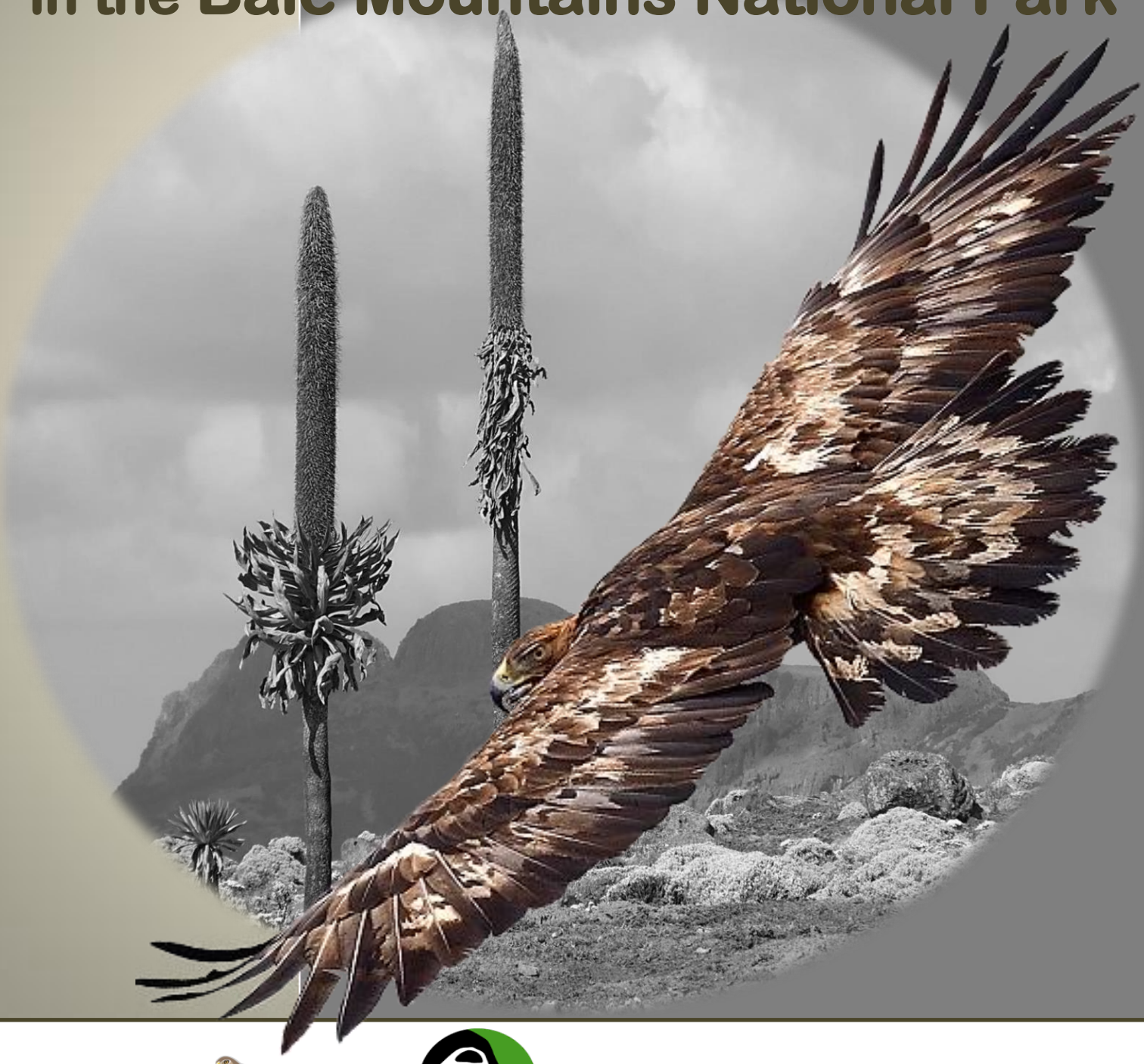
2017

Preliminary Survey

Situation of the Ethiopian Golden Eagle

in the Bale Mountains National Park



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Results of the Golden Eagle Preliminary Survey in Bale Mountains National Park (Ethiopia)

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Photographs: Mario Bregaña, Jesús Bautista, Enrique Navarro, Adam Wentworth and Javier Fuentes.

