



POTENTIAL SPECIES DISTRIBUTION MODELS CAN HELP IN THE CONSERVATION OF THREATENED SPECIES: THE CASE OF THE GUIGNA (*LEOPARDUS GUIGNA*) IN LOS ALERCES NATIONAL PARK, ARGENTINA

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ABSTRACT

The Guigna (*Leopardus guigna*) is a felid with one of the smallest geographical distributions. In Argentina, this species occurs in four national parks: Los Alerces National Park (LANP), Lago Puelo National Park, Nahuel Huapi National Park and Lanín National Park. However, because estimations suggest that, by 2050, human land use and climate change will negatively affect 40 per cent of its potential distribution, LANP is very important to the conservation of the species. With the aim to help the Argentine Administration of National Parks to define strategies to protect the Guigna, the present study aimed to: (1) map sightings reported in LANP over the last 45 years and determine the areas with confirmed presence and probable absence of Guignas, taking into account the possibility of observation in different areas of the park; (2) map the park's suitable habitats; and (3) map potentially optimal areas for the Guigna's conservation. The results identified four valleys as potentially optimal areas for the conservation of Guignas within LANP and another two as secondary suitable areas. The results also indicated that to maintain a healthy population of Guignas within LANP, the understorey structure of forest strips that connect the valleys should also be conserved, and that the main threat to this structure is the expansion of Wild Boars.

Key words: Andean forest, felids, invasive species impacts, Patagonia, conservation threats

INTRODUCTION

The Guigna (*Leopardus guigna*) (Felidae, Molina 1782), also known as Huiña or Chilean Cat, is the smallest felid in the American continent and is a species listed as Vulnerable and decreasing (IUCN, 2022). This species is endemic to Chile and Argentina and has one of the smallest geographical distributions of felids (Nowell & Jackson, 1996; Sunquist & Sunquist, 2002; 2009). In Chile, the Guigna inhabits the Valdivian forest and the Matorral, from the Andes to the Pacific coast, approximately from 30° S to 48° S, whereas in Argentina, it inhabits the area of the Patagonian Andean forest from 30° S to 44° S, in an area of less than 20,000 km² (Freer, 2004; Monteverde et al., 2019). In Chile, it is considered endangered (Acosta & Lucherini, 2008; Monteverde et al., 2019), because several human impacts such as deforestation, fragmentation, presence of farms, and forest plantations of exotic species affect its distributional range (Zuñiga et al., 2009). In addition, in agricultural areas of Chile, the Guigna is hunted and killed for being

a predator of poultry (Freer, 2004). In southern Chile, where human presence is low, the altitude and mountainous relief restrict the species' dispersion and population growth (Freer, 2004). As a consequence, in the disconnected valleys of these latitudes, where the species takes refuge, the Guigna's densities and home-range overlaps increase strongly (Freer, 2004). In Argentina, this species is considered vulnerable and the most important threat is climate change (Cuyckens et al., 2015).

Some studies suggest that the distribution of Guignas is almost exclusively restricted to native *Nothofagus* forests (Acosta-Jamett & Simonetti, 2004). However, Guigna faeces have been observed in *Pinus radiata* plantations (Zuñiga et al., 2009), and some studies have shown that this species is able to inhabit substantially modified habitats as long as they provide sufficient dense vegetation for shelter and to hunt small mammals and birds (Sanderson et al., 2002; Galvez et al., 2013; García et al., 2021). However, the Guigna becomes more

difficult to detect when domestic dogs are present in an area and its densities decrease as the human population increases (García et al., 2021). Similarly to that observed for many felids within reserves, Guignas prefer dense and structured habitats (Ludlow & Sunquist, 1987; Konecny, 1989; Libereck, 1996; Lombardi et al., 2020), probably because these habitats facilitate their predatory behaviour, concealment, and stalking behaviour (Sanderson et al., 2002; Freer, 2004). When Guignas inhabit preserved habitats and have the possibility to choose, they are found in forests, mainly in thickets, avoiding open areas (Freer, 2004).

Estimations suggest that, by 2050, 40 per cent of the potential distribution of Guignas will be negatively affected by human land use and climate change (Cuyckens et al., 2015). In Chile, the main human factors likely to be responsible are deforestation of Valdivian forests (1.86 per cent per year), the growth of large cities, most of them located in the Central Matorral, as well as hunting of Guignas outside of protected areas (Cuyckens et al., 2015). In Argentina, the main factors impacting populations of Guignas are declines in rainfall and the increase in evapotranspiration in the east that restrict its distribution (Cuyckens et al., 2015). Cuyckens et al. (2015) predict that, in Argentina, the most stable populations will be within Los Alerces National Park (LANP). However, there are no studies about the Guigna in LANP and there are no conservation projects for the species in Argentina (Lucherini et al., 2018). Thus, with the aim to help the Administration of National Parks of Argentina (APN) to define strategies to protect the Guigna, the present study aimed to:

1. Map the sightings reported in LANP over the last 45 years and determined the areas with confirmed presence and probable absence of the species, taking into account the possibility of observation in different areas of the park;
2. map suitable habitats; and
3. map potentially optimal areas for the conservation of Guignas within LANP.

