



Aquila a-Life

Reintroduction of Bonelli's Eagle in Sardinia

Action D.1

Post-release monitoring



ISPRA

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BONELLI’S EAGLE (*Aquila fasciata* Vieillot, 1822) REINTRODUCTION INSARDINIA

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Cover photo: Riccardo Nardelli

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FOREWORD

This report is aimed to present the results of post release monitoring (Action D1) of the eagles still alive in 2022, including those hacked in the same year, also presenting summary data on releases made from 2018 to date.

Action D1 covers all the activities on the field and desk work targeting the eagles, other than hacking. Hacking normally only went from eagles' arrival to their release, eventually including the care in the cage of recaptured individuals needing veterinary care. Monitoring released eagles included post releases observations, survey on areas of dispersion and on cluster of positions, managing the process to activate on-site inspections if necessary and follow up on them, recapturing activities, searching for censored eagles through base station and UHF radio etc. Desk work under D1 included checking and carefully inspecting positions and activities (twice a day for the newly release eagles, each year), managing data on Movebank (notably, managing bin files, checking data for outliers etc.), in-deep inspection of positions to highlight used pylons and mark them (the basis to search for funds for retrofitting), setting up and discussing data analysis.

RESUMEN

By the end of 2022 (30 September), twelve animals, all constantly monitored by GPS tags, out of the 32 released are surely alive. One death (female hacked in 2021) and three signal lost occurred in 2022. Overall, signal was lost for 9 animals. There is no evidence supporting their death, but rather battery depletion in at least three cases and one tag loss. Electrocutation is by far the most important cause of death (six fatalities) while illegal killing caused the death of only one eagle.

Currently (at 30/09/2022) and referring only to hacking seasons 2018-2021, one eagle from 2019, two from 2020 and two from 2021 hacking seasons are still alive, with a sex ratio of 2F:3M.

Age dependent survival analysis (Kaplan Mayer) showed that survival is 75% during the first year, 81% from the first to the second year, becoming 100% later on. That is to say that the first two years are the most critical periods for the survival of released eagles.

The post release movements displayed by the animals show the importance of wetlands and, and notably, of several areas in Sardegna: Oristano province (west coast), Sulcis (south Sardinia), Coghinas Lake and Chilivani plain. Eagles also visited islands (Sant'Antioco, Tavolara, Asinara, Isola della Vacca). Overall, three eagles moved to Corsica and one is still there, using two core areas located in the central east and north west coasts.

The first attempt of pair formation was recorded in March 2022, but the female disappeared (probably for battery depletion) and the male moved to another area. The first pair was formed some months later (in June-July) involving the same male (from 2019) and a new female (from 2020). Although these two animals spent time together, it's too early to declare the presence of a breeding pair.

As for the diet, the remains of 53 preys from several eagles, belonging at least to 14 different species were found. More than 97 % of the whole sample was made up by birds remains, although the sample is highly biased towards larger preys, whose consumption takes longer and is more likely to produce leftovers. The most represented species is the Buzzard (16 individuals, 30%) followed by several species of Ardeidae (11), the Wood Pigeon (7 individuals, 13%) and the Southern Crow (6 individuals, 11%) and others. The two fishes found in Pratteri's positions cluster at Coghinas, have been probably obtained through kleptoparasitism on ichthyophagous species (Grey Heron, Osprey or other).

1. SURVIVAL AND CAUSE OF DEATH

By the end of 2022 (30 September), twelve animals, all constantly monitored by GPS tags, out of the 32 released are surely alive (Tab.1). Three other cases of signal lost were documented in 2022: Inoche, Arcantzelu and Nino from hacking season 2019, 2020 and 2021 respectively. There are no signs or indications suggesting their possible death, but none of them has been seen afterward in the wild. The disappearance of Inoche is very peculiar. In March 2022 she seemed to have finally paired with a male (Pratteri) and both moved and frequented an area at north west of Olbia (Stazzi Monte Ruiu). On 24/3/22 during a field survey dedicated to the new pair, Pratteri was seen regularly, while Inoche stopped transmitting data and her UHF radio signal was never detected. On the day after, Pratteri, who had also showed territorial behavior, left the area and came back to Crastazza (release site, Nuoro province). It can be hypothesized that the female left the site, as she had done before on few occasions, but this cannot be proven. A powerline runs in the site chosen by the pair, notably between the forest where they usually roosted and the hunting grounds, whose pylons were sometimes used by Pratteri. The powerline was carefully inspected and only rest of preys from the two eagles were found (Fig. 1).

As for Arcantzelu, it is probable that the tag's battery depleted, because it started malfunctioning around one month before definitively stopping data transmission (Tab. 1).

In 2021 we lost contact with two animals from hacking 2021: Babbu Mannu and Bonaria. Babbu Mannu data transmission stopped on 16th September in west Sardinia, close to Arborea. The area was immediately surveyed because of the presence of dangerous electric lines, but no carcass was found. For what concerns Bonaria, we lost the signal while she was flying over the sea between Capo Ceraso and Tavolara Island (north-east Sardinia) on the 5th October. We requested the Coastal Guard support for a check and/or to eventually collect the carcass, but unfortunately nothing was found. Two main hypotheses were made to explain the disappearance: 1) a fatal attack by seabirds (possibly seagulls) or 2) hopefully, a jamming activity due to transmission from the military base in Tavolara, which could have compromised the tag functionality. However, this would be the first case of malfunctioning due to military radio transmission, since several other eagles have visited Tavolara before.

Going back to the very first years of release, in 2018 and 2019 signal was completely lost for two eagles (Helmar and Illiorai respectively) probably due to tags malfunctioning; Ichnusa (2019) kept on contacting the server up to 2022 for download, without transmitting any data. She was also spotted and photographed on May 21 in Asinara Island, a site frequently visited by this eagle.

Sightings of Bonelli's eagle in S. Antioco and Isola della Vacca have been reported also in 2022 and it is possible that Prenna – who probably lost the tag – is still roaming in the area.

All the eagles whose signal was lost were extensively searched through the E-obs base station and the UHF radio in an attempt to find evidence of their presence. It only worked for Ichnusa, who was therefore confirmed to be alive.

On 7 september 2022 Lia was recovered dead in the area she was frequenting since the release (Fraigas, Ozieri). The necropsy showed diaphysis fracture of the right femur and a fracture of the distal epiphysis of the right humerus, the last one already welded (Fig. 2). The GPS positions from the days before the carcass recovery were not suggesting that the animal was in distress. Yet, based on the carcass condition, the death probably occurred a few days before and the transmitter was heavily damaged and misplaced. This suggests that a predator may have repeatedly moved it after death, finally caused by trauma with a fixed object from unknown origin.

