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INCREASE IN THE NUMBER OF PAIRS IN A SOUTH AMERICAN PEREGRINE FALCON (*Falco peregrinus cassini*) BREEDING POPULATION OF NORTHERN PATAGONIA, ARGENTINA

Aumento en el número de parejas en una población reproductiva de halcones peregrinos sudamericanos (Falco peregrinus cassini) *del norte de la Patagonia, Argentina.*

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Abstract. In the present study we provide information about two breeding seasons (2020 and 2022) for a South American Peregrine Falcon (*Falco peregrinus cassini*) population studied since 2010 at the seacoasts of northern Patagonia, Argentina. In both seasons 13 territorial pairs were detected along 29 km of sea-cliffs (1 pair/2.23km) of which twelve were active and ultimately successful (1 pair/2.42 km). Average distances between nests were 2.64 km in 2020 and 2.44 km in 2022. Before 2020, and over five seasons, this population had shown breeding stability, ranging from 8 to 9 active pairs. We presume that two outstanding events that took place during 2020, the Covid19 pandemic lock down as well as an intense La Niña climatic phase were phenomena that, acting independently or jointly, may have been behind the increase in the number of breeding pairs.

Keywords. Covid-19 pandemic, breeding performance, La Niña, Patagonia, raptor demography, raptor abundance.

Resumen. En el presente trabajo se aporta información de dos temporadas reproductivas (2020 y 2022) para una población de Halcón Peregrino Sudamericano (*Falco peregrinus cassini*) que, desde 2010, es estudiada en el litoral marítimo de Patagonia Norte, Argentina. En ambas temporadas, a largo de 29 km de acantilados marinos se hallaron 13 parejas territoriales (1 cada 2,23 km) de las cuales doce resultaron exitosas (1 cada 2,42 km). La distancia promedio entre nidos fue de 2,64 km en 2020 y de 2,44 km en 2022. Previo a 2020, y por cinco temporadas, esta población mostró estabilidad reproductiva, oscilando entre 8 y 9 parejas. Se presume que dos destacables eventos que tuvieron lugar en 2020, como ser el confinamiento por la pandemia Covid19 y una fase intensa de La Niña fueron fenómenos que, actuando de manera independiente o conjunta, pudieron haber tenido relación con el aumento en el número de parejas reproductivas observado.

Palabras clave. Pandemia de COVID-19, éxito reproductivo, La Niña, Patagonia, demografía de rapaces, abundancia de rapaces.

INTRODUCTION

The Peregrine Falcon (*Falco peregrinus*) is a territorial raptor species (Cramp and Simmons, 1980, Cade, 1982) with a cosmopolitan distribution (Ratcliffe, 1980, Weick and Brown, 1980) that breeds at highly variable densities around the world (White *et al.*, 2013). Raptor breeding densities are mainly determined by food and nest site availability but other factors, such as interspecific interactions and anthropogenic pressure may also play a role (Nelson and Myers, 1976, Newton, 1979, Poole, 1989, Tapia and Zuberogoitia, 2018). The Peregrine Falcon, being an specialized avian predator, and thus having more stable food supplies than other raptors that depend on cyclic prey, shows high stability in breeding populations (Hickey and Anderson, 1969, Ratcliffe, 1980, Pruett-Jones *et al.*, 1981, Cade, 1982).

