once, for less than half an hour, to move them from the inside aviary nest to the open-air nest. This handling provided the opportunity to take measurements of the young eagles as well as fit GPS transmitters (Figure 1A). The young eagles were reared by their parents in the same way in both 2022 and 2023 (Figure 1B). Parental rearing mimics what occurs in the wild; the eaglets benefit from the presence of and education by their parents. We called this new method parental hacking.

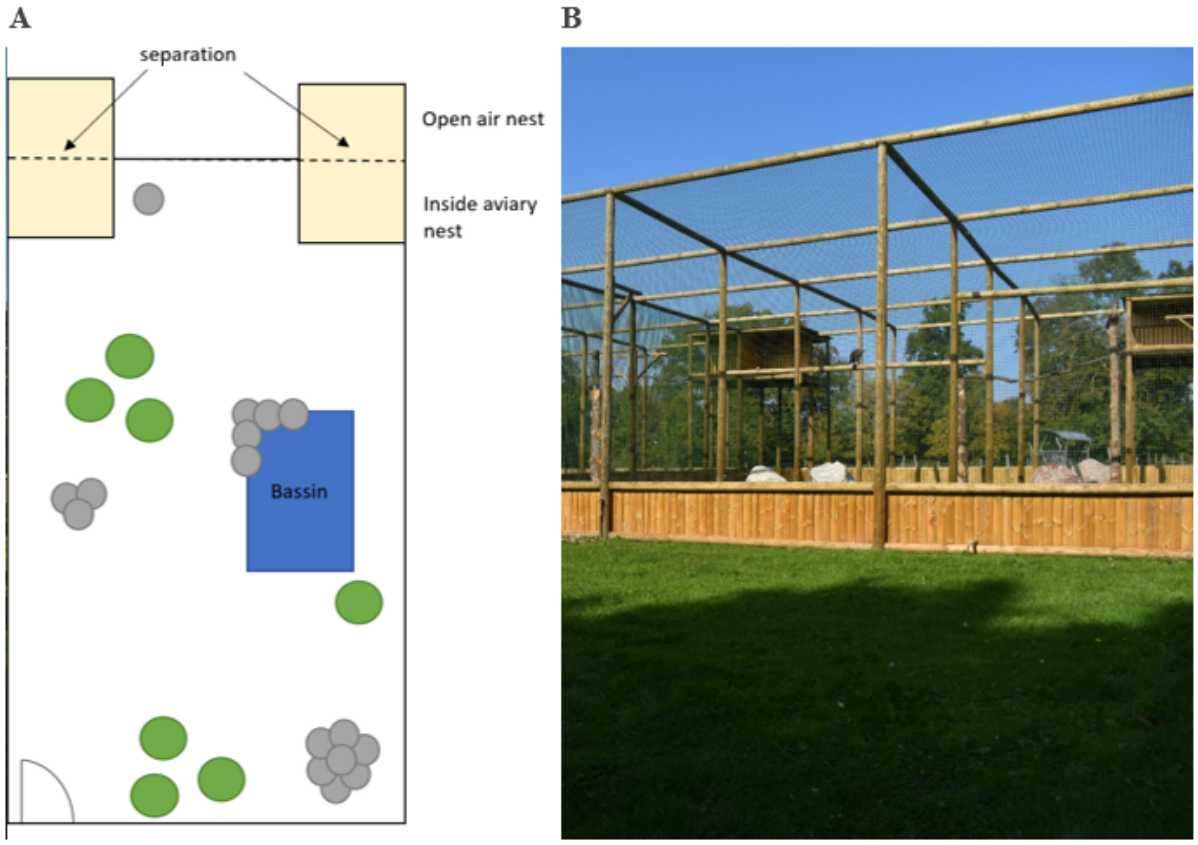


Figure 1. (**A**). A diagram of aviaries at Les Aigles du Léman, Haute-Savoie, France. The nest with the two parts are shown in yellow: one inside the aviary (inside aviary nest) and one outside the aviary (open air nest). The trees are shown in green, the rocks in grey, and the water in blue. (**B**). An image of the aviaries at Les Aigles du Léman, Haute-Savoie, France.