Year	Name	Origin	Sex	Birth date	Arrival date	Release in nature	Date of death/SL
2018	Abbaluchente	LPO	F	4-5-18	29-6-18	20-ago-18	24-4-2020
2018	Helmar	LPO	M	5-5-18	29-6-18	20-ago-18	SL ¹
2018	Posada	LPO	F	7-5-18	29-6-18	20-ago-18	3-7-2020
2018	Tepilora ²	LPO	F	9-5-18	29-6-18	20-ago-18	26-9-2019
2018	Nurasè	Grefa	F	29-5-18	24-7-18	20-ago-18	7-11-2018
2018	Saccaia	Andalucia	F	10-4-17	15-7-18	21-dic-18	27-4-2019
2019	Muscatoglio	Andalucia	M	2-3-19	27-4-19	15-giu-19	7-01-2020
2019	Artaneddu	Andalucia	M	27-2-19	27-4-19	15-giu-19	6-7-2019
2019	Prenna	Andalucia	F	25-2-19	27-4-19	15-giu-19	SL ³
2019	Illiorai	Andalucia	M	11-3-19	27-4-19	15-giu-19	SL ⁴
2019	Pratteri	Grefa	M	9-3-19	27-4-19	15-giu-19	
2019	Battore	Sicilia(AG)	M	17-3-19	12-5-19	15-giu-19	4-12-2020
2019	Ichnusa	Valencia	F	19-3-19	13-7-19	26-lug-19	SL ⁵
2019	Inoche	Grefa	F	19-4-19	13-7-19	26-lug-19	SL ⁶
2020	Mantzena ⁷	Grefa	M		4-8-20	2-set-20	-
2020	Dure ⁸	Grefa	M		4-8-20	2-set-20	14-11-20
2020	Sadonna	Andalucía	F	14-4-20	4-8-20	2-set-20	8-12-20
2020	Arcantzelu	Grefa	M	2-5-20	4-8-20	2-set-20	SL ⁹
2020	Zoseppe	Grefa	M	14-4-20	4-8-20	2-set-20	27-9-20
2020	Minnena	Grefa	F	05-5-20	4-8-20	2-set-20	
2020	Arroyto	LPO	F	29-4-20	4-8-20	2-set-20	
2021	Lia	Sicilia	F	18-3-21	16-5-21	1-ago-21	7-9-2022
2021	Prisco	Sicilia	M	23-3-21	16-5-21	1-ago-21	
2021	Nino	Sicilia	M	30-3-21	16-5-21	1-ago-21	SL ¹⁰
2021	Yorgi	Grefa	M	7-4-21	5-6-21	1-ago-21	
2021	Babbu Mannu	Grefa	M	11-4-21	5-6-21	1-ago-21	SL ¹¹
2021	Bonaria	Grefa	F	9-4-21	5-6-21	1-ago-21	SL ¹²
2022	Maria	Grefa	F		05-05-22	10-giu-22	
2022	Bandideddu	Andalucía	M	17-02-22	05-05-22	10-giu-22	
2022	Sunesa	Andalucía	F		05-05-22	10-giu-22	
2022	Zirone	Andalucía	F	27-02-22	05-05-22	10-giu-22	
2022	Malvasia	Andalucía	F	27-02-22	05-05-22	10-giu-22	
2022	Isabella	Sicily	F	01-03-22	20-06-22	11-lug-22	
2022	Nieddu	Sicily	M	01-03-22	20-06-22	11-lug-22	

Tab. 1 List of the Bonelli's eagles hacked and released in Tepilora Regional Park (2018-2021) and in Bosa (2022). Eagles were fitted with metal/aluminum rings and GPS-tags (data omitted). Year is referred to the hacking season. Grey lines: SL (signal lost) animals whose fate is unknown. In red, the two adult males released from captivity and excluded from the analysis

¹ Signal lost on 21/1/2019

² Recaptured on 12/9, second release on 27/9/2018

³ Signal lost on 20/9/2020

⁴ Signal lost on 4/7/2019, probably seen on 13/7/2019

⁵ Signal lost on 23/4/2020, still alive in December (see text)

⁶ Signal lost on 24/3/2022

⁷ Recaptured on 16/9/2020, no longer released

⁸ Recaptured on 15/9/2020, second release on 29/10/2020

⁹ Signal first lost on 17/6/22 than reappeared on 17/7/22. Signal lost definitively on 9/8/2022

¹⁰ Signal lost on 29/1/22

¹¹ Signal lost on 16/9/2021

¹² Signal lost on 5/10/2021



Fig. 1 Prattereri in the area of Stazzi Monte Ruiiu. Left: the eagle close to an abandoned nest and (right) roosting in the powerline present in the area



Fig. 2 Radiography on the carcass of Lia. On the right: fracture of the femur; on the left, a welded fracture of the right omerus.

Currently (at 30/09/2022) and referring to hacking seasons 2018-2021, one eagle from 2019, two from 2020 and two from 2021 hacking seasons are still alive, with a sex ratio of 2F:3M. Age dependent survival analysis (Kaplan Mayer) showed that survival is 75% during the first year, it drops to 81% from the first to the second year, becoming 100% later on. That is to say that the first two years are the most critical periods for the survival of released eagles (Fig. 3).

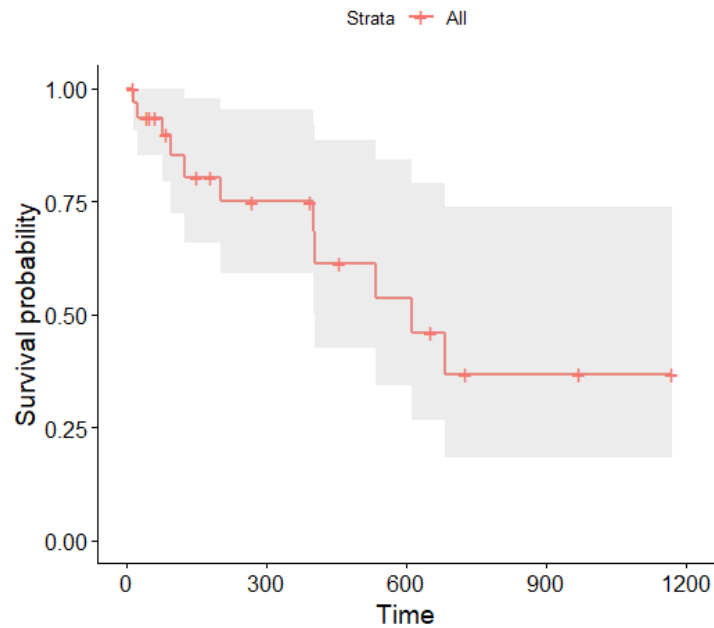


Fig. 3 Survival of the released eagles (2018-2022). The two males from captivity are excluded from the analysis. Time is in days.

Looking at the causes of death according to the origin of the animals (wild vs captive breeding, Tab. 2 and 3 and fig. 4), electrocution is the most important cause of death notably for eagles coming from natural populations.

		ORIGIN		tot
		Captive	Wild	
GENDER	F	8	10	18
	M	6	8	14
tot		14	18	32

Tab. 2 Distribution of released eagles according to gender and origin; wild: from natural populations (Andalucia and Sicily) and captive: captive breeding programmes (Grefa and LPO) (From deliverable Action C2)

	Electrocution	Predation	Illegal killing	West Nile	Septicemia	Inedia	Unkown	Tot
Wild	4	0	0	0	0	1	1	6
Cap	1	1	1	1	1	0	0	5

Tab. 3 Causes of death according to eagles' origin, wild: from natural populations (Andalucia and Sicily) and cap: captive breeding programmes (Grefa and LPO).

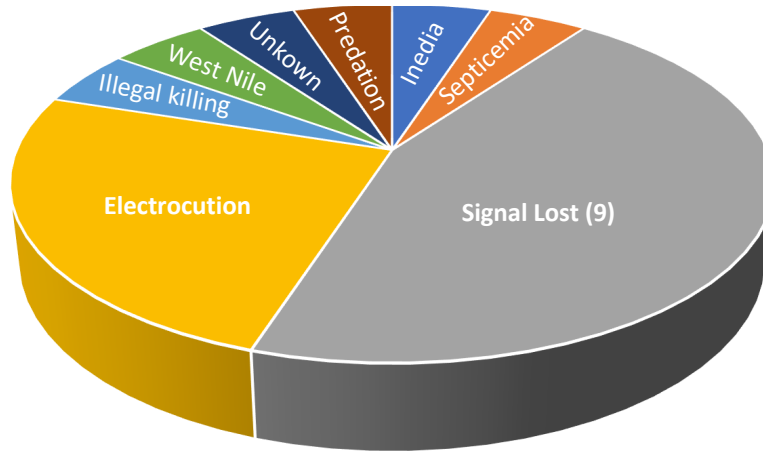


Fig. 4 Overall distribution of causes of death among the released eagles.

The effect on the survival probability of several covariates was tested. Among all, the origin of the eagles (wild vs captive) and the date of leaving seem to affect the survival probability (Tab. 4 and fig. 5).

Notably, eagles from captive breeding seem to perform overall better than those from wild population, while leaving the release site later on in the season increases survival probability.

While these results can provide insight to be better explored, it must be underlined first that the sample size is limited to draw conclusion and secondly that the electrocution as a cause of death tend to flatten any differences in mortality between animals, because it might act as a random mortality factor with respect to many of the variables considered.