Being an apex predator, it plays an important role as a bioindicator of toxicity because of its accumulating power for persistent and lipophilic compounds. During the past century its northern hemisphere populations suffered crashes because organochlorine pesticides, which accumulated in their prey, caused eggshell thinning and an extensive breeding failure (Ratcliffe, 1980, Swarz *et al.*, 2016). Although Peregrine Falcon populations have recovered (Cade, 1985, Fish and Wildlife Service, 1999), they continue being affected by direct human disturbance, weather conditions (lastly derived from climatic change), encroachment of development and several contaminants such as mercury and flame retardants (Bradley *et al.*, 1997, Fernie *et al.*, 2017, Barnes *et al.*, 2018, Carlson *et al.*, 2018). The past sharp population decline of the Peregrine Falcon explains why this is the raptor species with the highest number of reproductive monitoring programs on a global scale. In Europe alone, there are more than thirty programs in 21 countries (Derlink *et al.*, 2018). In South America, the situation is very different, with a lack of current information about the status of the only resident subspecies (*F.p. cassini*; Sharpe, 1873). No national monitoring programs are being carried out in any South American countries to estimate numbers, population trends, and potential threats. Intensive surveys at regional or local scales are also not being conducted, except for the one conducted by us, in the framework of the project "Aves de presa del nordeste Patagónico" (Birds of prey of northeastern Patagonia) and one study that is taking place in Santa Cruz province (M. Saggese *pers com*).

Our project began in 2010 with the finding of a Peregrine Falcon's breeding population on the maritime coast of the northernmost Patagonia. Since 2013, we conducted population studies to gather information about pair numbers, reproductive performance, breeding phenology, nest site characteristics, and interactions with Burrowing Parrots (*Cyanoliseus patagonus*) and other raptor species (De Lucca, 2013, 2014, 2016, 2017, 2023 De Lucca *et al.*, 2015). Throughout all these breeding seasons, the Peregrine Falcon breeding numbers remained stable.

In this article, we present the results of the monitoring of this population carried out in 2020 and 2022 breeding seasons where an increase in the number of pairs was recorded.

MATERIAL AND METHODS

The Peregrine Falcon population we studied distributes along the maritime coast of northern Patagonia, Adolfo Alsina County, Río Negro Province, Argentina. The study area is within the Monte phytogeographic province (Cabrera, 1971,

Burkart *et al.,* 1999). It has a semi-arid climate with annual precipitation of 200-350 mm and average temperatures of 15°C (Bran *et al.,* 2000). Dry and cold winds, predominantly from the north and west, occur more frequently between March and September (Giaccardi and Reyes, 2012). The main human activities in the study area are related to recreational tourism activities carried out in El Cóndor resort and the beaches: Bajada del Faro - Picoto, El Espigón, Playa Bonita, and Lobería. It is worth noting that the largest parrot colony on the planet, consisting of about 37.000 pairs of *C. patagonus*, occupies about 12 kilometers of coastline in the study area (Masello and Quillfeldt, 2007, 2012). This is to highlight as parrots seem to be the main *F. peregrinus* prey in the study area (author's observations). During the 2020-2021 and 2022-2023 breeding seasons, we surveyed Peregrine Falcon breeding territories along coastal cliffs. We conducted surveys of 29 km of coastline, with the eastern end located at the Faro Rio Negro (a lighthouse) in "El Cóndor" maritime village (41°03′28′′S; 62°50′20′′W), and the western end at the visitor center of the Punta Bermeja Protected Natural Area (41°09′23′′S; 63°09′25′′W). This transect line, interrupted only by four artificial accesses to the beach, includes the Area of Importance for the Conservation of Birds (AICA) El Cóndor Maritime Village (Masello and Quillfeldt, 2007) and the Punta Bermeja Protected Natural Area.

In both breeding seasons, we started the survey in early November (as in previous years), at a time when the chicks of the more advanced pairs are completing the nestling period. This allowed us know the average number of chicks raised per successful pair (average brood size) and the total number of chicks produced by the population. We conducted surveys from the beach during low tides on foot. When we found a territorial pair, an active pair (i.e., pair incubating or with chicks), or a successful one (i.e., at least one chick raised of around 30 days old), we georeferenced the nest location using a Global Positioning System device (GPS Garmin). Occasionally, we used all-terrain vehicles (quads) to recheck nests from the beach. We also surveyed territories on foot from the top of the cliffs. The distances between nesting pairs (i.e., distance from one pair to the next in a series, *sensu* Newton, 1979) were measured using GPS device. We use the average distance between active nests as a measure of density and of distribution of pairs along the transect (Newton, 1979). Following our previous studies, we expressed the chick production as number of chicks/ km of coastline. We visited nesting sites the number of times that were necessary to determine their success and brood size. We observed nests using 8x40 binoculars. We also made photographic records using a Canon Powershot SX60HS camera.