METHODS

Study area

The study was carried out in LANP, located in Chubut Province, Argentina (Figure 1). This national park was designated as a World Heritage site by UNESCO (Ref. 1526), because it is vital for the protection of some of the last remaining areas of continuous Patagonian Forest that are in an almost pristine state and are the habitat for several endemic and threatened species of flora and fauna. Including both park and reserve areas, LANP covers 2,596 km² (Martin & Chehébar, 2001), of

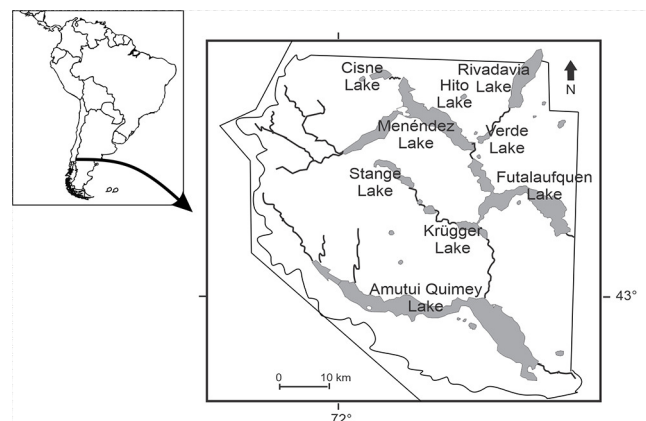


Figure 1. Location of Los Alerces National Park (LANP) and detailed map of the park showing the main lakes

which the park represents 1,973 km². In the park area, human activities are restricted to some tourism visits (Martin & Chehébar, 2001), whereas in the reserve area, some human activities such as livestock raising, tourism lodges and cabins are permitted (Martin & Chehébar, 2001).

Camera trap sampling

During our studies of seed dispersal and seed predation conducted in LANP between 2019 and 2021, we opportunistically collected camera trap records of Guignas. Our experimental stations were located at random in the forest near the following lakes: Amutui Quimey (2019, 2020 and 2021), Futalaufquen (2019, 2020, and 2021) and Verde (2021) (Figure 1). Seed dispersal and seed predation were monitored by using camera traps, totalling 16,488 trap hours. Cameras were also used to monitor the use by animals of trails closed to tourism during the autumn season (April–May). Cameras were located along three closed trails: Laguna Toro, near Amutui Quimey Lake (2020), Krugger, near Futalaufquen Lake (2021) and Alto el Petizo, near Verde Lake (2021), totalling 12,000 trap hours. To estimate the relative abundance of Guignas, records of vertebrates detected by our cameras at different locations were classified according to their frequency of detection per 100 trap/hours: low (less than 0.05 per 100 trap/hours records), medium (between 0.05 and 0.09 per 100 trap/hours) and high (0.1 or more per 100 trap/hours records).

Determination of suitable habitats and optimal areas

To determine suitable habitats, we classified areas within the park as suitable or unsuitable habitat for Guignas, based on published literature on habitat use by the species as outlined here. Native forest fragments connected by corridors within disturbed landscape are

considered suitable for the species (Sanderson et al., 2002; Galvez et al., 2013). Considering that Guignas avoid scrub, cleared areas, rocky areas and saltmarshes (Dunstone et al., 2002; Freer, 2004; Zuñiga et al., 2009), environments with these characteristics were considered unsuitable. Water bodies and areas with permanent snow and ice were also excluded (Dunstone et al., 2002). The remaining categories (all forests) were classified as suitable. We excluded unsuitable environments and joined environmental categories that were classified as suitable using Qgis 2.18 (Figure 2a).

Estimation of the presence and absence of Guignas

Records of Guignas were searched for in the Biodiversity Information System (BIS) of the APN, our records and the literature. The BIS was accessed on 31 January 2021. Records of the previous five years (2017–2021) were classified as recent, while earlier records were classified as historical. Historical records ranged only between 1978 and 2000 because we found no records of the species between 2000 and 2016. Qgis was used to map all the Guigna records and areas with higher human activity (tourist activities, dwellings of local residents, park rangers and our experiment locations), to define areas with intense use and those with higher probability of detection. To determine whether human activities in areas with no records of the Guigna are too intensive and incompatible with wild fauna, the BIS was also searched to map records of another two species: the Pudú (*Pudu puda*, Cervidae), which is especially sensitive to human presence, and the Puma (*Puma concolor*, Felidae), a felid species with several records in the park. We took into account only the observation of animals and no other presence indicators (e.g. faeces) because Guigna traces are difficult to detect or identify. The overlaying of information allowed us to define areas where the species is absent or has low probability of presence (suitable environment, no records of the Guigna, records of other species and higher human presence) and areas with confirmed presence of the species.