We did not interfere with the reproductive process in any way: fertilisation was natural, and incubation and rearing were conducted by both parents without any human intervention, and so there was no risk of imprinting on humans. The reintroduction aviaries are 25 m long, 15 m wide, and 6 m high (Figure 1A,B). The aviaries are constructed of wood

and netting to ensure they blend in with the site and to protect the eagles' welfare. Not only are these materials more natural than metal structures and wire netting, but over the 20 years that the park has been using them, they have proven to age well and completely limit the risk of injury to the birds. The aviaries contain rocks, ponds, plants, and dead trees to keep them as natural as possible.

Pairs and young eagles were fed ad libitum during the breeding months to reduce the risk of aggression between partners and between parents and eaglet/s. Food was placed at the entrance to the aviary twice a day, at 8 am and 6 pm, by a zookeeper. The parents came to collect the food and bring it to the eaglet/s (Figure 2) whenever they wanted. This happened shortly after the zookeeper tour, an hour later, or even during the afternoon and the evening. Therefore, young eagles were never allowed to associate the food with humans as it was only placed at the entrance of the aviary, and the parents fed the eaglet/s whenever they felt it was appropriate for the young. The diet consisted of fresh fish from European lakes (roach (*Rutilus rutilus*), trout (*Salmo trutta*), perch (*Perca fluviatilis*), pike (*Esox lucius*), etc.), rats (*Rattus norvegicus*), rabbits (*Oryctolagus cuniculus*) and quail (*Coturnix coturnix*). We paid particular attention to the birds' diets. The aim was to feed them prey they would find in the wild, and so the food was never cut or opened. For example, roach and trout from Alpine rivers were fed whole, but we selected for the size so that the parents and then the chicks could easily take them straight to the nest or eat them from a perch.



Figure 2. The feeding of a 2-day-old sea eagle by its parents in one of the aviaries at Les Aigles du Léman.

The four birds released in 2022 were the offspring of two pairs of sea eagles kept in the Aigles du Léman. On the 1 June, when the young eagles were 60 days old (±2 days) and they had their first black plumage, they were transferred from the inside aviary nest to the open-air nest and separation bars were placed between parents and young eagles (Figure 1A). While the parents remained in the aviary, the young eagles were outside the aviary but in the same nest as the parents; therefore, the juveniles were released, but were not yet able to fly (Figure 3). Tests were carried out with captive birds to determine the perfect distance between the bars (around 18 cm), so that they were far enough apart to allow the adults to feed the young eagles and to reduce the sense of separation, but also close enough to ensure that neither member of the pair could escape (Figure 3). In 2022, the released sea eagles fledged in June, but unfortunately, they had to be captured and returned

to their parents' aviary because they were grounded and had not yet developed adequate flight skills and because the wild black kites nesting around the reintroduction site were aggressive, forcing the sea eagle to move away from the nest area. The first trees with a black kite nest were only about 100 m from the parents' aviary. With no flying experience, the young eagles often landed on the ground. The second release took place in mid-August and after one more month with the adults, the young eagles were better able to cope with the mobbing of the black kites and to orientate themselves around the release site (Figure 4).



Figure 3. The feeding of a 60-day-old eagle by an adult in the double nest.