The following issues are addressed: 1) during the breeding seasons of 2013, 2014, and 2015, the surveys covered 40 km of cliff coastline (De Lucca, 2014, 2017, De Lucca *et al.,* 2015). However, for logistic reasons, we shortened that distance to 29 km during seasons of 2017,18,19,20,22 (De Lucca, 2023, this study); 2) to avoid introducing methodological bias, we did not include the results of the 2013 breeding season were we employed only quads to search for nesting sites in part of the transect; 3) in order to compare the number of breeding pairs and reproductive performances between seasons, we reanalyzed results obtained in 2014 and 2015 breeding seasons (Table 1) ; 4) during the 2020 breeding season, due to pandemic restrictions, the last two kilometers of the transect (restricted access area of the Punta Bermeja Natural Protected Area) could not be surveyed as required to accurately determine the number of successfully raised chicks by the two pairs present there.

RESULTS

During breeding season 2020, we located 13 territorial pairs, of which 12 were active and successful pairs (1 territorial pair per 2.23 km of coastline, and 1 pair active/successful per 2.42 km). The average distance between nests was of 2.64 km (SD: 1.59, range = 0.57 - 6.41 km; N: 11).

During the breeding season, of 2022, we again observed 13 territorial pairs and 12 active/ successful pairs (Table 1). The average distance between nests was 2.44 km (SD: 1.75: range: 0.45 - 7.47 km; N: 11) slightly lower compared to the breeding season 2020, but notoriously lower that past breeding seasons (Table 1).

During the 2020 breeding season, we could not determine the total number of chicks produced by the population due to that we couldn't t determine the number of chicks raised by the two pairs nesting in the westernmost sector of the transect (it was observed that each of the two mentioned pairs at least raised one fledgling). Among the remaining 10 successful pairs, the average brood size per successful pair was 2.5. One pair successfully raised four chicks, four pairs raised three each, four pairs raised two each, and one pair raised one chick. We could not precisely establish the total number of chicks successfully raised by the population, but it was at least 27.

During 2022, the average brood size for the 12 successful pairs was 2.92. Four pairs successfully raised four chicks each, three pairs raised three each, and the remaining five pairs raised two each. The total number of chicks successfully raised by the population was 35, equivalent to one per 0.83 km of transect.

DISCUSSION

Our results show an increase in the number of active pairs in relation to previous seasons that range from 33,33% to 50%, depending on the compared seasons (Table 1).

The increase in the number of breeding pairs in the last two breeding seasons did not negatively affect the reproductive performance of the South American Peregrine Falcon population. On the contrary, in 2022 there was an increase in the average brood size, which reached the highest value of all monitored seasons. Consequently, the number of chicks produced was very high, increasing by 150% compared to the lowest value observed in 2014 and by 40% to 100% compared to the rest of the breeding seasons before 2020 (Table 1). In view of the previous results of the breeding seasons before 2020, which indicated population stability (De Lucca, 2023), it was assumed that the number of active pairs in the study area would not increase and would remain between eight and nine (Table 1). The results of the present study clearly showed that the area could support an even higher number of pairs and produce a greater number of chicks/fledglings (Table 1-Figure1).