Areas with potentiality to support stable populations of Guignas were identified by looking for extensions of suitable habitats, preferentially forest with preserved understorey located at low elevations (Freer, 2004) with records of the Guigna or without records but without human presence. Considering that the Guigna avoids steep slopes (Freer, 2004), these were not considered based on an elevation map (APN, 2017). We then defined the optimal areas for the preservation of stable populations in LANP and classified them as having: 'highest relevance' (less than 10 km of forest strip

connecting the area with another) or 'secondary relevance' (more than 10 km of forest strip connecting the area with another).

RESULTS

Our cameras detected the presence of several native and exotic animals (Table 1). Guignas showed low frequency with recent records of the Guigna in areas where it had been historically reported, namely forests on the margins of the Rivadavia and Verde Lakes (Figure 2a). All records in locations that had not been reported

Table 1. Frequency of detection per 100 trap/hours of native and exotic species by camera trap in Los Alerces National Park, Chubut, Argentina. * Exotic species

| Species detected | Frequency of detection /100 trap hours | | |
|---------------------------------|--|--------------------------|---------------|
| | Low <0.05 | Medium 0.05 – 0.09 | High ≥ 0.1 |
| Mammals | | | |
| <i>Leopardus guigna</i> | X | | |
| <i>Oncifelis geoffroyi</i> | X | | |
| <i>Puma concolor</i> | | X | |
| <i>Lycalopex culpaeus</i> | | | X |
| <i>Conepatus humboldtii</i> | X | | |
| <i>Chaetophractus villosus</i> | X | | |
| <i>Pudu puda</i> | X | | |
| <i>Dromiciops gliroides</i> | X | | |
| Micro rodents | | | X |
| Bats | | | X |
| <i>Sus scrofa</i> * | | | X |
| <i>Cervus elaphus</i> * | X | | |
| Birds | | | |
| <i>Milvago chimango</i> | | | X |
| <i>Glaucidium nanum</i> | X | | |
| <i>Campephilus magellanicus</i> | X | | |
| <i>Aphrastura spinicauda</i> | | | X |
| <i>Pteroptochos tarnii</i> | X | | |
| <i>Schelorchilus rubecula</i> | | | X |
| <i>Elaenia albiceps</i> | | X | |
| <i>Turdus falcklandii</i> | | | X |
| <i>Phrygilus patagonicus</i> | | X | |