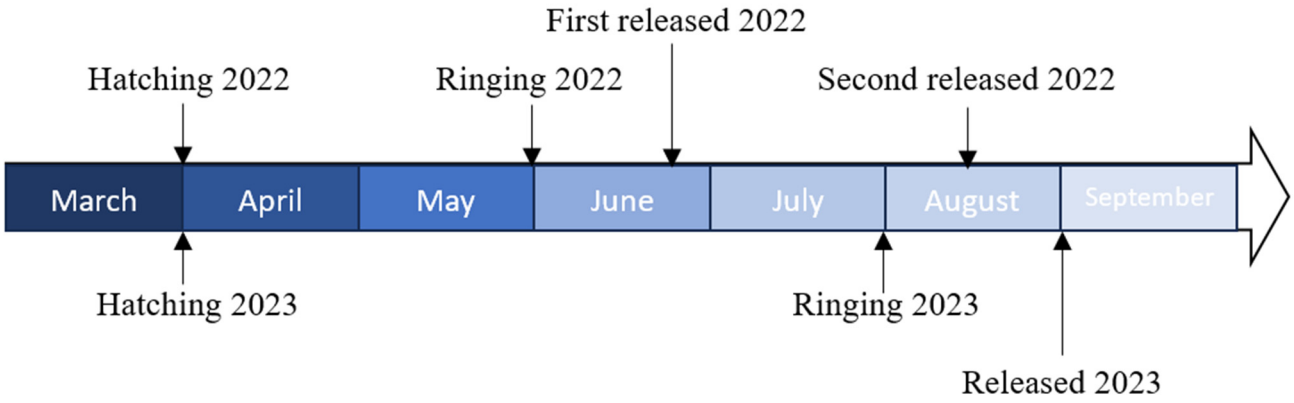


Figure 4. A timeline of the reintroduction in 2022 and 2023.

As shown by several authors [49–51], a bird is old enough to be fitted with a transmitter when it is between 5 and 8 weeks old. Therefore, all released sea eagles were fitted with GPS transmitters when they were moved from the inside aviary nest to the open-air nest (Figure 5). We used Ornitela GPS tags (OrniTrack-50 4G solar, 50 g, dimensions 76 × 38 × 24 mm), which were supplemented by ATSR1535 VHF beacons (10 g) to compensate for any lack of solar power (Figure 5). These GPS transmitters were attached to the sea eagles as a backpack: Teflon harnesses were looped around both wings of the bird, with the loops crossing at the sternum and the transmitter placed on the bird's back. These GPS transmitters allowed us to track the young eagles over long distances and periods of time. They also helped us to react if there was a problem. Data collection and transmission varied according to weather conditions and battery levels. During summer, when the weather is sunny, the solar batteries charge more efficiently; so we collected a fix every ten

seconds and transmitted it every three hours. In contrast, in winter, when conditions are mostly cloudy and the day is short, we collected a fix every five minutes and transmitted it every six hours. The GPS data was uploaded to the MOVEBANK database. The young eagles were also fitted with metal rings from the Paris Natural History Museum and the Centre de Recherches sur la Biologie des Populations d'Oiseaux (CRBPO programme) and coloured rings. We used a specific French colour code following the guidelines of the European Colour Ringing Programme. We took several feathers to determine the sex by via DNA analysis.



Figure 5. GPS tag deployment by Bernd Meyburg and Jacques-Olivier Travers.

In the winter of 2022/2023, we built five more aviaries to double our capacity from 5 to 10 breeding pairs by 2023. Parental rearing method was similar for the first two months (April and May) in 2022 and 2023 (Figure 4). In 2023, we left 10 young eagles with their parents for an additional two months (June and July; Figure 4); they were ringed at the end of July when they were able to fly and feed themselves. They were then separated from their parents and kept together in a flight aviary (50 m long, 20 m wide and 6 m high) for an additional month (August), where they learned to fish, socialise, and develop good flying skills while apparently imitating their parents in the neighbouring aviaries. The young eagles were then released at the age of five months (Figure 4).

In 2023, we added a feeding platform inside the training aviary to ensure that the young eagles were used to platforms similar to those at the reintroduction site. This feeding platform consisted of a 3 square metre table made from sheet metal (i.e., the material that covers the aviary and serves as the feeding platform at the release site) of 3 square metres to help the young eagles familiarise themselves with the future outdoor platform. This allowed them to get to grips with this new feature without any pressure, making them more likely to learn this how to use feature and associate the platform with food once released. The aim was for the young eagles to quickly understand where to find food if they stayed at the reintroduction site, but also to improve the birds' philopatric memory.

Twice a week, the zookeeper in charge of the programme also inflated three to five fish to float on the pond to simulate a dead fish on the surface. At this point, the zookeeper

would deliver the food through a pipe from outside the aviary to the feeding platform or the pond, to ensure that the young eagles did not associate humans and food. Sea eagles were particularly receptive to this food and perfected their fishing technique. Even though the young eagles waited for the fish to go aground, we wanted them to understand that in the wild they could find food next to the water.