	Estimate	St. error	T- value	P-value
Intercept	651.120	654.161	0.995	0.3321
Sex (m)	-187.974	112.017	-1.678	0.1097
Origin (wild)	-440.063	199.124	-2.210	0.0396
Age at release	9.997	7.074	1.413	0.1738
Age at leaving	-3.951	3.084	-1.281	0.2156
Date of release	-8.077	3.745	-2.157	0.0840
Date of leaving	4.880	2.489	1.961	0.0448
Buffering	0.3285	2.226	0.148	0.8839

Tab.4 GLM parameters of the effect of covariates on survival probabilities. Dates are all transformed in Julian date.

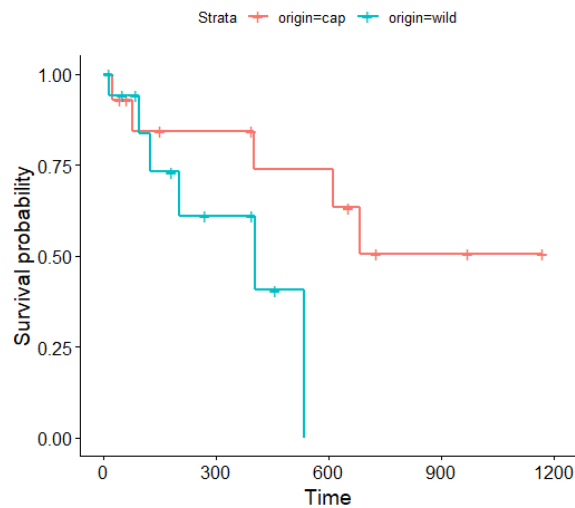


Fig. 5 Survival probability according to the origin of the eagles.

2. MOVEMENT AND DISPERSION

To check for any territory settlement, net squared displacement (NSD – net squared Euclidean distance between the release site and all subsequent locations) was used. This metric highlights quite clearly the movement away from the release site as well as any settlement at a certain distance from it. Kernel home range are also shown. For eagles not yet settled, home ranges only have the scope to present the areas frequented.

2.1 Eagles from 2019, 2020 and 2021 hacking seasons

During 2022, no eagle released in 2018 was left, while two eagles from 2019 (Pratteri and Inoche) were regularly monitored (Inoche only up to March 2022).

Pratteri is, among all eagles released, the one who didn't roam extensively as the others did (Fig. 6). It remains in north-central Sardinia (Coghinas lake), around 40 km north-west from the release site (Crastazza). This male has probably chosen the lake area as a hunting range, thanks to the high availability of potential prey species. Both in 2020 and in 2021, this male moved to Crastazza while the hacking season was going on and in 2021 remained there up to the release of the eagles from aviary and after. Several times it was captured by the camera trap on the feeding platform, interacting with the young eagles just released.

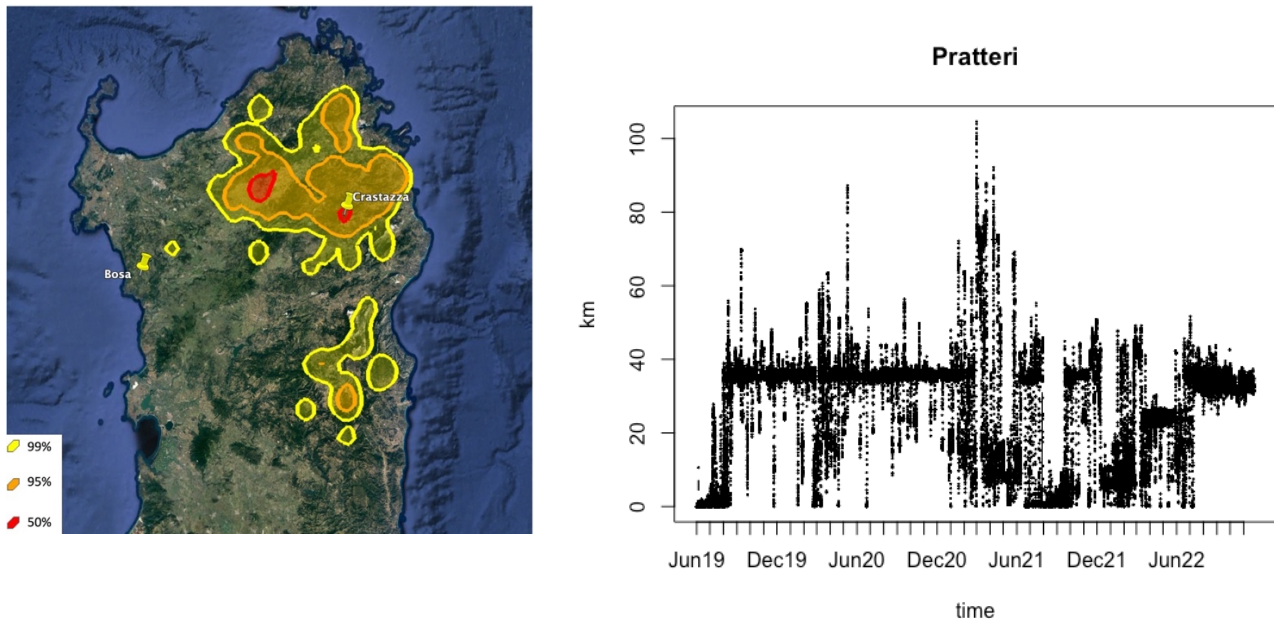


Fig. 6 Left: Prattereri home ranges, all positions pooled from 2019 up to 2022. Right: NSD. Point “0” correspond to the release site. The two released sites are shown (Crastazza and Bosa)

By the end of 2021, Prattereri seems to have established a territory in the area of Sos Littos Forest, around 6 km north from the release site, within Tepilora Regional Park. From here, he uses to move to Coghinas (west) and along the valley of Posada river (east, Fig. 6).

According to the home ranges, basically two areas appear to be pivotal in its movements: the release site Crastazza, where he often came back, and the area of Coghinas’ s lake (around 40 km straight distance from Crastazza), in the center north Sardinia (50% Kernel Home range). The disjointed 95% area north of Crastazza encompasses the area chose by the male when he was associated with Inoche, before she disappeared.

This space use pattern is well reflected in the NSD (Fig. 6), where the frequent visits to the release site in Crastazza are shown (return to point “0”), as well as the initial (2019-2020) and final (2022) fidelity to the area of central Sardinia.

Soon after the release in 2019, Inoche roamed all over Sardinia and by the end of 2020 she restricted the movement to Sulcis (south-west), an area also chose by other eagles. During 2021, Inoche (Fig. 6) moved mostly in north-east Sardinia (Gallura), also going in Maddalena National Park, moving among the islands of Caprera, Spargi, Corcelli but also to the islets of Isola delle Bisce, Mortorio and Soffio, down up to Tavolara and Molarra (from late January to July). By the end of 2021 Inoche’s tag showed some problems, namely the battery never fully recharged and data download were irregular as well as the recording of GPS positions. In 2021 and 2022, Inoche kept on moving in a more restricted area, in the outback of Olbia, frequently approaching the release site, as shown by the NSD (Fig. 7).

At the beginning of February 2022, Prattereri made some movements reaching the area frequented by Inoche. The two seemed to have formed a pair later in March, but the attempt was unsuccessful. Inoche disappeared and Prattereri came back to Crastazza.