Acknowledgments

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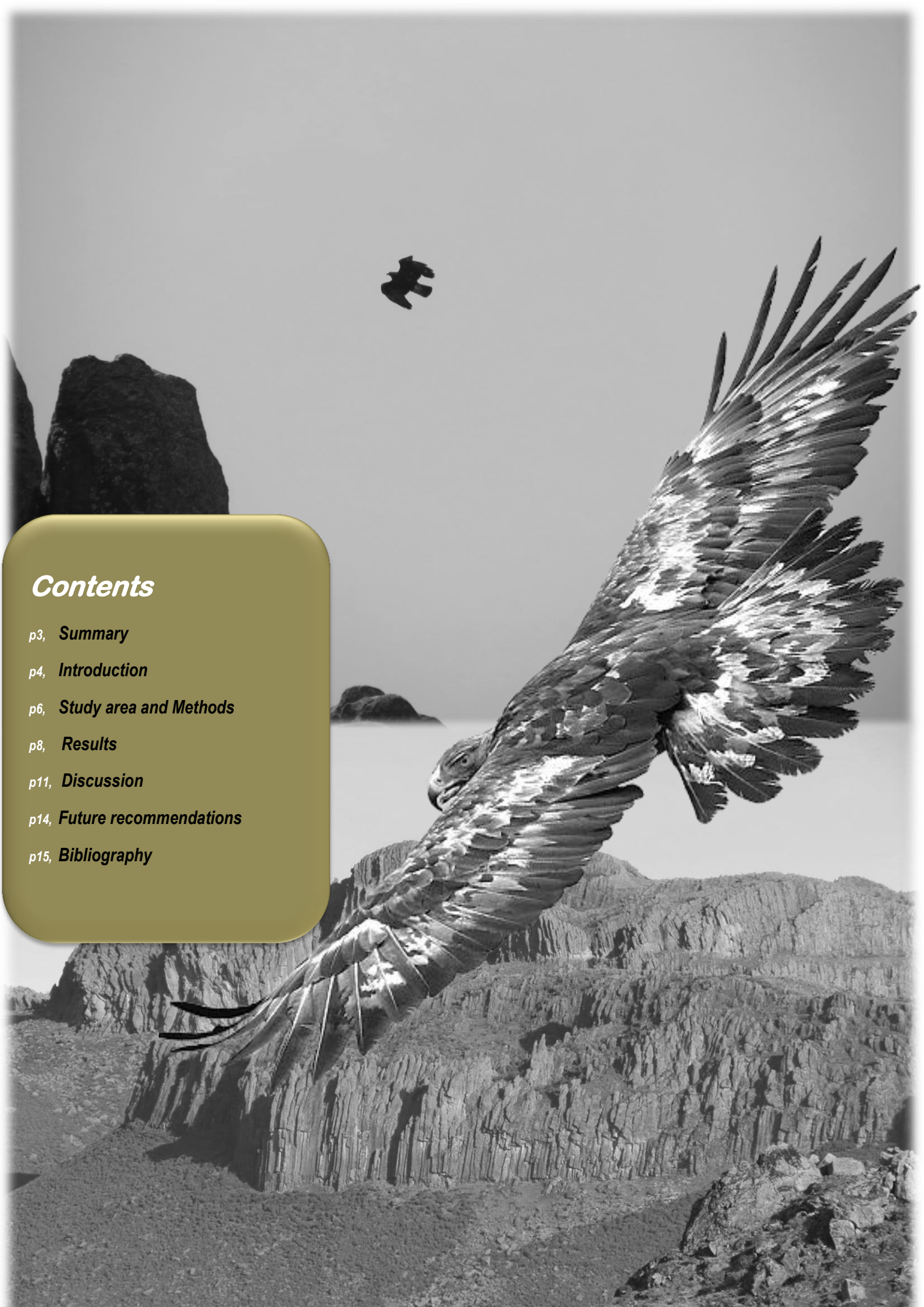
Last, but not least, we want to thank **Mengistu Wondafrash** (chief executive officer) of the Ethiopian Wildlife and Natural History Society **(EWNHS)** for showing interest in a future partnership for the implementation of a future conservation project.



Contents

SUMMARY

Ethiopia is harbor to a small isolated population of Aquila chrysaetos, the only known population in tropical Africa, found and followed for the first time 20 years ago. During the start of the breeding season of 2017 (12-24 November), a fourth survey was conducted in the Web valley, the same area several previous surveys of the Ethiopian Golden Eagle were conducted in the Bale Mountains National Park.

A total of six mature individuals have been observed during the present survey, two adult territorial couples, a territorial adult solitary and an apparently non-reproductive individual with subadult plumage. Of the seven territories known in previous surveys (1993-1997, 2014 and 2016), only one was occupied by a couple of adults who showed a behavior prior to reproduction (copulations, repair of nests etc ...), the other six territories they were unoccupied. As a novelty in this survey, located two new territories in another new area not surveyed in previous surveys. One of the territories was occupied by a solitary adult individual and another by an adult couple, in the which the female was incubating. Both territories were located at more than 4000 meters of altitude (4080 and 4270 m).

Given the results of this survey, only six mature individuals observed, and the absence of observations of juvenile non-breeding individuals in the surveyed area, we estimated in no more than fifteen or twenty mature individuals the golden eagle population in Bale Mountains National Park and possibly from the rest of Ethiopia.

This critical situation can be attributed to the growing anthropogenic impacts and the demographic problems typical of small and isolated populations. This relict population of *Aquila chrysaetos* that contributes to the biodiversity of the Afro-Alpine ecosystem and to the genetic diversity in the species seems to be highly vulnerable and be on the verge of extinction.

INTRODUCTION

The golden eagle is an exclusive species of the northern hemisphere, and the species of the genus *Aquila* more widely distributed. It is present in four continents, with a typically holarctic distribution with advanced Afrotropical (up to 7º N in the South), its main breeding areas are between 70ºN and 20ºN, with important populations in North America, Europe and large part of Asia, and others small and dispersed in North Africa and the Middle East, and geographically isolated in Saharan Africa and tropical Africa **(Watson, 2010; Ferguson-Lees & Christie, 2001; Del Hoyo *et al.*, 1994; Clouet & Barrau, 1993, 2015, 2017; Clouet *et al.*, 1999, 2000; Ash & Atkins, 2009; Wink *et al.*, 2004)**.

In the early nineties the small and isolated golden eagle population located in the Bale Mountains, southern high plateau, east of the Rift Valley, Ethiopia was discovered, this being the only population of golden eagle known in tropical Africa **(Clouet & Barrau 1993, 2015, 2017; Clouet *et al.*, 1999, 2000; Ash & Atkins, 2009)**. In the decade of the 90, the population was composed of seven territories (four territories occupied by two adults, and another three occupied by a single individual); In another subsequent survey, carried out in 2014, three territories were occupied by two adult individuals each, and in the 2016 survey, the situation was even more critical, the presence of a single territory occupied by two adult individuals and others was confirmed two territories occupied by a single individual, giving a total for the population of four mature individuals at liberty **(Clouet & Barrau, 1993, 2015, 2017; Clouet *et al.*, 1999, 2000)**. These individuals possibly accounted for most of the golden eagle breeding population of Bale Mountain National Park and even the rest of Ethiopia **(Ash & Atkins, 2009)**.