The young eagles remained in the aviary for a month and were released on 4 September 2023 when they were five months old (Figure 4). By this time, the black kites had left for migration again, and the young eagles muscles were more developed than in 2022 and they had no particular problems returning to the wild.

After the release, a platform feeder was placed around the area of Les Aigles du Léman. The feeder was filled every morning with the same food that the eagles had received in their aviary. The amount of food was adjusted according to the number of sea eagles returning to feed.

3. Results

3.1. Breeding Data

The average incubation period was 37.5 days in 2022 (SD = 2.75) and 36 days in 2023 (SD = 3.8). The mean nestling period was 81.8 days in 2022 (SD = 11.69) and 78.2 days in 2023 (SD = 17.36) (Table 1).

Table 1. Breeding data for each juvenile in terms of sex, the parental ID, the laying date, the incubation period, the hatching dates, the rearing period, fledging weight, fledging date. The laying date is the day the first egg is laid, and the incubation period is the number of days from the laying of the first egg to hatching. The hatching date is the day the chick hatches and the rearing period is the number of days from the hatching until the young eagle fledges and flies out of the aviary. In 2022, the fledgling weight was measured when the eaglet was transferred from the aviary to the field and the fledging date corresponded to the fledging of the eagle outside the aviary. In 2023, the fledgling weight was taken when the young eagle was transferred from the aviary to the new training aviary and the fledging date corresponded to the fledging of the eaglet outside the nest in new training aviary.

Sea Eagle ID	Sea Eagle Breeding Pair ID	Sea Eagle Sex	Laying Date	Incubation Duration (in Days)	Hatching	Rearing Duration (in Days)	Fledgling Weight (in kg)	Fledging Date
WF 01	5	M	23/02/22	38	02/04/22	77	3.72	18/06/22
WF 02	2	M	24/02/22	40	05/04/22	85	4.57	29/06/22
WF 03	1	F	27/02/22	36	04/04/22	85	4.72	28/06/22
WF 04	1	F	04/03/22	36	09/04/22	80	4.85	28/06/22
Egg 1	3	NA	26/02/22	NA	NA	NA	NA	NA
Egg 2	3	NA	27/02/22	NA	NA	NA	NA	NA
WF 11	1	M	12/02/23	36	20/03/23	79	3.70	07/06/23
WF 12	6	M	20/02/23	35	27/03/23	75	3.80	09/06/23
WF 13	2	M	02/02/23	37	11/03/23	75	3.25	25/05/23
WF 14	2	M	06/02/23	36	14/03/23	75	3.60	25/05/23

Table 1. *Cont.*

Sea Eagle ID	Sea Eagle Breeding Pair ID	Sea Eagle Sex	Laying Date	Incubation Duration (in Days)	Hatching	Rearing Duration (in Days)	Fledgling Weight (in kg)	Fledging Date
WF 15	3	F	15/03/23	37	21/04/23	78	4.20	08/07/23
WF 16	3	F	20/03/23	35	24/04/23	78	4.00	08/07/23
WF 17	4	F	06/03/23	41	16/04/23	75	3.80	30/06/23
WF 18	6	M	23/02/23	34	29/03/23	75	3.60	13/06/23
WF 19	5	F	01/02/23	35	11/03/23	86	4.44	05/06/23
WF 20	5	F	05/02/23	34	13/03/23	86	4.35	05/06/23
Egg 1	7	NA	12/02/23	NA	NA	NA	NA	NA
Egg 2	8	NA	22/02/23	NA	NA	NA	NA	NA
Egg 3	8	NA	24/02/23	NA	NA	NA	NA	NA
Hatchling 1	1	NA	10/02/23	35	17/03/23	11	NA	NA

3.2. Post-Release Period

After the second release in mid-August 2022, the young eagles fared much better. After one month, the two males were already independent and living in colonies of great cormorants (*Phalacrocorax carbo*) around Lake Geneva and Lake Neuchâtel, Switzerland. GPS data also showed that juvenile eagle WF01 flew over 350 km just 12 days after leaving the nest (Figure 6). The first predation on a cormorant nest occurred in the first month after the male flew to Lake Neuchâtel. The sea eagle WF01 stayed for almost five months at the BirdLife Centre-Reserve de la Sauge in the canton of Neuchâtel in Switzerland, where its basic needs were met: it had large trees to sleep in and plenty of food (great cormorants, greylag goose (*Anser anser*), mallard ducks (*Anas platyrhynchos*), sea gulls (*Larus* spp.), coot (*Fulica atra*), etc.).