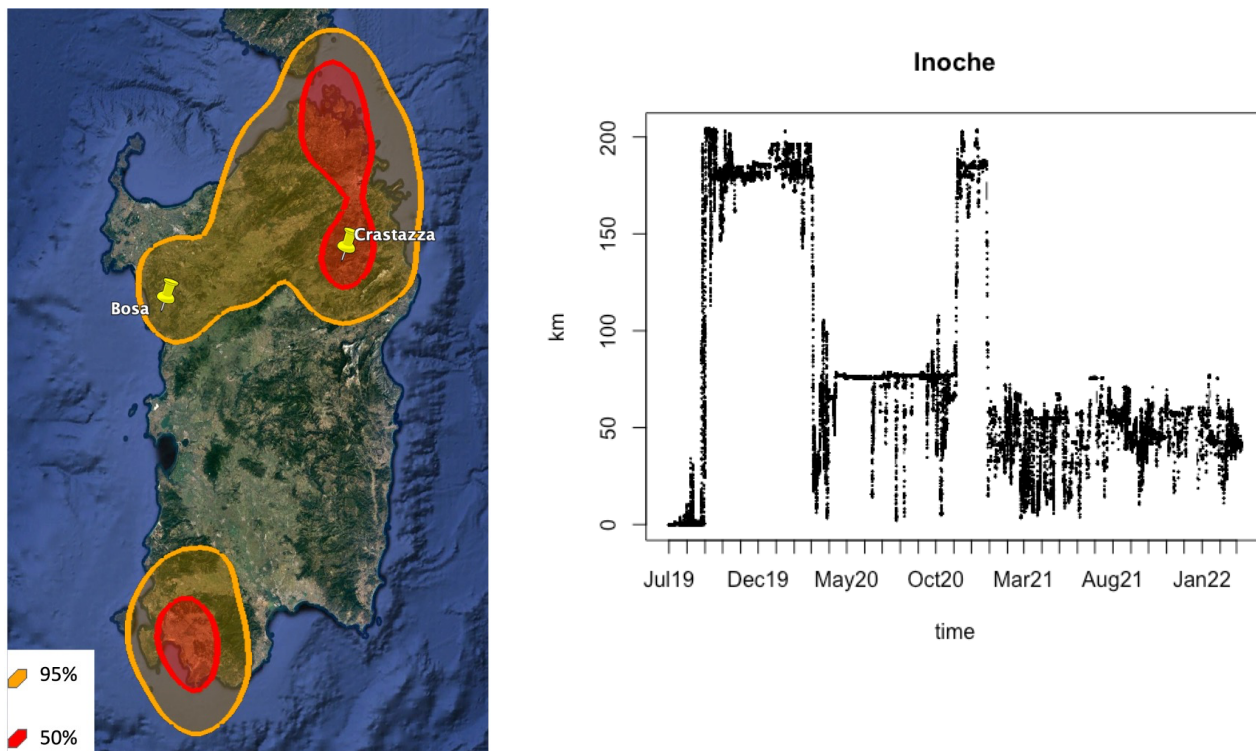


Fig. 7 Left: Inoche home ranges, all positions pooled (2019-2022). Right: NSD up to the end of March, when the tag stopped transmitting data.

As for the eagles hacked in 2020, Arcantzelu (Fig. 8) roamed extensively, apparently avoiding the central-south west of the island as well as the northern coasts. By the end of 2021 he frequented preferentially the inland area behind the Gulf of Orosei (east coast) having left the south-east coast in January of the same year, where he spent the first period after release. From 2021 to 2022 he restricted the movements closer to the release site, but in 2022 he moved in central Sardinia, suggesting that a territory was not yet established (as highlighted by the NSD, fig.8). His movements concentrated in the mountainous areas of central Sardinia, where the last position was located, before its disappearance between Seulo and Gadoni.

Arroyto also visited all Sardinia staying longer in the southwest of the island. She moved to Corsica on 9/4/21 and she is currently still there. Arroyto is the third eagle leaving Sardinia to Corsica. Here, she roamed all around the island; however she mostly frequented Scandola Regional Reserve (North west) and the area between Aléria and Ghisonaccia (south-east coast), making regular movements between the two sites during summer 2022 and frequently stopping in between, in Evisa in which outskirts there is a bearded vultures feeding station (Fig. 9). All these areas were also frequented by Posada during her staying in Corsica.

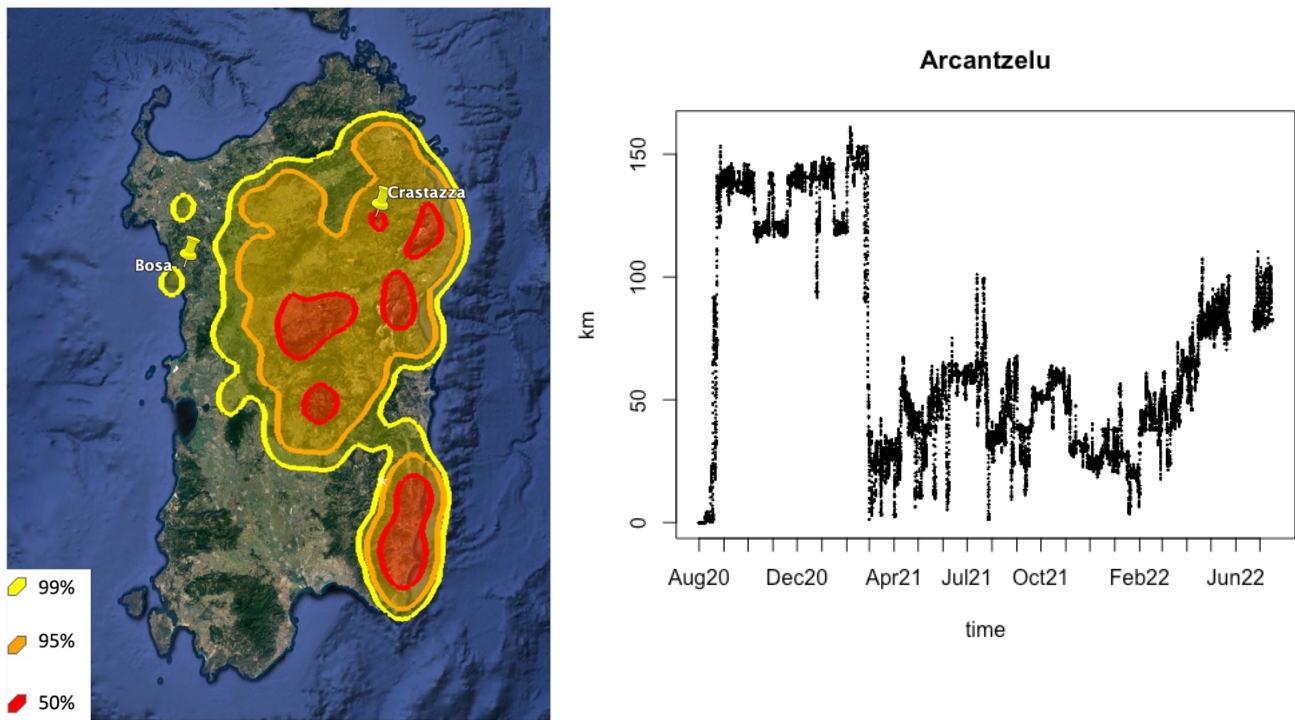


Fig. 8 Left: home range of Arcantzelu, the star indicates the last known position before its disappearance, between Seulo and Gadoni. Right: NSD showing absence of stabilization.