This small population may have survived for thousands of years in this Afro-Alpine enclave, and is probably a relic of an older and larger one dating from the time when the Afro-Alpine habitat was geographically much more extensive during the Pleistocene glaciations, which allowed the emergence of a community of species adapted to high altitude with a high level of endemism (eg, rodents, wolves) and also, easily colonized by Palaearctic species (e.g., hare, eagle) **(Clouet & Barrau, 1997, Messerli *et al.*, 1977; Hamilton, 1982)**. Preliminary studies based on molecular DNA sequencing techniques, found sufficient genetic differences between the eagle individuals of this population and those of other subspecies, being clearly individualized in the western palearctic clade (containing *Aquila chrysaetos chrysaetos* and *A. homeyeri*) suggesting a considerable isolation time that goes back from 200,000 to 300,000 years, which goes beyond the last ice age **(Wink *et al.*, 2004)**. This palearctic relic that

colonized Africa has all the characteristics due to its own merit of a new taxon at the subspecies level, which seeks to be formally described by the international scientific community before its last representatives disappear and part of the species' genetic diversity is lost.

In this context, and given the critical situation of this unique and threatened population, in november 2017, it was decided to carry out a new survey to assess its current state of conservation with the aim of establishing the long-term an urgent coordinated monitoring program of the population and habitat of this flagship that contributes to the biodiversity of the Afro-Alpine ecosystem and to the genetic diversity of the species. In addition, it is a unique opportunity to formally describe a new taxon at the subspecies level before it is extirpated.

Below are the results of this survey, and a series of recommendations to continue working in favor of the preservation of this unique population of golden eagle.