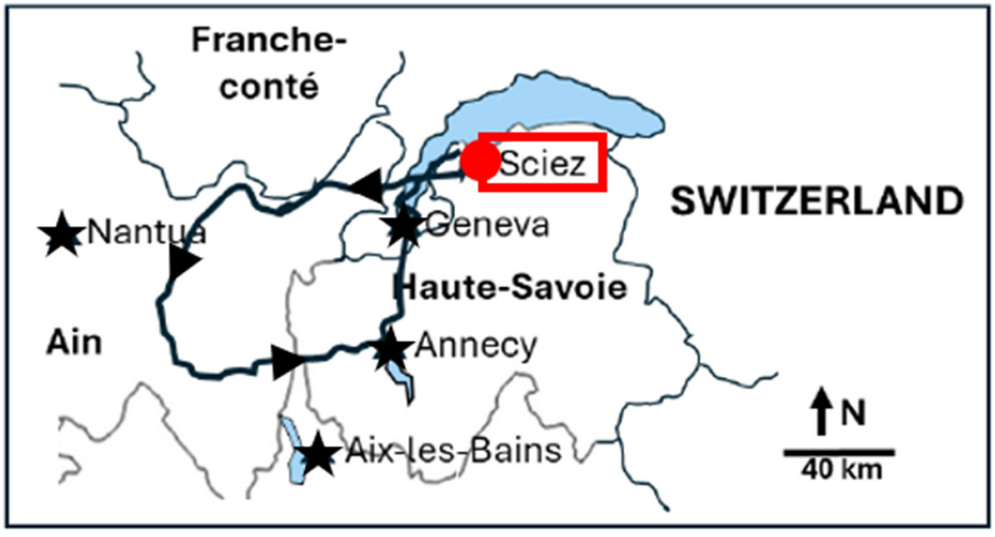


Figure 6. Journey of 350 km in 7 days by a juvenile male (WF01) 12 days after fledging. Sciez, the reintroduction site, is depicted in red.

The second male (ringed WF02) settled in the Dranse Delta Reserve (Thonon-les-Bains, Haute-Savoie, France) for about a month. As at La Sauge, conditions were ideal for the sea eagle. However, the river is used by a company that sells gravel, and at the beginning of September they started up the machines again, causing the sea eagle to fly away. It returned to the reintroduction site in January. Upon its return, it chose to feed on the platform and sleep in the large trees surrounding the release site.

The females remained close to the release site for a little longer, feeding regularly at the feeder for almost a month. In mid-September, one of the two ringed eagles (WF03) moved to the mountains, where she found her first meal in the wild. After this experience, the sea eagle stayed in the mountains in search of food. This female spent several months flying between the peaks of Morzine-Avoriaz (France) and Gstaad (Switzerland) over Lake Geneva before moving further afield (Austria) in January.

The second female ringed (WF04) stayed on the shores of the lake between Chens-sur-Léman and Sciez (France). Professional fishermen often saw her feeding on American crayfish (*Orconectes limosus*). She also often returned to the feeding platform and sometimes slept near the reintroduction site. In the autumn, this individual flew to Eastern Europe.

In the 2023 breeding season, the data of the GPS tags showed us two main types of behaviour (already present in the 2022 birds): residents and travellers. In total, 4 out of 10 young eagles visited various areas in Europe: Stuttgart (Germany), Courmayeur (Italy), Colmar (France), and Zurich (Switzerland; Table 2). The other six explored the surrounding area and returned to feed on the platforms set up at the reintroduction site. Among the travellers, one female covered an incredible distance in just 8 days (Figure 7). Female WF16 travelled as far north as Mulhouse (France) and then returned to Les Aigles du Léman via Bern (Switzerland). She travelled 1622 km and reached a maximum altitude of 3547 metres.