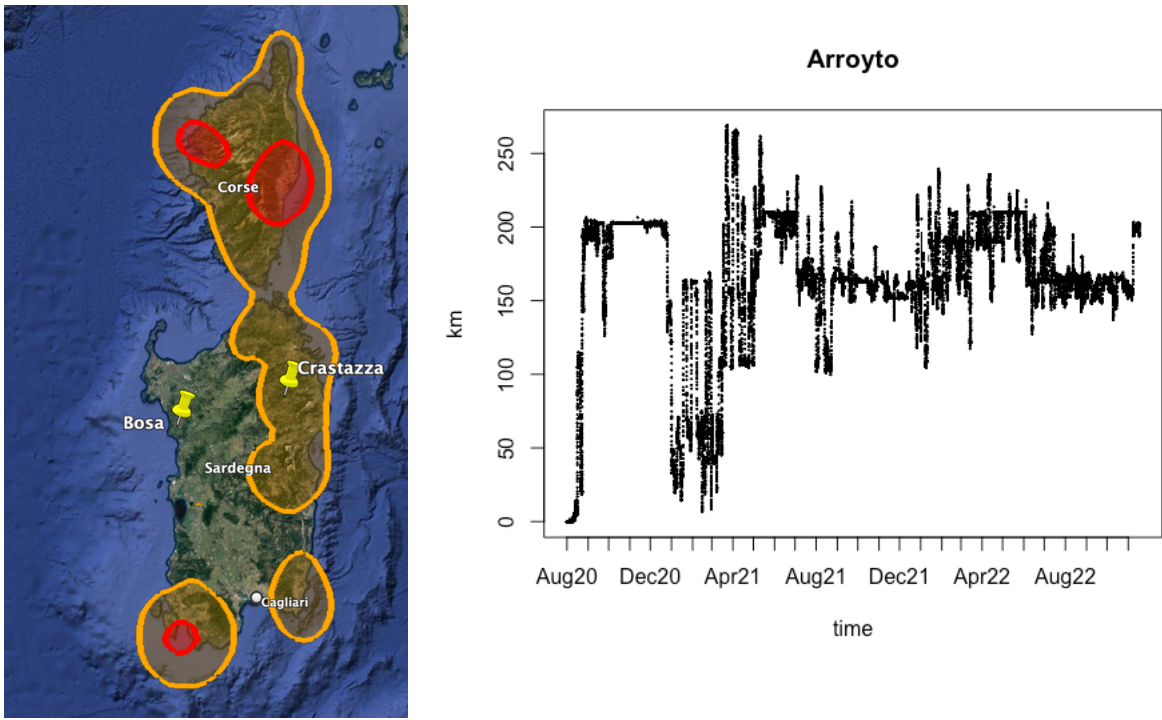


Fig. 9 Right: home range of Arroyto in Corsica and in Sardinia. Left: NSD highlights the eagle is regularly moving between two main sites in Corsica, from late 2021.

Minnena clearly clustered her movements between two different areas (Fig. 10): the first in the south, corresponding to a wetland (Macchiareddu) already heavy used by Posada from hacking 2018, and the second corresponding to the area surrounding Coghinas lake, where she also joined the eagles released in 2021 frequenting the same area.

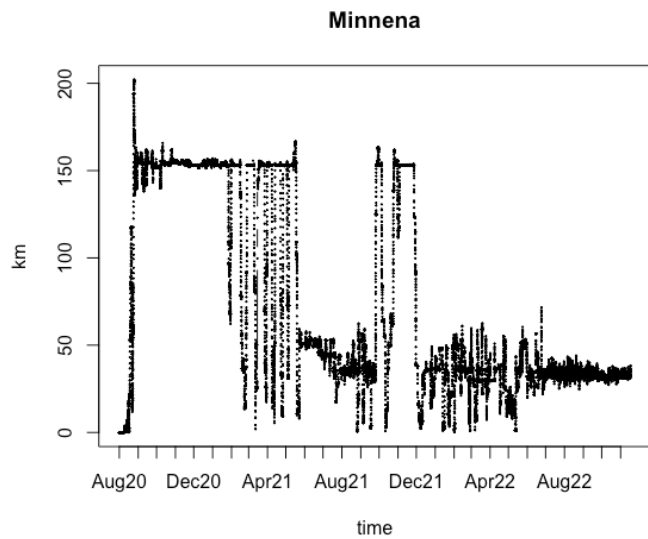
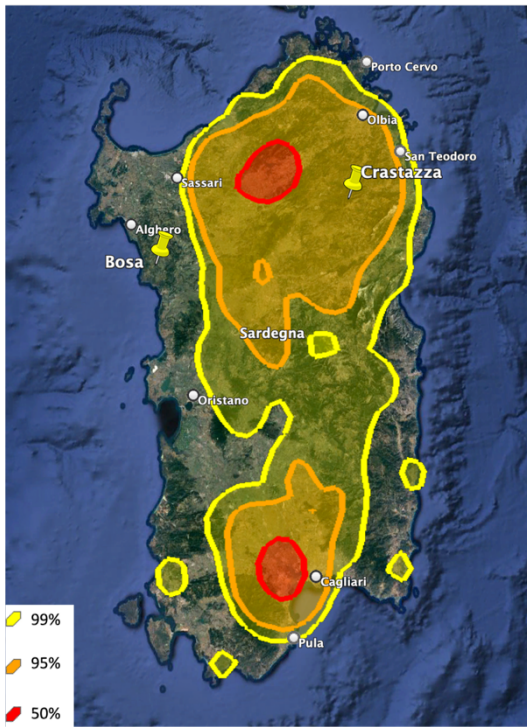


Fig. 10 Left: range covered by Minnena since the release in nature. Right: NSD showing that a territory is probably established by the end of 2022, in central north Sardinia.

NSD is shows substantial stabilization (Fig. 11) in association with Pratterri. If the pair formation will be confirmed in the next months, it would be the first reproductive pair since the extinction of the species in the last century.

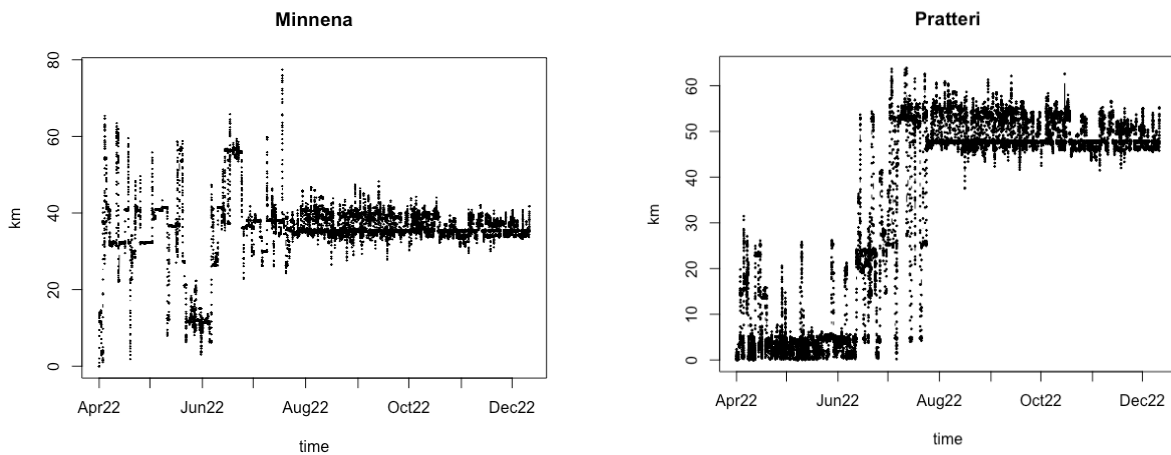


Fig. 11 NSD of Minnena and Pratterri from April 2022. Substantial stabilization in the same area occurred since late July 2022.

In the area roky outcrops are present, surrounded by large open fields, optimal hunting ranges and high maquis (Fig. 12).

There are relatively few powerlines that have been already characterized and prioritized for retrofitting.



Fig. 12 Area frequented by the first pair.

As for eagles released in 2021, they do not seem to have settled yet, even if they show concentrated utilization distribution. Therefore, the home range concept is not applicable yet, and the ranges are showed only to give an idea of the spatial scale of their dispersal.

Among the eagles released in 2021, Bonaria and Babbu Mannu stopped transmitting data 46 and 65 days after the release, respectively. Babbu Mannu explored the north and moved south up to Oristano province where he disappeared. Bonaria left the release valley very soon, but she moved in a valley near to release site, where she was caught again on 12 august. At the second release, after the surgery, she soon left the release site, moving north and towards Tavolara, when the signal was lost before she reached the island. Also, Nino stopped transmitting at the beginning of 2022. He frequented only north Sardinia, from the coast of Bosa on the west – where the second aviary was built up – to the east, between Porto San Paolo and Monte Albo. However, he mostly frequented the plain of Chilivani, slightly south Coghinas, as many other 2021, and later 2022 eagles did. A similar movement pattern was shown by Lia, who however also visited the southwest Sardinia. This eagle spent long time in the area crossed by the rio Mannu (Fig. 13) and, apart from large explorative movements, she remained in the Chilivani plain (Fig. 14).

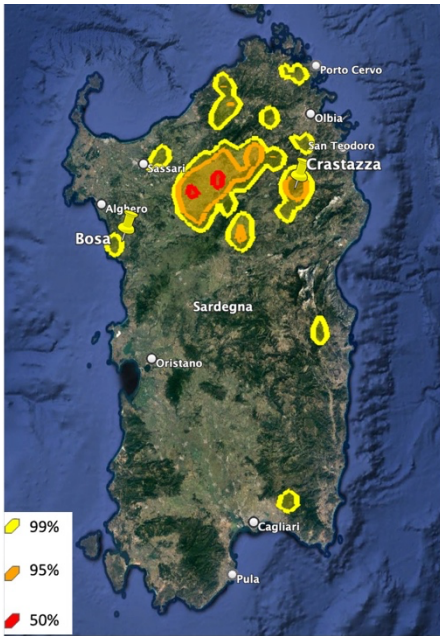


Fig. 13 Lia home range (right) and habitat of the area frequented, along the Rio Mannu. The area (Chilivani plain) is characterized by uncultivated fields and pastures, with small and localized rock outcrops.