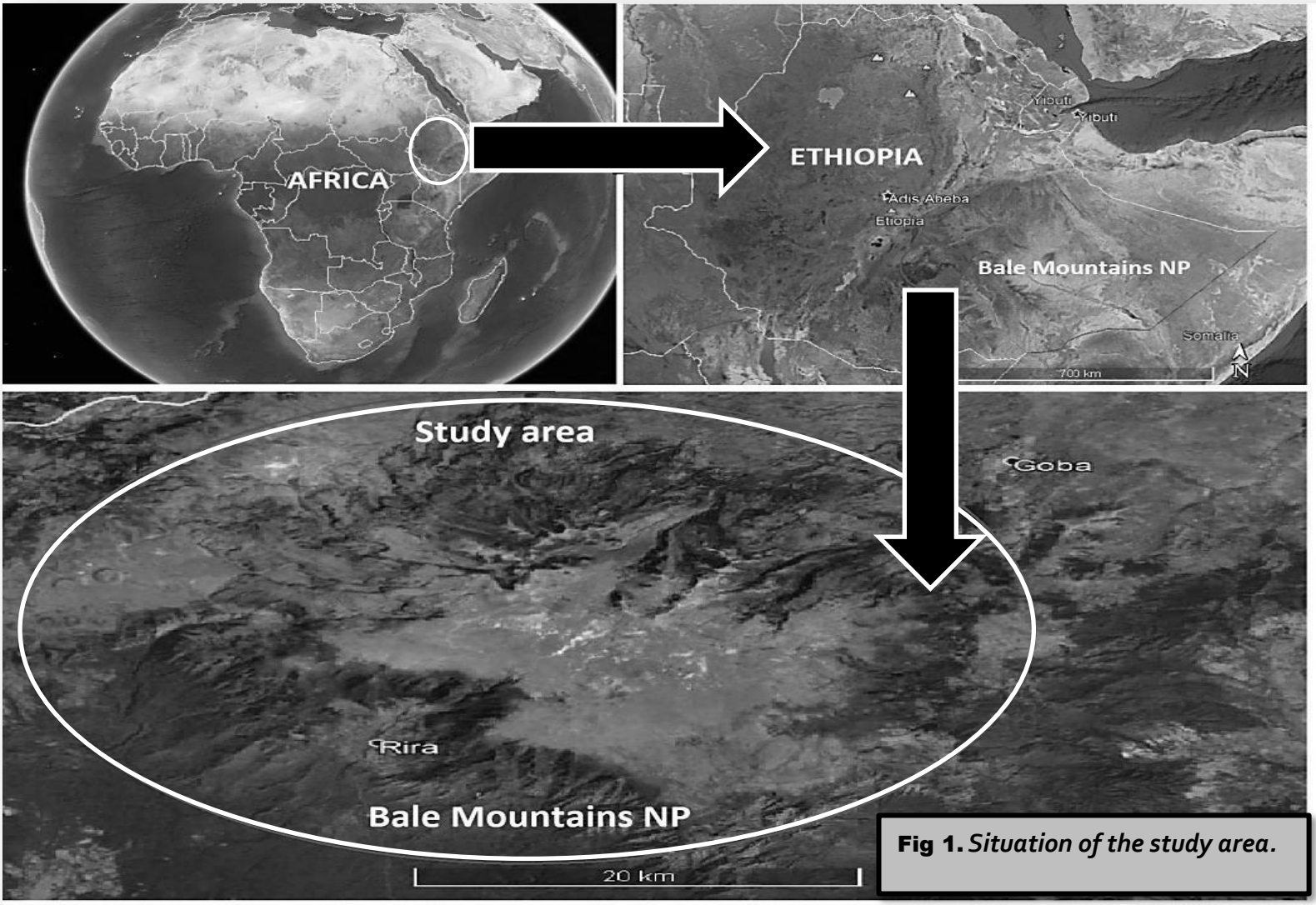


Fig 1. *Situation of the study area.*

STUDY AREA and METHODS

The survey was conducted mainly in the upper valley of the Web (Bale Mountains National Park) **(Fig 1)**, between 3500 and 3800 masl, and focused on the same seven territories monitored from previous surveys **(1993-1997, 2014 and 2016) (Fig 2)**, in an area of 200 km2. During the last two days of this survey, the upper part of the valleys of Worgona and Batu, both located in the northern sector of the Sanetti plateau, were prospected in search of new territories **(Fig 2)**. The Afro-alpine habitat is present throughout the study area and has a tropical climate tempered by the altitude, characterized by an alternating wet season that lasts from March-October and a dry season that lasts from November-February and represents the typical Afro-Alpine steppe, with its endemic community of rodents, mainly the giant mole rat (*Tachyoryctes macrocephalus*) and two species of murine rodents, *Arvicanthis blicki* and *Lophumoris melanonyx*, which constitute the majority of the prey of the Ethiopian wolf (*Canis simensis*) **(Sillero-Zubiri & Gottelli, 1995)** and a rich association of raptors **(Clouet *et al.*, 2000)**. The upper valley of the web hosts the highest biomass of rodents of any area studied within the BMNP **(Sillero-Zubiri *et al.*, 1995; Tallents *et al.*, 2012)** and previously harbored a high density of the endemic Starck hare (*Lepus starcki*), main prey of the Golden Eagles **(Clouet et al., 1999)**.

Our survey was conducted during the start of the breeding season of 2017 (November 10-23). During this time a total of 130 kilometers were traveled on foot and a total of 75 hours of observation were

invested, dedicated exclusively to the detection and observation of the eagles (registering presence and activities of the birds). Complementary transects were also carried out in the valley of the Web and on the Sanetti plateau to try to locate other sites occupied by golden eagles. Equally, data were collected on the presence of livestock (species, number), people and settlements during the survey, number of prey, especially Starck Hare (*Lepus starcki*) and other species of raptors, such as the black eagle (*Aquila verreauxii*). Observations were made with ground telescopes of 20x60 magnification and 10x42 binoculars.

RESULTS

Only one territory (Territory 6), of the seven monitored in previous surveys, was occupied by a couple of adults during this survey. In it, couple's copulations, contributions of material to nests and undulating flights of the couple were observed. In the other territories, no individual was observed occupying any of the territories.

During two days **a subadult bird was observed that frequented territories 5 and 7**, but at no time was a territorial behavior observed in it.

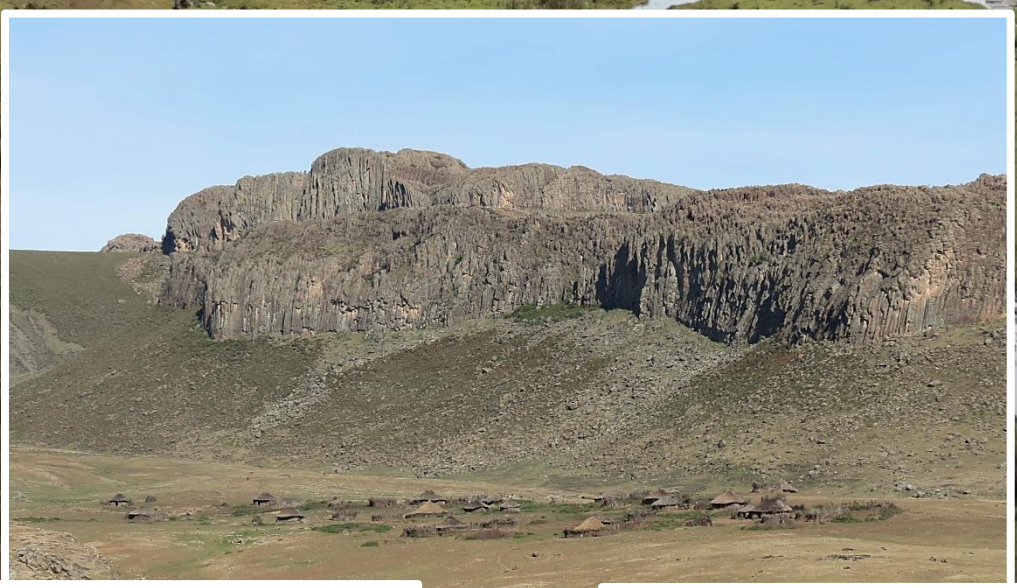
In the new survey area, located in the northern sector of the Sanetti plateau, **two new Ethiopian Golden Eagle territories were located**, both were found in the highest part of the valleys of Worgona and Batu, and were named territories 8 and 9. **They were located at an altitude of more than 4000 meters above sea level**, **4080 m** (Worgona) and **4270 m** (Batu) and and separated from each other by 7,6 km.

In the territory of Worgona a **single individual** with a very marked territorial behavior was observed. **Although the time of control of this territory was insufficient for logistical reasons**, being the maximum observation time of 2 hours. The possibility that there was another individual is not ruled out.

On the other hand, in the territory of Batu, **a territorial pair formed by two adult individuals was observed. The female was incubating in a nest located at 4270 meters** above sea level. During our observations, the male limited himself to actively defend the territory and to hunt. The couple performed a relay in the incubation that lasted no more than 10 minutes.