Table 2. Distance travelled during the first month after release for each eagle in 2022 and 2023.

ID	Breeding Pair	Sex	Farthest Travel Location in the First Month
WF 01	5	M	Ambérieu-en-Bugey (France)
WF 02	2	M	Sciez (France)
WF 03	1	F	Sciez (France)
WF 04	1	F	Sciez (France)
WF 11	1	M	Aix-les-Bains (France)
WF 12	6	M	Geneva (Switzerland)
WF 13	2	M	Colmar (France)
WF 14	2	M	Zurich (Switzerland)
WF 15	3	F	Morzine (France)
WF 16	3	F	Stuttgard (Germany)
WF 17	4	F	Sciez (France)
WF 18	6	M	Courmayeur (Italy)
WF 19	5	F	Apples (Switzerland)
WF 20	5	F	Collonges (Switzerland)

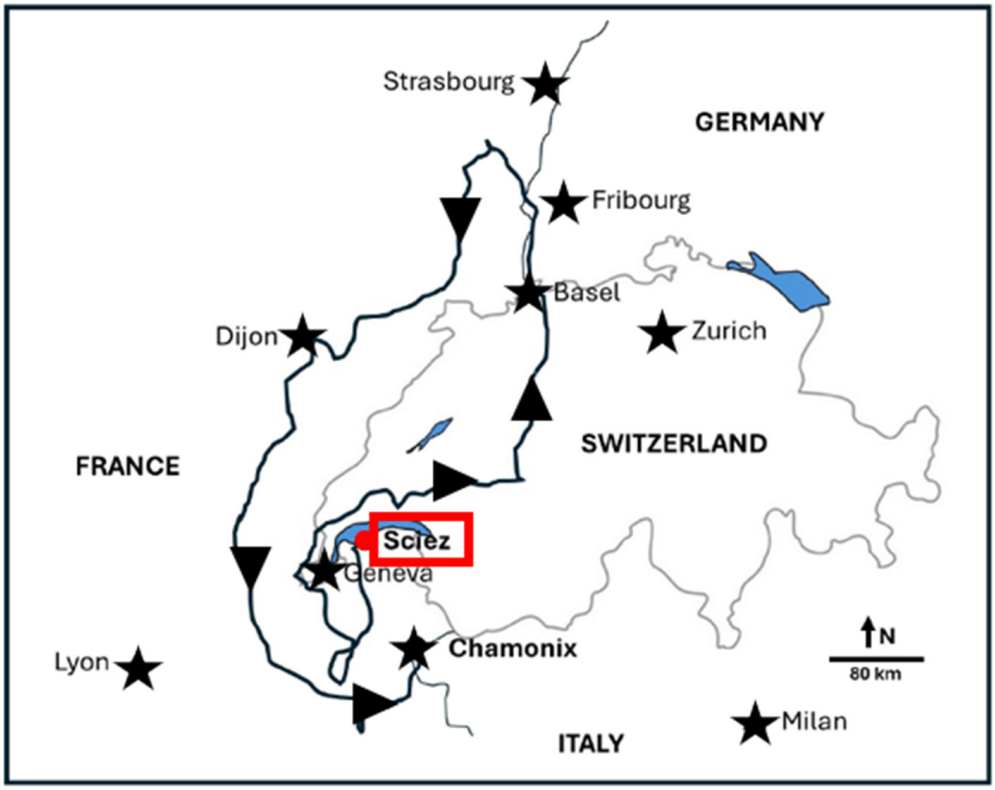


Figure 7. A journey of 1622 km in eight days made by a juvenile female (WF16) eight days after she fledged. Sciez, the reintroduction site, is shown in red.

4. Discussion

4.1. Method

There are two main sources from which young eagles are taken for reintroduction. The first is the removal of nestlings from the nests of stable wild populations (mainly from Norway), and the second is the release of captive-bred sea eagles. Until now, the transfer of nestlings from distant countries and regions has been used almost exclusively.