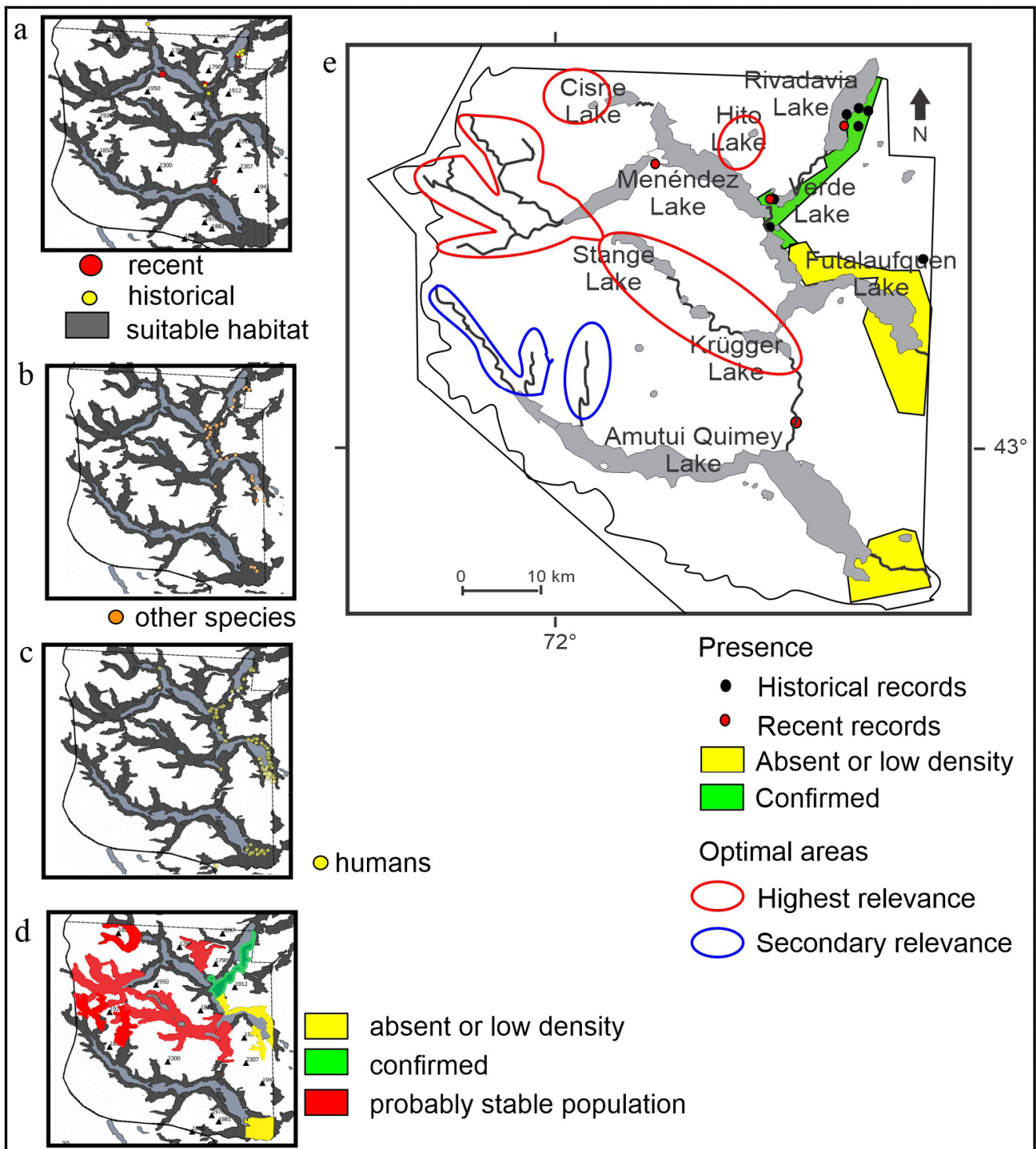


Figure 2. 2a. Map of suitable habitats defined by the authors, showing historical and recent records of the Guigna (*Leopardus guigna*) within LANP; 2b. Map showing records of other species (*Puma concolor* and *Pudu puda*) within LANP; 2c. Map showing the location of human presence and activity within LANP; 2d. Map of suitable habitats showing areas where the species is absent, areas where its presence is confirmed, and areas that might potentially support stable populations; 2e. Map of areas with confirmed presence, absence or presence at low densities of the Guigna, and optimal areas with highest or secondary relevance for the conservation of the Guigna as a result of information integration.

previously, such as forests on the margins of the Menéndez Lake and Frey River, were sites without human activities. Guigna were recorded in both the more strictly protected park area as well as in reserve areas (west coast of lakes).

All records of the Guigna were within the suitable habitat as defined in the literature (Figure 2a). A GIS overlay of records of the Guigna (Figure 2a), other species (Figure 2b) and human presence (Figure 2c) allowed us to determine areas where the Guigna might be absent or at very low densities, areas where the presence was confirmed, and areas with potential to support stable populations (Figure 2d).

Areas where the Guigna was absent or at very low densities were: the west coast and part of the east coast of Futalaufquen Lake, and the area near the Futaleufú dam, whereas areas where the presence of Guignas was confirmed were: the east coast and part of the west coast of the Rivadavia and Verde Lakes (Figure 2e). In addition, we predicted four optimal areas for the conservation of a healthy Guigna population in LANP: the valleys at the end of the south branch of Menéndez Lake, totalling 13,000 ha and connected directly to the valleys of Stange and Krugger Lakes, totalling 23,000 ha, the valley of Cisne Lake, totalling 6,500 ha within the park and less than 2,000 ha outside the park, and the valley of Hito Lake, totalling 4,000 ha (Figure 2e). A further two areas with optimal potential (7,000 and 4,000 ha respectively) were identified in the south of the park but classified as secondary because they had

the lowest connectivity to other suitable habitats (Figure 2e). All the valleys are connected by a suitable habitat strip of 1,000 to 2,000 m in width that surrounds lakes and rivers (Figure 2e). Recent records confirmed the presence of the species in this strip of suitable habitat (Figure 2e).

DISCUSSION

Both historical and recent records were located within the suitable habitats defined by us, which allowed validating our map. Characteristics of spatial use defined by Freer (2004) at the same latitude but on the other side of the Andes, in Chile, allowed us to define some valleys as optimal areas for the Guigna within LANP. In addition, studies on populations of the Guigna in Chile also highlight the importance of forest strips to connect populations because the species rarely uses open areas (Galvez et al., 2013; García et al., 2021). The Guigna avoids elevated areas, and mountains represent barriers to dispersion (Freer, 2004). As a consequence, the preservation of forest strips along the margins of lakes and rivers that connect the valleys in our study area will be very important to preserve a healthy, connected population. This is very important as, according to models that take climate change into account, the Guigna population of LANP is the most stable in Argentina (Cuyckens et al., 2015).

Despite the lack of historical records of the Guigna in valleys, recent records in the forest strips that connect them suggest that the Guigna is indeed present in valleys. The lack of presence data in areas considered



Menéndez Lake © Victor Cueto

optimal are likely a consequence of the difficult access and restrictions on human activities (Martin & Chehébar, 2001). Only some sporadic scientific research is permitted in these valleys, which constitute a great part of the suitable habitats. Only one project searched specifically for the Guigna inside the park, near Villa Futalaufquen (at the southernmost point of Futalaufquen Lake). In this project, the researchers worked during one summer (110 trap-days) and located only one Guigna (Lucherini et al., 2001; Lucherinni & Luengo Vidal, 2003). The three most recent records of the Guigna were in the context of scientific research not related to the species and it was the first time that vision traps (Gerisoli et al., 2020) and cameras were located in these areas (our study). This shows the importance of allowing, promoting and supporting the presence of researchers in the park even if they are working on issues other than identified reserve priorities.