In total**, a total of six different individuals of the Ethiopian Golden Eagle**, five with adult plumage and one with sub-adult plumage, have been observed during the present survey.

The population of the Ethiopian golden eagle is under increasing pressure from an ever-growing human population, resulting in a strong negative effect on the habitats and the fauna.



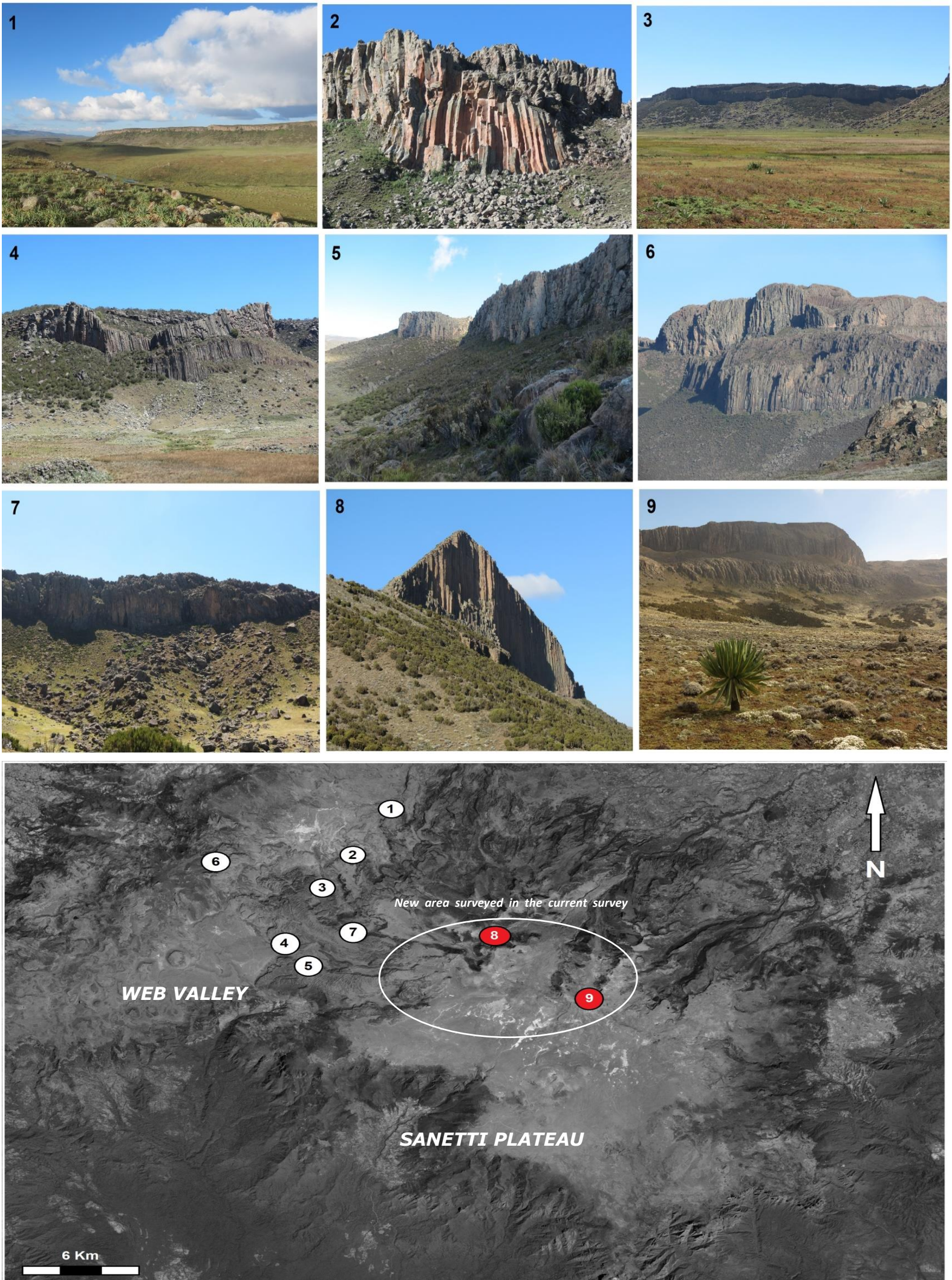


Fig 2. *Distribution and photographs of the nine territories visited in this survey. The white points correspond to the seven territories monitored in previous surveys, and the red points to the new territories located in the present survey. Photographs: Jesús Bautista.*

Table 1. ***Evolution of the Ethiopian Golden Eagle population in the Bale Mountains National Park during the surveys of 1993-1997, 2014, 2016 and 2017.***

Territory	1993	1994	1995	1996	1997	2014	2016	2017
GE 1	Single adult	Adult pair	Single adult	Single adult	Adult pair	Not occupied	Not occupied	Not occupied
GE 2	Adult pair / 1 young flying	Adult pair / 1 young flying	Adult pair	Adult pair	Adult pair	Not occupied	Not occupied	Not occupied
GE 3	Single adult	Adult pair	Adult pair	Adult pair	Adult pair / 1 young 5 weeks	Not occupied	Not occupied	Not occupied
GE 4	-	Single adult	Single adult	Single adult	Adult pair	Not occupied	Not occupied	Not occupied
GE 5	-	Adult pair / 1 young 10 weeks	Adult pair / 1 young 7 weeks	Adult pair / 1 young 7 weeks	Adult pair / 1 young flying w hit adults	Adult pair	Single adult	Not occupied ??
GE 6	-	-	-	Adult pair / 1 young 9 weeks	Adult pair	Adult pair	Single adult	Adult pair
GE 7	-	-	-	-	Adult pair	Adult pair	Adult pair / 1 young	Not occupied
GE 8	-	-	-	-	-	-	-	Single adult*
GE 9	-	-	-	-	-	-	-	Adult pair / Incubating
Annual population productivity	0,33	0,4	0,2	0,33	0,29	0	0,33	?
Nº non-breeding individuals	1	-	1	-	-	-		1
Nº mature individuals	4	9	8	10	14	6	4	5
Total number of individuals population	**5**	**9**	**9**	**10**	**14**	**6**	**4**	**6**