According to several studies reintroduction studies [12,52,53], birds reared by their parents have a better chance of survival in the first three years than birds translocated to the same site. These papers show that philopatric memory is stronger when the young birds are reared by their parents. However, it can happen that the birds are not released until past normal fledging age in Europe. In parental hacking, the young are not abruptly separated from their parents and this may have a positive effect on behavioural development, increasing the time they spend in the area before dispersing and thus improving their philopatric memory [20,53–57]. This is the basis of parental hacking. Furthermore, in the wild, young eagles remain dependent on their parents for food for several months, as is the case here [58].

We wanted our young sea eagle to be used to humans so that they would be better equipped to breed in an anthropomorphic world without being too close to them. They are not completely unaware of the presence of humans, as they can see them from a distance from their aviaries, but the only direct contact the sea eagles have with keepers is when they are fitted with GPS trackers and rings and when they are transferred to the other side of the nest. As a result, the released sea eagles are reluctant to get too close to humans, which they associate with fear rather than comfort.

4.2. Breeding Data

The incubation period of the sea eagle is 39.5 days and the average rearing period from hatching to flight is 73.75 days [59,60].

As shown in Table 1, the incubation period was shorter in our study (2022 37.5 days and 2023 36 days). We can postulate that data collected in the wild are estimates, whereas our data, based on video evidence, are more accurate. On the other hand, the rearing period in our study is longer: 81.8 days in 2022 and 78.2 days in 2023.

The average weight of the released sea eagle in 2022 and 2023 was around 4 kg, which was comparable to that recorded in the wild [60]. These data clearly show that parents in captivity raised their young eagles as well as adults in the wild. By the time the young eagles fly, their bodies are fully developed and the birds can fly and feed themselves. Our method gives the young eagles some physical skills to start their life in the wild.

4.3. Post-Fledging Dependence Period

Monitoring birds from their first flight in the wild is a priority as it allows us to assess their adaptability, survival skills, and the threats they face. The first ever satellite-tracked juvenile sea eagle remained with its parents until 13 November, when it left the natal area and settled about some 100 km away from its birthplace [58]. A study of the Scottish reintroduction programme [49] found that sea eagles disperse between 18 and 200 km from their reintroduction site, with an average distance of 90.6 km for females and 78.4 km for males in the first year. A study of the Scottish reintroduction programme [49] found that sea eagles disperse between 18 and 200 km from their reintroduction site, with an average distance of 90.6 km for females and 78.4 km for males in the first year.

The 2023 reintroduction season showed the benefits we expected. In 2023, six of the ten juveniles remained at the reintroduction site for at least two months after reintroduction. We can therefore assume that the philopatric nature of the sea eagle will be as strong as it is in the wild [20,53–57]. Secondly, none of the released sea eagles approached humans during their first year in the wild as none of them had been imprinted by their keeper during their rearing. Finally, they all managed to find food on their own in less than two months, although they returned to the feeding platform from time to time. Some hunted cormorants soon after release, while others foraged for crabs and fish or ate carcasses in the mountains. The sea eagles did not approach the dwellings to feed. Parental hacking enabled the young eagles to catch prey in the wild. This new technique can provide a large number of young eagles for reintroduction without depleting the wild population of sea eagles, which is another benefit of parental hacking.

In contrast, the early life of these young eagles from the 2022 release was a little more complex, resulting in them being captured and later re-released. Firstly, we completely underestimated the aggressiveness of the black kites nesting around the reintroduction site. They had no hesitation in furiously attacking young eagles. Sea eagles pose a real threat to the young kites still in the nest, although no eagles had been seen at the released site for over a century.

Secondly, when the young eagles were released at the end of June, they were still dependent on their parents for food and the parents did not necessarily feed them. As a result, we often found the young eagles on the ground near the parents' aviary, begging for food. They would not necessarily return to the nest, but would go where the parents would feed them. At 3 months old, released sea eagles are unable to find food.