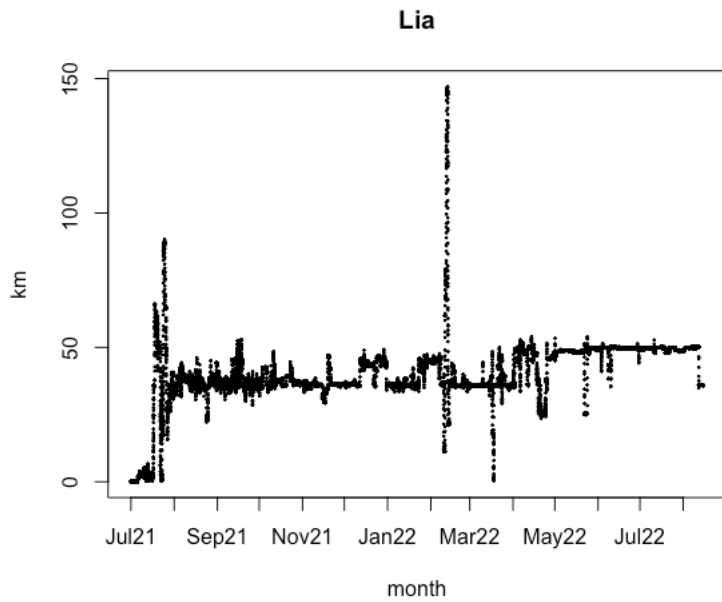


Fig. 14 Lia NSD. This eagle made large explorative movements, but she was linked to sites along Chilivani plain.

Prisco roamed almost all over Sardinia, but he also concentrated his movements in the Chilivani plain, among other areas. This area seems to be the site where he moved from and come back while roaming in Sardinia, as shown by the NSD (Fig. 15)

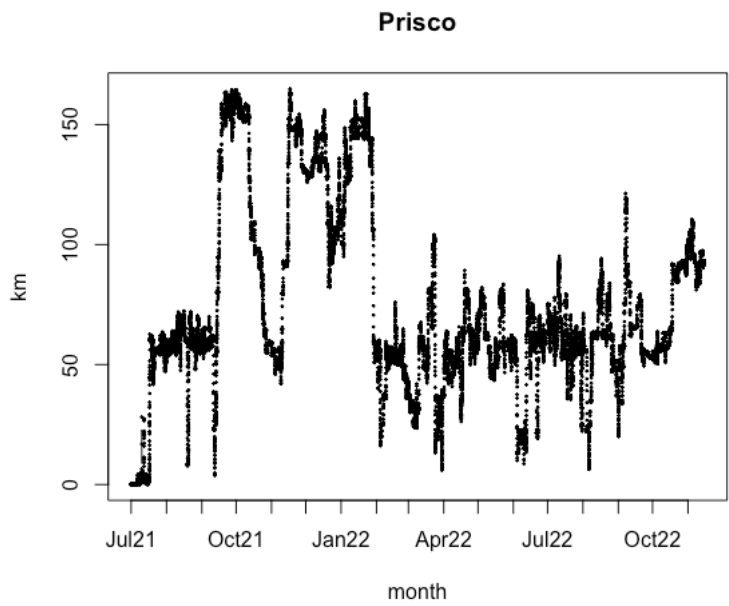
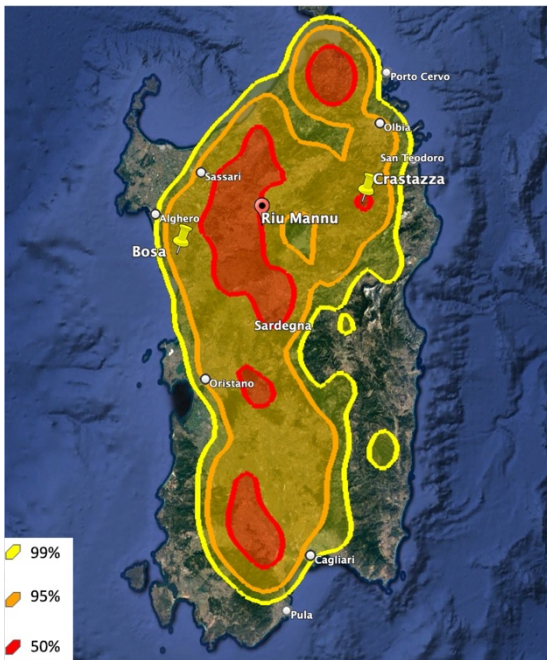


Fig. 15 Left: Prisco, area of use. Right: NSD showing the presence of a site where he moved from and come back while roaming in Sardinia

Yorgi only moved in the center-north Sardinia, even if a frequently used site is not evident (Fig. 16). This eagle showed a remarkable attraction for the release site (Crastazza) where he often came back. From the NSD pattern, it is quite sure that this eagle didn't find a territory yet.

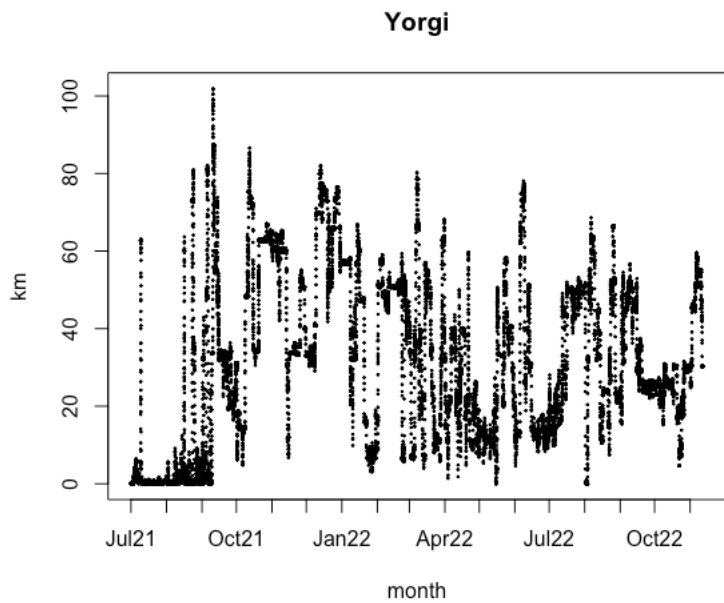
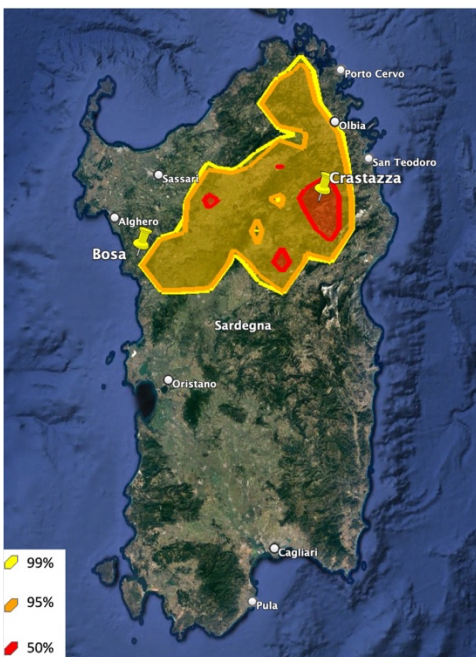


Fig. 16 Left: area used by Yorgi and right, NSD showing no settlement pattern

2.2 2022 Hacking season

In 2022 hacking season 5 eagles coming from Spain were first release on 10/6 while the last two, coming from Sicily, were released one month later. As happened in the past years, eagles still in the aviary attract those already free which tend to stay longer in the release site, which in 2022 was located in S. Maria di Bosa (west Sardinia).