Considering that Guignas are strongly associated with dense and structured habitats such as well conserved *Nothofagus dombeyi* forests (Sanderson et al., 2002; Freer 2004), the preservation of the forest as well as of the density and complexity of the understorey in both valleys and strips is vital. The fact that recent records of the Guigna were located in the forest strips suggests that, at present, these habitats have an appropriate structure. However, the cover and diversity of the understorey of Patagonian forest can be decreased by the expansion of introduced exotic ungulates such as domestic cows (*Bos taurus*), Red Deer (*Cervus elaphus*) and Wild Boar (*Sus scrofa*) (Relva et al., 2010; Piazza et al., 2016; Panebianco et al., 2019). In LANP, livestock is not a significant problem because populations are controlled and restricted to reserve areas. In addition, many of the Guigna records were in the area where livestock are allowed, indicating that the management of livestock within the park is probably compatible with the Guigna. However, in 2019, the presence of a small population of around 30 feral cattle were detected in the area of Stange Lake (APN, 2019), a fact that could represent a problem.

In relation to Red Deer (*Cervus elaphus*), male and female deer were detected by our cameras, only in the south part of LANP during autumn and winter. In addition, according to BIS (2021), a male deer was observed in the same area in 2011. According to the National Park personnel, this record was considered as a breeding dispersal individual, because several males disperse up to 18.5 km before the breeding season (Jarnemo, 2011) and because there is a deer hunting area less than 40 km from the park and individuals have been seen outside this area and in ranches next to the



Guigna (*Leopardus guigna*) with lizard © Jim Sanderson

park on several occasions. Our detection of male and female deer confirms the presence of Red Deer in the south part of the park and highlights the relevance of controlling their numbers because the Guigna has been recently recorded in the area.

Finally, regarding Wild Boar, our cameras recorded groups of boars or solitary individuals in all the experiments and areas monitored. This confirms that boars are entering the park and are abundant in some areas where the Guigna has been historically recorded. In LANP, the movement of boars is partially restricted by the spatial pattern of roads, paths and cleared areas for public use because all these impacts are in the east area of the park where they initially dispersed (Panebianco et al., 2019). This situation suggests an apparent preference of boars for less humid eastern habitats (Panebianco et al., 2019) rather than more humid areas, which are optimal habitats for the Guigna. In fact, in the western areas defined as optimal for the Guigna, boars are absent (Schiaffini & Vila, 2012; Panebianco et al., 2019). However, the maximum potential densities of Wild Boars have not been reached yet (Sanguinetti & Pastore, 2016). In protected areas where boars have been present for longer and the pattern of roads, paths and cleared areas has helped in their dispersion, boars show preference for humid western habitats (Pescador et al., 2009; Gantchoff et al.,

2013; Gantchoff & Belant, 2015). Therefore, it will be important to maintain the characteristics that restrict the expansion of boars within LANP, for example, the access to western areas only by water and the closed structure of the forest. Finally, we consider that special attention should be paid to intentional fires common in the last decades in LANP (a cultural practice of human populations in Patagonia) because they open the habitat and help the dispersion of boars, at least temporally (Seijo et al., 2020).

To prevent potentially indirect effects of the expansion of exotic ungulates on the potentially most stable Guigna population in Argentina, it will be important to take actions to avoid the arrival, dispersion, and population increase of exotic ungulates in the priority areas defined for Guigna conservation. The present study allowed determining the potentially best areas for the conservation of the Guigna in Argentina and highlights some characteristics of the environment that should be conserved, namely the connection of valleys mediated by forest strips along the margins of lakes and rivers. The prediction of the distribution and habitat use of target species is an important preliminary step to plan conservation actions and management strategies of protected areas (Walker et al., 2000; Manel et al., 2001; Guisan et al., 2013). As recommended by Guisan et al. (2013), we also present recommendations considering social land use and potential threats such as the expansion of exotic ungulates.

CONCLUSIONS

Opportunistic records of the Guigna allowed the identification of four areas with high potential for conservation of stable populations of the species within Los Alerces National Park in Argentine Patagonia and the relevance of forest strips along waterbodies for the maintenance of connectivity. Integration of data also showed the relevance of managing the expansion of exotic ungulates in the park to prevent a change in the understorey structure.

ACKNOWLEDGEMENTS

We thank the Administration of National Parks of Argentina for authorising our studies in the area, especially Park Rangers Pedro Cenoz and Laura Fenoglio. We also thank the journal editor and the anonymous reviewers for suggested improvements to earlier versions of the manuscript, and Dr Jim Sanderson and Dr Victor Cueto for photos. This project was partially supported by the National Agency for Scientific and Technological Promotion of Argentina (PICT 948).