DISCUSSION

Given the results of this survey, only six mature individuals observed, and the absence of observations of juvenile non-breeding individuals in the surveyed area, we estimated in no more than fifteen or twenty mature individuals the golden eagle population in Bale Mountains National Park and possibly from the rest of Ethiopia.

Two are the main ecological problems that are leading to this isolated population on the verge of extinction. On the one hand, the demographic decompensation that affects the population has caused the so-called "*Allee effect*". The very low juvenile production rate of 0.27 per occupied territory and 0.4 juveniles per pair / year is among the lowest recorded for the species in its entire range **(Table 1) (Clouet *et al.*, 1999; Watson, 2010)**. This phenomenon, known as the "*Allee effect*", occurs when, after a certain threshold, the population size is so low that the survival rate and / or the reproductive rate falls because individuals do not reproduce as they do not encounter more individuals of the same population, the 29% (n = 35) of the territories occupied during the period 1993-2017 were run by solitary adult individuals **(Table 1)**. From a genetic point of view, the "*Allee effect*" is considered as a process in which first there is a decrease in the population size that changes the genetic structure of the latter, and subsequently there is a decrease in the "biological effectiveness" of the individuals (for example, a decrease in the reproduction capacity). Although this effect occurs individually, this usually affects the entire population due to the fact that there is no recruitment of new individuals (only three non-breeding individuals observed between 1993-2017). This lack of recruitment could be

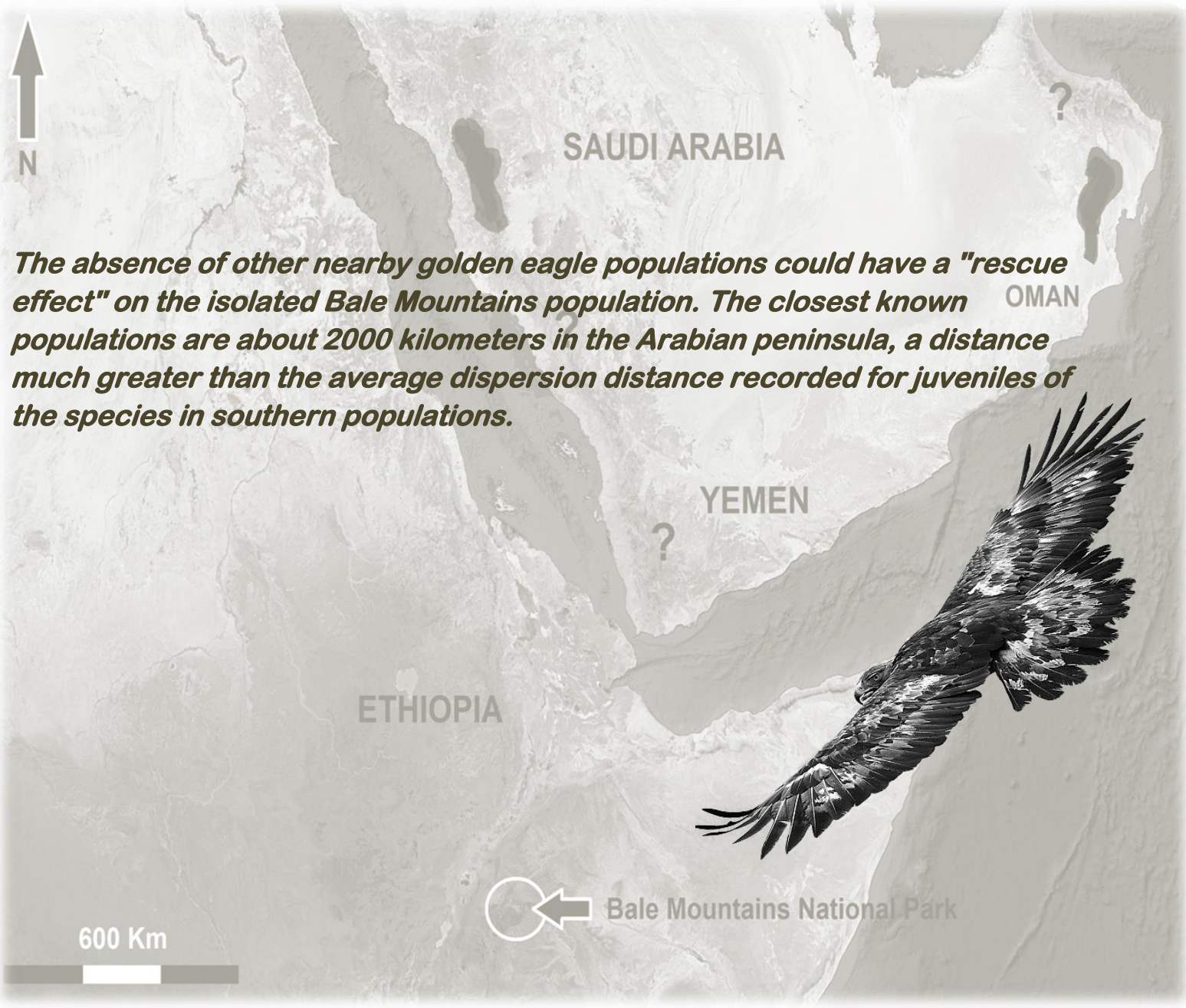
counteracted if this population had immigration from other nearby populations that could have a "*rescue effect*" on it, but as far as is known, no other golden eagle nuclei have been registered in other parts of Ethiopia **(Clouet & Barrau, 2017; Ash & Atkins, 2009)**. The closest population known to this is located about 2,000 km on the Arabian Peninsula, distance much higher than the average dispersion distance of juveniles of the species in southern populations **(Soutullo *et al.*, 2006 a,b,c)**. This very restricted distribution, highlights even more, the potential importance of Bale Mountains National Park for the preservation of this critical and peculiar population of golden eagle.