As general pattern, among the Spanish ones two made large movements after few days (17 and 18 June, Zirone and Maria respectively, fig. 17). Zirone moved quite soon towards the east and remained close to Monte Albo for a couple of months. She was observed here close to a *Columba palumbus* roosting site. By September she moved north of Oristano and after an excursion in the south, she is currently in the area of Arborea (southern Oristano). From the west coast, Maria moved to the east one to cross Sardinia and reaching Sulcis (south west). From Sulcis she is gradually going up along the west coast and she is currently in Arborea (Oristano). In late June-July she restricted her movements around Olbia (Fig. 17) moving towards the release site and crossing the area of Coghinas. While in Sulcis, as other eagles before her, she moved to the island of Sant'Antioco.

Malvasia stayed longer at the release site (Fig. 17) and also used the feeding platforms outside the aviary. Apart from fast excursions towards the east, she moved mostly along the west coast, also visiting the island of Asinara. She moved to the south and she is currently in an area at north of Oristano, not far from the release site.

Bandeddu remained in the release site up to September, feeding on the platform outside the aviary, also making exploratory movements. The first large movement was towards Sulcis (south Sardinia) where he remained for a while moving around and visiting Sant'Antioco. Then he gradually came back along the west coast towards the release site and he is now close to Santa Giusta pond (slightly south of Oristano). Leaving the release site in September, Sunesa wandered extensively around Sardinia, visiting the islands of Asinara and Sant'Antioco. She is currently in center south Sardinia.

Nieddu left the release site very late, on 1st November (Fig. 17). He only moved toward Olbia (east) and he is currently along the Chilivani plain (central-north Sardinia).

Lastly, Isabella didn't leave the release site yet. She made large movements, always coming back to the release site, where she continues to be fed inside the aviary (Fig. 18).

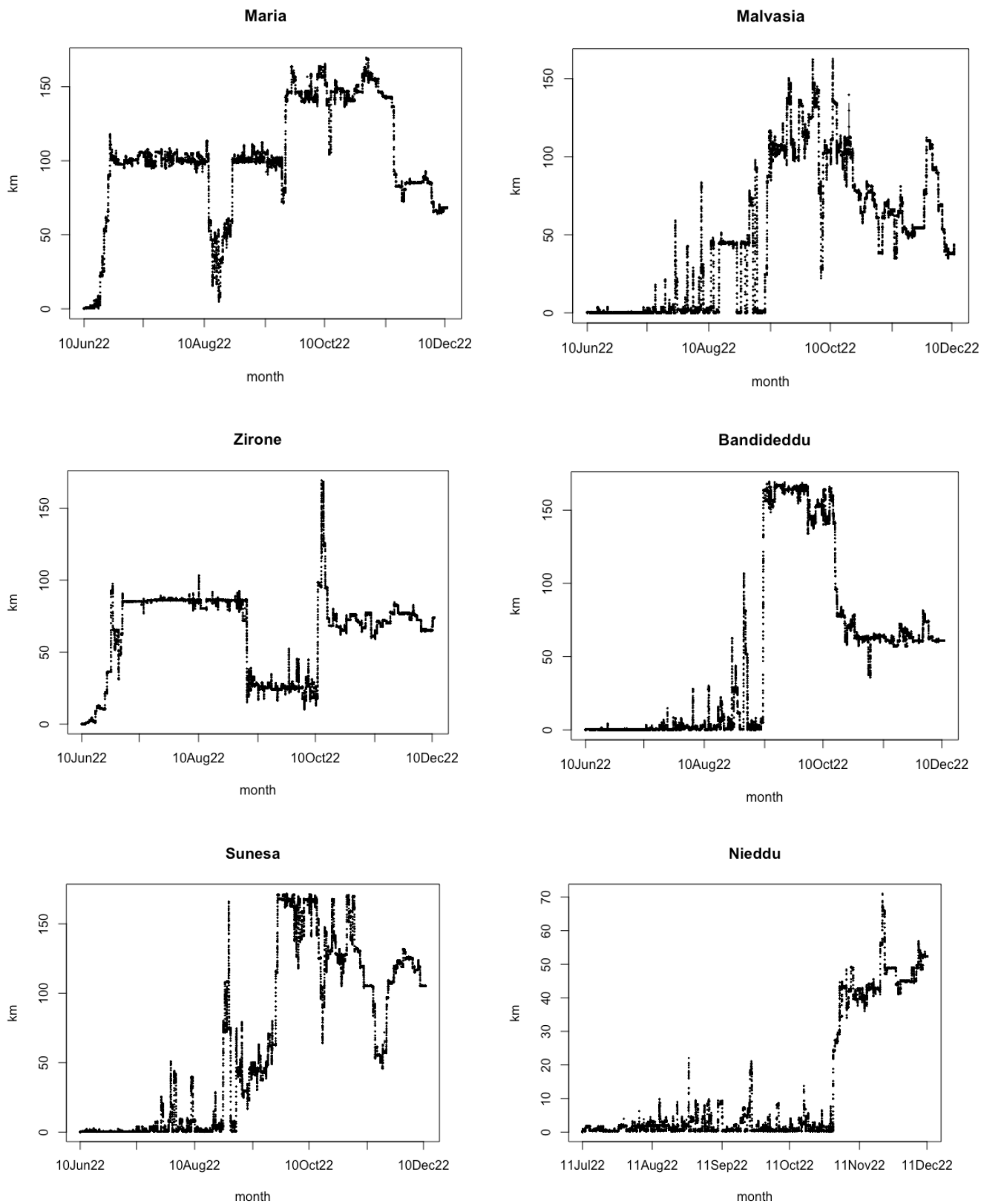


Fig. 17 NSD of movements displayed by eagles released in 2022. All eagles are from Spain except Nieddu (Sicily, Italy)

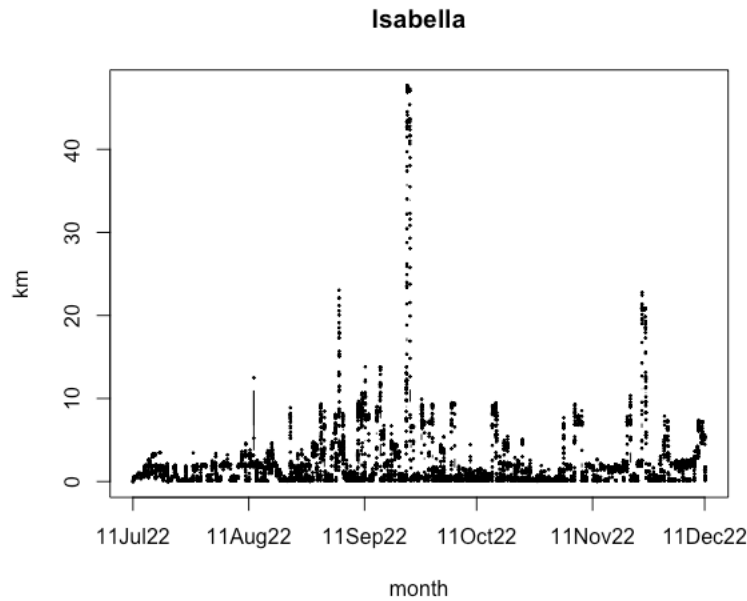


Fig. 18 NSD of Isabella’s movements showing substantial stability at the release site.

3. TIMING OF RELEASE AND DISPERSAL

Release in nature normally occurred within one month after the last chick has left the nest, in the aviary. However, in 2020, the chicks arrived later than previous years and they were not put into the nest. In 2022, the nest was open within few days from arrival, so that the animals were free to use it or not. We considered that an eagle started the post release dispersal (onset dispersal) when it flew beyond the average inter-nest distance (11.4 km) and did not return within that distance in the following seven days (modified from Cadahía et al., 2008).

Mean age at arrival varied between a minimum of 101 days in 2018 and a maximum of 130 days in 2020, when the arrivals were delayed due to the Covid restrictions (Fig. 19). Age at leaving (onset dispersal) does not vary accordingly; the maximum age at leaving was recorded in 2022. In this year for the first time an eagle has not left yet the release site, therefore data are pending to be updated.