The increases observed in in 2020 and 2022, resulting in around one pair every two kilometers of coastline, places this Patagonian population among one of the most dense in breeding pairs. On a global scale populations with very high breeding numbers have been recorded on marine coasts in Kent, England, where nine pairs were found along 17,5 km of cliffs (1 pair every 1,94 km) (Ratcliffe, 1993), on the Hokkaido Peninsula, Japan, with six pairs in 10 km of coastline (1 pair every 1,67 km) (White *et al.,* 2013), on an island in Tunisia with 10 and 12 pairs nesting on 9,5 km of coast (Thiollay, 1988), in Catalonia, Spain, with an average distance between nests of 2,3 km (Zuberogoitia *et al..* 2002), and the most well-known case ("one celebrated example of high breeding density" *sensu* White *et al.,* 2013), the population of Langara Islands, Canada, where around one

Figure 1- South American Peregrine (*Falco peregrinus*) pairs with nestlings at seacoast cliffs of Río Negro province, northern Patagonia, Argentina. Photos by Eduardo De Lucca.

pair every 1,5 – 2,4 km of seacoast were recorded (Beebe, 1960).

We ignore what caused the increase in the number of Peregrine Falcon breeding pairs during the last years in our study site. However, two presumed factors could have acted alone or in combination: the lockdown due to the COVID-19 pandemic and the climatic phenomena of La Niña. These were two evident events that took place starting in 2020.

The COVID-19 pandemic lockdown caused a global pause in human activities (COVID-19 anthropause; Rutz *et al.,* 2020), which modified bird ecology, including raptors. Some effects were changes in population demographics, physiology, feeding behavior, and mortality rate (see Sumasgutner *et al.,* 2021). In our study area, tourism activity is intense on weekends, and daily from December to March. Thus, the human disturbance reduction during the eight-month lockdown from March to December 2020 may have benefited South American Peregrine Falcon breeding performance. For example, the absence of humans could have facilitated the settlement of new pairs or prevented the abandonment of nesting sites by those pairs in previous years could have settled there. Additionally, the lockdown may have also promoted an increased density of the falcon´s avian prey, as more birds could have concentrated on spaces without humans.

During the 2020 breeding season, we observed four pairs nesting in sectors close to beach access points. These sectors are highly exposed to human activity under normal conditions (i.e., without the lockdown). Before 2020, we did not witness nesting pairs in those sectors. It is not possible to determine whether those pairs choose those less suitable nesting because of the lockdown, but it remains a possibility. Notably, one of these pairs managed to reproduce in an abandoned nest of Burrowing Parrots on a beach adjacent to the town of El Cóndor, at the eastern end of the surveyed transect, a sector previously considered unsuitable for Peregrine nesting due to lower cliffs (20-25 m in height; the lowest of the study area) and subject to intense human disturbance (Figure 2). Several investigators have demonstrated that human recreational activities can negatively impact raptor reproduction by causing disruption in nest attendance by parents, nesting territories abandonment, foraging patch disturbing, and reducing chick productivity (Knight and Sagen, 1988, Martinez-Abraín *et al.,* 2010, Richardson and Miller, 1997).

In our study area, concurrent with the COVID-19 lockdown was the climatic event La Niña. We cannot rule out that this event could have affected the local Peregrine population size. During 2020, its effects on continental birds in this area were evident. For example, in December 2020, a food shortage caused by an intense drought killed at least 1.400 Burrowing Parrots in the colony (Balbiano and Masello, 2021). Mortality affected mainly adult birds that weighted on average 20% less than normal parrots. We presume that during that year, the low body condition of the parrots may have increase their vulnerability to falcon attacks resulting in an "extra" food supply for the population, thus favoring the incorporation of new pairs. On the other hand La Niña phase could have benefit marine bird's populations thus increasing prey availability for falcons. Well known is the detrimental effect of El Niño on the breeding success, mortality rate and survival of seabirds (Schreiber and Schreiber, 1988, Jaksic and Fariña, 2010). In fact, our perception during these two seasons was that of an increment of certain seabirds with respect to previous years such as the Pale-Faced Sheathbill (*Chionis alba*), cormorant species (*Phalacrocorax brasilianus*, *Leucocarbo atriceps),* terns *(Sterna sp.),* etc.