Human pressure is the other factor that is seriously endangering the persistence of the last individuals of this population. Recent human colonization in the higher lands of Ethiopia has also been observed in Bale Mountains National Park, and has been intensifying and accelerating between 2014 and 2017, including nominally protected areas such as national parks **(Stephens *et al.*, 2001; Gower *et al.*, 2013; Clouet & Barrau, 2017; EWCP, 2010 & 2016; Kefyalewalemayehu *et al.*, 2015)**. While the human presence within the Bale Mountains National Park was limited, sporadic or temporary due to transhumance, now groups of houses and small villages dot the area of permanent occupation of the species. These are usually accompanied by a procession of livestock, half-wild shepherd dogs, and shepherds who usually wander on foot from the cliffs where the golden eagles nest, causing constant discomfort during reproduction.

Human pressure is a highly influential factor in the selection of nesting habitat for birds of prey **(Newton, 1979)**, and as is known, the Golden Eagle is a species particularly very little tolerant to human presence. In this context, it is possible that part of the territories known in previous surveys are being relocated to other non-surveyed areas, a fact that could have occurred in one of the new territories located in the present survey (territory 9). These displacements to areas located at higher altitudes, in this particular case at 4270 meters (the maximum registered altitudinal record for the species), are almost certainly due to the strong pressure exerted in areas of lower altitude such as the valley of the Web, that as a result of this man-eagle interaction, they have pushed the eagles towards the less populated and inaccessible areas of the massif, corresponding to the headwaters of the valleys. This pattern of vertical distribution of these territories is made possible by the meridionality of the Bale Mountains, that have a more benign environment than the northernmost mountains of the holarctic region, where nesting above 2500 m is very rare **(Watson, 2010)**.

As well, overgrazing is transforming the habitat by altering the vegetation cover, which is assuming a notable decrease in the main prey species, both of the golden eagles and other predators present in these afro-alpine ecosystems. The competition of several species of endemic rodents (*Tachyoryctes macrocephalus, Arvicanthis blicki* and *Lophumoris melanonyx*) that are part of the diet of the golden eagles and of much of the community of predators of these afro-alpine ecosystems, with the livestock, confirmed that the biomass of rodents decreased as grazing pressure increased **(Clouet & Barrau, 1999, 2014, 2017)**. Another negative effect, and no less important, caused by human pressure are the intentional fires produced at the base of the golden eagle nesting cliffs, which us ually have a series of disastrous consequences for viability at the territorial level. These intentional fires aim to eliminate the vegetation cover that serves as a refuge for leopards (*Panthera pardus*), thus decreasing the these presence of this in areas with abundant livestock. This also implies an increase in livestock in these areas discovered due to an increase in grass and in turn a decrease in the main prey species of golden eagle.These effects caused by the increase in human pressure, in relation to overgrazing on the golden eagle are similar to the impact observed in the Ethiopian wolf (*Canis simensis*), where it shares the

same habitat, and at least, in part, the same categories of prey species. Finally, the increase in human presence, in relation to the increase in the number and size of herds, has led to an increase in doubts about the appearance of conflicts between people and wildlife, especially towards predation (*livestock vs. hyena* and *leopards*). This is evidenced by the recent cases of poisoning that appeared on the Sanetti plateau **(EWCP, *com pers*. in Clouet & Barrau, 2015, 2017)**. Although the Balé National Park is the most important conservation area in Ethiopia and is listed as an Important Bird and Biodiversity Area (IBA) by BirdLife International, the only representatives of this peculiar population of Ethiopian Golden Eagle could become a victim charismatic of the growing human pressure on the environment. As suggested for other taxa that share this Afro-Alpine ecosystem, one of the main priority conservation actions is to limit human invasion in this environment **(Gower *et al*., 2013)**. The protection of their last representatives and their habitat is therefore essential and should be one of the priority missions of the authorities of the Balé Mountains National Park and the Ethiopian Wildlife Conservation Authority, incapable, so far, of limiting human pressure that threatens this ecosystem, so that special emphasis is placed on the need to establish an urgent coordinated program of monitoring of population and habitat, and a more detailed study to understand the ecology and demography of this flagship that contributes to the biodiversity of the Afro-Alpine ecosystem and the genetic diversity of the species, in addition to presenting a unique opportunity to formally describe a new taxon at the subspecies level before it is extirpated.



FUTURE RECOMMENDATIONS

This preliminary survey objetives to promote and boost future actions necessary to eliminate the imminent danger of extinction faced by this isolated and unique population of golden eagle. To achieve this purpose, the following objectives are proposed to take it to a situation of lesser threat than the current one.