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REFERENCES

- Acosta, G. and Lucherini, M. (2008). *Leopardus guigna*. The IUCN Red List of Threatened Species 2008: e.T15311A4512594. Downloaded on 15 April 2021.
- Acosta-Jamett, G. and Simonetti, J.A. (2004). Habitat use by *Oncifelis guigna* and *Pseudalopex culpaeus* in a fragmented forest landscape in central Chile. *Biodiversity and Conservation* 13: 1135–1151. <https://doi.org/10.1023/B:BIOC.0000018297.93657.7d>
- APN (2019). *Plan de gestión del Parque Nacional Los Alerces 2019-2029*. Bariloche, Argentina: Administración de Parques Nacionales.
- Cabrera, A. (1971). Fitogeografía de la República Argentina. *Boletín Sociedad Argentina de Botánica* 1: 1–42.
- Cuyckens, G.A., Morales, M.M. and Tognelli, M.F. (2015). Assessing the distribution of a Vulnerable felid species: threats from human land use and climate change to the Kodkod *Leopardus guigna*. *Oryx* 49: 611–618. <https://doi.org/10.1017/S003060531300135X>
- Dunstone, N., Durbin, L., Wyllie, I., Freer, R. Jamett, G.A., Mazzoli, M. and Rose, S. (2002). Spatial organization, ranging behavior and habitat use of the Kodkod (*Oncifelis guigna*) in southern Chile. *Journal of Zoology of London* 257: 1–11. <https://doi.org/10.1017/S0952836902000602a>
- Freer, R.A. (2004). 'The spatial ecology of the Guina (*Oncifelis guigna*) in Southern Chile'. PhD Thesis. Durham: Durham University.
- Gálvez, N., Hernández, F., Laker, J., Gilabert, H., Petitpas, R., Bonacic, C., Gimona, A., Hester, A. and MacDonald, D.W. (2013). Forest cover outside protected areas plays an important role in the conservation of the Vulnerable Guigna *Leopardus guigna*. *Oryx* 47: 251–258. <https://doi.org/10.1017/S0030605312000099>
- Gantchoff, M.G. and Belant, J.L. (2015). Anthropogenic and environmental effects on invasive mammal distribution in northern Patagonia, Argentina. *Mammalian Biology* 80: 54–58. <https://doi.org/10.1016/j.mambio.2014.10.001>
- Gantchoff, M.G., Belant, J.L. and Masson, D.A. (2013). Occurrence of invasive mammals in southern Nahuel Huapi National Park. *Studies on Neotropical Fauna and Environment* 48: 175–182. <https://doi.org/10.1080/01650521.2013.875245>