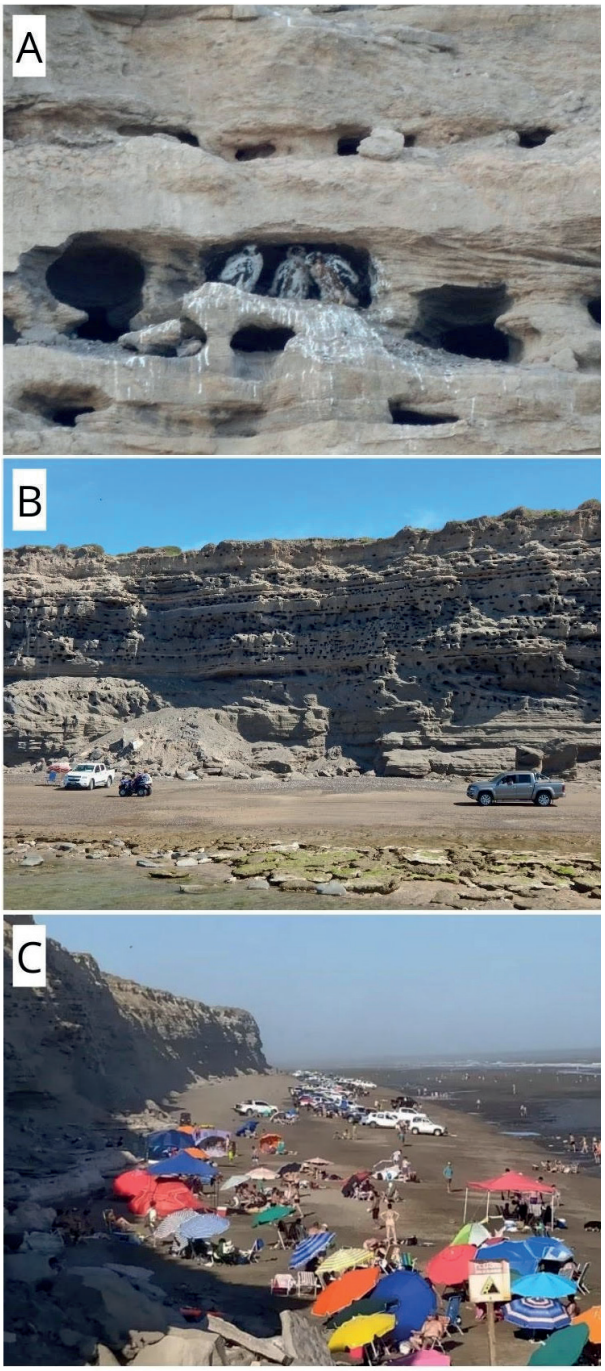

Figure 2 - In 2020 a pair nested in a sector of low cliffs that in normal years suffers intense human disturbance. Photos **A** and **B** by Lucas Albornoz; **C**, Rionegro.com.

Table 1. Interannual variation in the number of pairs and breeding performance of South American Peregrine (*Falco peregrinus cassini*) breeding pairs measured along 29 km seacoast and breeding performance. Adolfo Alsina County, Río Negro Province, northern Patagonia, Argentina.

	Breeding season						
Reproductive variable	**2014**	**2015**	**2017**	**2018**	**2019**	**2020**	**2022**
N° territorial pairs	10	9	9	9	9	13	13
N° active pairs	9	9	9	8	8	12	12
N° nestlings raised to 30 days	14	25	23	18	17	?	35
Brood size	1.75	2.78	2.55	2.25	2.13	2.5	2.92
Average distance between nests	3.15	3.29	3.05	3.49	3.66	2.64	2.44

Furthermore, during La Niña, climatic conditions (absence of heavy rains) could benefit the falcons increasing territory occupancy and as a result, augmenting the breeding population as well as improving reproductive parameters (see De Lucca 2017).

Finally, we do not rule out that these extrinsic factors may have intensified the manifestation of other intrinsic factors, such as the formation of additional breeding pairs within the same population. In the absence of human presence and with a greater local availability of food, recruits of reproductive age may have preferred to remain and reproduce.

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