1) Determine if the Ethiopian golden eagle is a new subspecies, and if so, it will be formally described to the international scientific community in order to obtain the necessary funds to implement urgent conservation measures in order to avoid the imminent extinction of this new taxon at the subspecies level.

2) Annual monitoring of the breeding population. In addition to an annual monitoring of the known territories, it is recommended to carry out a comprehensive annual census in all the appropriate areas for your Bale Mountains presence, which allows to have updated and continuous information on the evolution of the population of and its conservation problems.

3) Perform an annual monitoring of the reproductive parameters of the known territories in order to detect the causes that limit the reproductive success of the population.

4) Conduct censuses of prey in the known territories, in order to determine their availability and detect the real causes that cause their decline, in order to implement urgent measures to try to recover the populations of prey species.

5) Minimize the disturbances of human origin, in this case, avoid intentional fires at the base of the nesting cliffs of the occupied territories.

6) Detect the causes of unnatural mortality that affects the population, especially cases of poisoning, with the aim of activating a series of actions to reduce them, delimiting the problem geographically by drawing up a map of risk areas, specifying the location of the known black spots and those that are detected.

7) To equip adult and juvenile individuals with satellite transmitters, in order to identify the demographic problems of the population, such as the causes of mortality, both for adults and juveniles and determine the different patterns of movement, especially of juvenile individuals, to determine their degree of phylopatry and connectivity with other populations.

According to our observations, at first sight, morphologically the Ethiopian golden eagle has a darker plumage and a tail proportionally longer than other subspecies.

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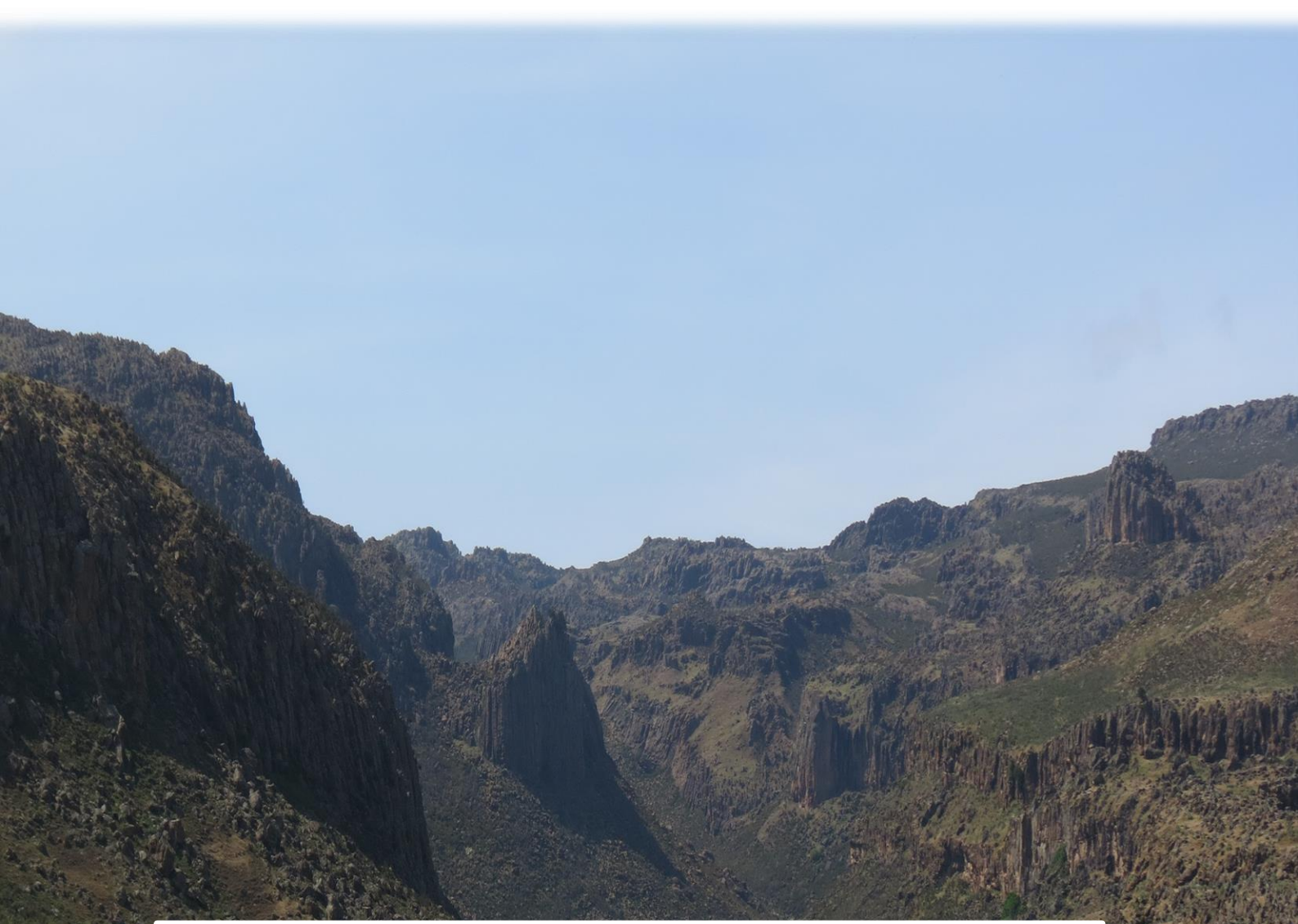
The protection of the last representatives of Ethiopian golden eagle and their habitat is essential and should be one of the priority missions of the authorities of the Bale Mountains National Park and the Ethiopian Wildlife Conservation Authority (EWCA).

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