In the wild, young eagles very rarely become independent and disperse at the same age [61–64]. They first go through a period of short forays near the nest before returning to be fed by parents or adults in the vicinity. This period allows the young eagles to gradually

become independent, build their muscles and learn to fly in the company of their parents before they actually leave [65].

In 2023, we adapted the method to overcome the problems experienced in 2022 by building a new training aviary for the young eagles and by not releasing them until September. This extra month allowed the young eagles to develop good flying skills and to learn how to feed themselves by hunting and fishing, and we also fed them on the metal sheet metal platform (used as a feeder at the reintroduction site; Figure 4). They also learned how to find food in the water, which saved them a lot of time compared to the 2022 young eagles, as they already knew that water could be a food source (Figure 8). The juvenile eagles to were fed thought a tube to hide the keeper while he was feeding in order to help sea eagle to dissociate food from humans. In addition, the feeding platform increased the survival rate, territorial behaviour, and social bonding of the young sea eagles. Food supplementation does not influence the age of independence of the eaglet, as shown by the British reintroductions, but improves the survival rate of the young eagles and contributes to good territorial fixation [53].

Christian Pacteau's advice on the "attachment" phenomenon in early life pair formation suggests that encouraging social interaction around a feeding platform can only improve future pair formation (Pacteau pers. comm.). This feeding can continue throughout the year if necessary. In addition, sea eagles begin their dispersal mid-September, which corresponds to the time of our release [64].



Figure 8. Young eagles hatched in 2023 scavenging dead fish in their pond.

However, the downside of our adaptation became apparent two weeks after release. A study conducted in 2009 by Whitfield showed that male sea eagles disperse farther than females in the first year (Table 2), which was confirmed in our study [49]. The travellers' pool is shown in Table 2 for WF13, WF14, WF16 and WF18 shows that a majority of males belonged to this group. Some of the males left without understanding that they could find food provided at the feeding platform. This physical fitness enabled the dispersing young eagles to travel for several days without eating and starve to death.

We also wonder whether the philopatric nature of these well-travelled sea eagles was properly activated and whether the flight aviary was sufficient as a site location to fix the reintroduction site for their future reproduction. It will be interesting to see if there is a significant difference in the location of first nests between travellers and residents. At first sight, males tend to leave their natal territory quickly, but the published data also suggest

that it is the males who have a significant tendency to return to nest close to their natal territory [20,49,53,54,56,57].

According to Evans et al. [12], sea eagle survival during the first year in the wild is 81.9 ± 5.1% for wild birds compared to 73.6 ± 7.7% for reintroduced birds. The ratio of survival to breeding age is 53% for wild birds compared to the 37% seen for reintroduced birds. In our reintroduction programme, the survival rate in the summer of 2023, 12 months after release, was 75%, with only one male not surviving. This was all the more disappointing as the male was killed by a poacher in Germany. The physical condition of the Sea eagle at the time of its death in April 2023 was very good: the bird had good plumage, weighed over 4 kg and was in very good health.

5. Conclusions

After two years, we have decided to continue with the parental hacking method. We are convinced that the best time to release sea eagle is in early September, when other migratory raptors have left and the immature sea eagles can easily make their first flights. The extra two months with their parents are beneficial for the young eagles, as they are able to feed themselves without begging in the flight aviary. The flight aviary also allows the birds to learn to fish and to get used to the outdoor feeding platform before being released.

The disadvantage of the method used in 2023 was that the immatures flew enormous distances in the first week after release without returning to the reintroduction site. We believe that the best way to anchor sea eagle to the site is to reintroduce them after only 10 days in the flight aviary. In this way, the young eagles have to learn to feed themselves and develop good flying skills in the Sciez region before they disperse across Europe.

As for the birds' philopatry, we do not know yet if this trait is improved by the parental hacking as the birds are still too young. We will not have our first results until 2026, when the 2022 when the first released birds will be four years old.

Our programme will continue until 2030, by which time we hope to have released 80 sea eagles in the Lake Geneva region to reclaim their lost territory. We believe that the parental hacking method will open new doors for future more ethical reintroductions, leaving wild populations unharmed by any human intervention. We also hope that this method will increase the number of zoos involved in reintroduction programmes.

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