- García, C., Svenson, G.L., Bravo, C., Undurraga, M.I., Díaz-Forestier, J.A., Godoy, K., Neaman, A., Barbosa, O., Abades, S. and Celis-Diez, J. (2021). Remnants of native forests support carnivore diversity in the vineyard landscapes of central Chile. *Oryx* 55: 227–234. <https://doi.org/10.1017/s0030605319000152>
- Gerisoli, M.M., Schiaffini, M.I. and Bauer, G. (2020). Updating records of a threatened felid species of the Argentinian Patagonia: the Guigna *Leopardus guigna* (Molina, 1782) (Mammalia: Carnivora: Felidae) in Los Alerces National Park. *Journal of Threatened Taxa* 12: 17252–17257. <https://doi.org/10.11609/jott.6208.12.16.17252-17257>
- Guisan, A., Tingley, R., Baumgartner, J.B., Naujokaitis-Lewis, I., Sutcliffe, P.R., Tulloch, A.I.T., et al. (2013). Predicting species distributions for conservation decisions. *Ecology Letters* 16: 1424–1435. <https://doi.org/10.1111/ele.12189>
- IUCN (2022). Red List of Threatened Species. <https://www.iucnredlist.org/search?query=Leopardus%20guigna&searchType=species> (Accessed 4 April 2022).
- Jarnemo, A. (2011). Male red deer (*Cervus elaphus*) dispersal during the breeding season. *Journal of Ethology* 29: 329–336. <https://doi.org/10.1007/s10164-010-0262-9>
- Kitzberger, T., Veblen, T.T. and Villalba, Y.R. (1995). Tectonic influences on tree growth in northern Patagonia, Argentina: the roles of substrate stability and climatic variation. *Canadian Journal of Forest Research* 25:1684–1696. <https://doi.org/10.1139/x95-182>
- Kitzberger, T., Veblen, T.T. and Villalba, Y.R. (1997). Climatic influences on fire regimes along a rain forest-to-xeric woodland gradient in northern Patagonia, Argentina. *Journal of Biogeography* 24: 35–47. <https://doi.org/10.1111/j.1365-2699.1997.tb00048.x>
- Konecny, M.J. (1989). 'Movement patterns and food habits of four sympatric carnivore species in Belize, Central America'. In: K.H. Redford and J.F. Eisenberg (eds.) *Advances in Neotropical Mammalogy*, pp. 243–264. Gainesville, Florida: Sandhill Crane Press.
- Liberek, M. (1996). Radiotracking the wildcat in Switzerland. *Cat News* 25: 18–19.
- Lombardi, J.V., Tewes, M.E., Perotto-Baldivieso, H.L., Mata J.M. and Campbell, T.A. (2020). Spatial structure of woody cover affects habitat use patterns of ocelots in Texas. *Mammal Research* 65: 555–563. <https://doi.org/10.1007/s13364-020-00501-2>
- Lucherini, M. and Luengo Vidal, E. (2003) Intraguild competition as a potential factor affecting the conservation of two endangered cats in Argentina. *Endangered Species Update*, 20: 211.
- Lucherini, M., Vidal, E.L. and Beldomenico, P. (2001). First record of sympatry of Güiña and Geoffroy's cat. *Cat News* 35: 20–21.
- Lucherini, M., Reppucci, J.I., Soler, L., González, A., González Ciccía, P., Palacios, R., Pereira, J. A. and Zapata, S. (2018) Analyzing efforts for the conservation of the terrestrial carnivores of Argentina. *Gayana* 82: 105–117. <https://doi.org/10.4067/s0717-65382018000200105>
- Ludlow, M.E. and Sunquist, M.E. (1987). Ecology and behaviour of ocelots in Venezuela. *National Geographic Research* 3: 447–461.
- Manel, S., Williams, H.C. and Ormerod, S.J. (2001). Evaluating presence-absence models in ecology: the need to account for prevalence. *Journal of Applied Ecology* 38: 921–931. <https://doi.org/10.1046/j.1365-2664.2001.00647.x>
- Martín, C. and Chehébar, C. (2001). The national parks of Argentinian Patagonia – management policies for conservation, public use, rural settlements, and indigenous communities. *Journal of the Royal Society of New Zealand* 31 (4): 845–864. <https://doi.org/10.1080/03014223.2001.9517680>
- Molina, G.I. (1782). 'La Guigna *Felis guigna*'. In: *Saggio sulla storia naturale de Chili*, p. 295. Stamperia di S. Tommaso d'Aquino, Bologna, Italy, 367pp. <https://doi.org/10.5962/bhl.title.62689>
- Monteverde, M., Morales, M.M., Cuyckens, E. and Lucherini, M. (2019). '*Leopardus guigna*'. In: Secretaría de Ambiente y Desarrollo Sustentable de la Nación y Sociedad Argentina para el Estudio de los Mamíferos (eds.). *Categorización 2019 de los mamíferos de Argentina según su riesgo de extinción. Lista Roja de los mamíferos de Argentina*. Ministerio de Ambiente y Desarrollo Sostenible Argentina, Sociedad Argentina para el Estudio de los Mamíferos. Electronic version at <https://cma.sarem.org.ar/es/especie-nativa/leopardus-guigna> (accessed on 1 April 2021).
- Nowell, K. and Jackson, P. (1996). 'Kodkod *Oncifelis guigna* (Molina, 1782)'. In: *Wild Cats: Status Survey and Conservation Action Plan*, pp. 115–116. Gland, Switzerland and Cambridge, UK: IUCN.
- Panebianco, A., Bó, R.F., Gregorio, P.F. and Vila, A. (2019). Macro and microhabitat patterns of habitat use and selection by wild boar in Los Alerces National Park. *Mastozoología Neotropical* 26: 143–154. <https://doi.org/10.31687/sarem.19.26.1.0.07>
- Pescador, M., Sanguinetti, J., Pastore, H. and Peris, S. (2009). Expansion of the introduced wild boar (*Sus scrofa*) in the Andean region, Argentinean Patagonia. *Galemys* 21: 121–132.
- Piazza, M.V., Garibaldi, L.A., Kitzberger, T. and Chaneton, E.J. (2016). Impact of introduced herbivores on understory vegetation along a regional moisture gradient in Patagonian beech forests. *Forest Ecology and Management* 366: 11–22. <https://doi.org/10.1016/j.foreco.2016.01.035>
- Relva, M.A., Nuñez, M. and Simberloff, D. (2010). Introduced deer reduce native plant cover and facilitate invasion of non-native tree species: evidence for invasional meltdown. *Biological Invasions* 12: 303–311. <https://doi.org/10.1007/s10530-009-9623-0>
- Sanderson, J., Sunquist, M.E. and Iriarte, A.W. (2002). Natural history and landscape-use of Guignas (*Oncifelis guigna*) on isla grande de Chiloé, Chile. *Journal of Mammalogy* 83: 608–613. [https://doi.org/10.1644/1545-1542\(2002\)083<0608:NHALUO>2.0.CO;2](https://doi.org/10.1644/1545-1542(2002)083<0608:NHALUO>2.0.CO;2)
- Schiaffini, M.I., and Vila, A.R. (2012). Habitat use of the wild boar, *Sus scrofa* Linnaeus 1758, in Los Alerces National Park, Argentina. *Studies on Neotropical Fauna and Environment* 47: 11–17. <https://doi.org/10.1080/01650521.2012.657916>
- Seijo, F., Godoy, M.M., Guglielmin, D., Ciampoli, C. Ebright, S., Picco, O. and Defosse, G. (2020). Conflicting frames about ownership and land use drive wildfire ignitions in a protected conservation area. *Environmental Management* 65(4): 448–462. <https://doi.org/10.1007/s00267-020-01265-w>
- SIB (2021). 'Parque Nacional Los Alerces'. In: Sistema de Información de Biodiversidad de la Administración de Parques Nacionales, Argentina. Electronic version at <https://sib.gob.ar/>