Days occurring from release to onset dispersal also varied among years. Eagles remained at the release site a mean of 9 and 55 days (as a minimum and maximum) in 2018 and 2022 respectively (Fig. 20). In 2019 and 2022 eagles remained longer at the release site (50 and 55 days, mean values respectively) probably attracted by the presence of new eagles arrived later in the aviary.

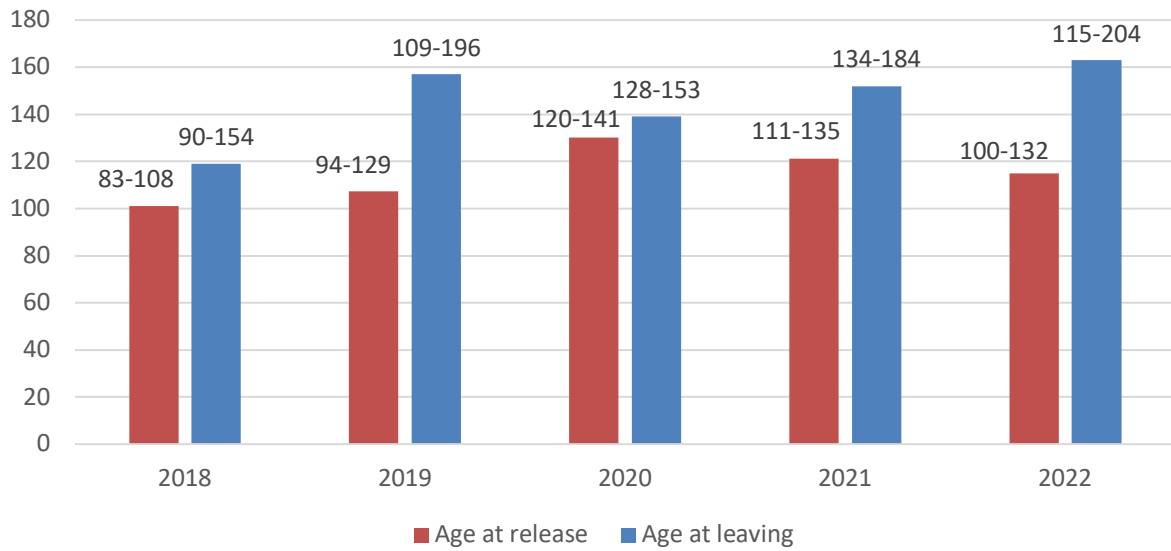


Fig. 19 Mean, min-max, age at release and at onset dispersal of the released eagles in the five years project.

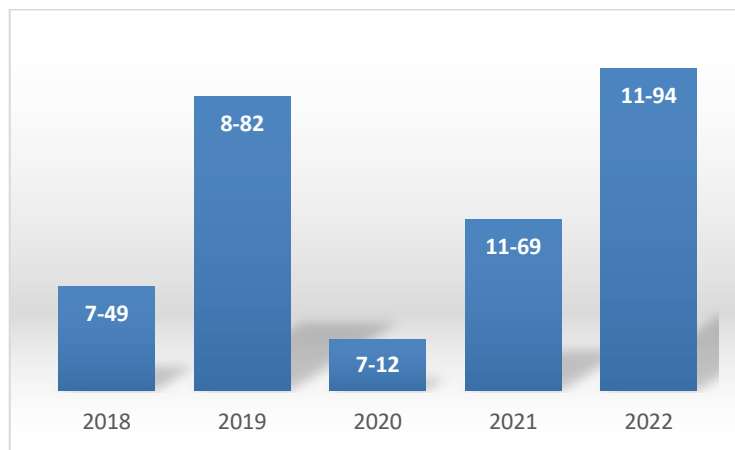


Fig. 20 Days from release to the onset dispersal by years.

4. FEEDING POINTS MONITORING

During the 2019, 2020, 2021 and 2022, clusters of positions of several eagles were checked in order to assess main prey species consumed. The surveys were also conducted when animals were stationary at the same site for a period of two days, in order intervene if necessary. In many cases, the consumption of large prey – such as *Buteo buteo* - determined the prolonged stop of the animals. Some of them, notably Battore, seemed specialized on this prey species.

The remains of 53 preys from several eagles, belonging at least to 14 different species (Tab. 5 and 6) were found. More than 97 % of the whole sample was made up by birds remains, although the sample is highly biased towards larger preys, whose consumption takes longer and is more likely to produce leftovers. As for the diet composition, the most represented species is the Buzzard (16 individuals, 30%) followed by several species of Ardeidae (11), the Wood Pigeon (7 individuals, 13%) and the Southern Crow (6 individuals, 11%) and others. The two fishes found in Pratteri's positions cluster at Coghinas, have been probably obtained through kleptoparasitism on ichthyophagous species (Grey Heron, Osprey or other). These data are better discussed within the ecosystem functions of the species.

Species	N
<i>Buteo buteo</i>	16
<i>Columba palumbus</i>	7
<i>Corvus corone sharpii</i>	6
<i>Ardea cinerea</i>	5
<i>Bubulcus ibis</i>	4
<i>Anas sp</i>	2
<i>Cyprinus carpio</i>	2
<i>Egretta garzetta</i>	2
<i>Larus ridibundus</i>	2
<i>Larus sp.</i>	2
<i>Columbiformes undet.</i>	1
<i>Gallinula chloropus</i>	1
<i>Larus michahellis</i>	1
<i>Lepus capensis mediterraneus</i>	1
<i>Nycticorax nycticorax</i>	1
	53

Tab. 5 List and number of individuals of species preyed by eagles listed in tab. 6.

Name	Date	n	Prey
Abbaluchente	18/07/19	1	<i>Gallinula chloropus</i>
	18/07/19	4	<i>Bubulcus ibis</i>
	18/07/19	1	<i>Nycticorax nycticorax</i>
Arcantzelu	23/07/20	1	<i>Buteo buteo</i>
	23/09/20	1	<i>Buteo buteo</i>
	19/10/20	1	<i>Egretta garzetta</i>
	20/05/21	1	<i>Corvus corone sharpii</i>
Arroyto	12/09/20	1	<i>Corvus corone sharpii</i>
	07/12/21	1	<i>Unidentified species</i>
	07/12/21	1	<i>Ardea cinerea</i>
Battore	29/09/20	1	<i>Buteo buteo</i>
	11/09/20	1	<i>Buteo buteo</i>
	11/09/20	1	<i>Corvus corone sharpii</i>
	17/09/20	1	<i>Buteo buteo</i>
	17/09/20	1	<i>Corvus corone sharpii</i>
	04/10/19	1	<i>Buteo buteo</i>
	23/05/20	1	<i>Buteo buteo</i>
	12/08/20	1	<i>Buteo buteo</i>
12/08/20	2	<i>Corvus corone sharpii</i>	
Inoche	16/10/19	1	<i>Ardea cinerea</i>
	31/01/20	1	<i>Ardea cinerea</i>
	04/11/20	1	<i>Columba palumbus</i>
Lia	26/03/22	1	<i>Buteo buteo</i>
Minnena	23/09/20	1	<i>Buteo buteo</i>
	23/09/20	1	<i>Columba palumbus</i>
Nino	27/02/22	1	<i>Larus michaellis</i>
Pratteri	19/09/20	2	<i>Larus sp</i>
	19/09/20	1	<i>Columbiformes</i>
	19/09/20	1	<i>Anas sp</i>
	01/10/20	1	<i>Anas sp</i>
	07/10/20	1	<i>Chroicocephalus ridibundus</i>
	07/10/20	2	<i>Cyprinus carpio</i>
	10/10/20	1	<i>Corvus corone sharpii</i>
	16/10/20	1	<i>Columba palumbus</i>
	20/10/20	1	<i>Chroicocephalus ridibundus</i>
	02/11/20	1	<i>Columba palumbus</i>
	05/11/20	1	<i>Lepus capensis</i>
	24/03/22	1	<i>Ardea alba</i>
	24/03/22	1	<i>Ardea cinerea</i>
24/03/22	3	<i>Larus michaellis</i>	

Tab. 6 Prey species consumed by the released eagles

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