- index.html#/area-prottegida/parque-nacional-los-alerces (accessed on 11 March 2021).
- Sunquist, M.E. and Sunquist, F. (2002). 'Kodkod *Oncifelis guigna* (Molina, 1782)'. In: *Wild Cats of the World*, pp. 211–214. Chicago, Illinois: University of Chicago Press. <https://doi.org/10.7208/chicago/9780226518237.001.0001>
- Sunquist, M.E. and Sunquist, F.C. (2009). 'Family Felidae'. In: D.E. Wilson and A. Mittermeier (eds.). *Handbook of the mammals of the world. 1. Carnivores*, pp. 54–168. Barcelona: Lynx Editions. <https://doi.org/10.1007/bf03193176>
- Tecklin, D., DellaSala, D.A., Luebert, F. and Pliscoff, P. (2011). 'Valdivian temperate rainforests of Chile and Argentina'. In: D.A. DellaSala (ed.) *Temperate and boreal rainforests of the world: ecology and conservation*, pp. 132–153. Washington, DC: Island Press. 298pp. https://doi.org/10.5822/978-1-61091-008-8_5
- Veblen, T.T., Kitzberger, T. and Lara, A. (1992). Disturbance and forest dynamics along a transect from Andean rainforest to Patagonian shrubland. *Journal of Vegetation Science* 3: 507–520.
- Walker, R.S., Novaro, A. and Nichols, J.D. (2000). Consideraciones para la estimación de abundancia de poblaciones de mamíferos. *Mastozoología Neotropical* 7: 73–80.
- Zúñiga, A., Muñoz-Pedrerros, A. and Fierro, A. (2009). Habitat use of four terrestrial carnivores in Southern Chile. *Gayana* 73: 41–51. <https://doi.org/10.4067/s0717-65382009000200004>

RESUMEN

Guigna (*Leopardus guigna*) es un felino con una de las distribuciones geográficas más reducidas. En Argentina, esta especie se encuentra en cuatro parques nacionales: Parque Nacional Los Alerces (PNLA), Parque Nacional Lago Puelo, Parque Nacional Nahuel Huapi y Parque Nacional Lanín. Sin embargo, dado que las estimaciones sugieren que, para 2050, el uso humano de la tierra y el cambio climático afectarán negativamente al 40 por ciento de su distribución potencial, el PNLA cobra relevancia para la conservación de la especie. Con el objetivo de ayudar a la Administración de Parques Nacionales de Argentina a definir estrategias para proteger a la Guigna, el presente estudio se propuso: (1) mapear los avistamientos reportados en el PNLA durante los últimos 45 años y determinar las áreas con presencia confirmada y ausencia probable de Guignas, y considerando la posibilidad de observación determinar; (2) mapear los hábitats adecuados del parque; y (3) mapear las áreas potencialmente óptimas para la conservación de la Guigna. Los resultados identificaron cuatro valles como áreas potencialmente óptimas para la conservación de las Guignas dentro del PNLA y otras dos áreas adecuadas como secundarias. Los resultados también indicaron que para mantener una población saludable de Guignas dentro del PNLA, la estructura del sotobosque de las franjas forestales que conectan los valles también debe ser conservada, y que la principal amenaza para esta estructura sería la expansión de los Jabalíes.

RÉSUMÉ

Guigna (*Leopardus guigna*) est un félin dont la répartition géographique est l'une des plus restreintes. En Argentine, cette espèce est présente dans quatre parcs nationaux : le parc national Los Alerces (PNLA), le parc national Lago Puelo, le parc national Nahuel Huapi et le parc national Lanín. Cependant, étant donné que les estimations suggèrent que, d'ici 2050, l'utilisation des terres par les êtres humains et le changement climatique affecteront négativement 40 % de sa répartition potentielle, le PNLA est très important pour la conservation de l'espèce. Dans le but d'aider l'administration argentine des parcs nationaux à définir des stratégies de protection du Guigna, la présente étude vise à : (1) cartographier les observations rapportées dans le PNLA au cours des 45 dernières années et déterminer les zones de présence confirmée et d'absence probable de Guignas, en tenant compte de la possibilité d'observation dans différentes zones du parc ; (2) cartographier les habitats appropriés du parc ; et (3) cartographier les zones potentiellement optimales pour la conservation du Guigna. Les résultats ont identifié quatre vallées comme des zones potentiellement optimales pour la conservation des Guignas au sein du PNLA et deux autres comme des zones secondaires appropriées. Les résultats ont également indiqué que pour maintenir une population saine de Guignas au sein du PNLA, la structure du sous-étage des bandes forestières qui relient les vallées devrait également être conservée, et que la principale menace pour cette structure est l'expansion des sangliers sauvages.