

Colony guardian programme improves recruitment in the critically endangered hooded grebe *Podiceps gallardoi* in Austral Patagonia, Argentina

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SUMMARY

The critically endangered hooded grebe *Podiceps gallardoi* has suffered a population reduction of 80% in the last 25 years. Although climatic conditions are suggested to be important causes of this decline, invasive species are also having a large impact. Hooded grebes have the lowest recruitment rate within the Podicipodiformes, but this is usually compensated by high adult survival. Considering these life history traits and threats, we designed the 'colony guardian programme', which aimed to protect nesting grebes by reducing the negative impacts of American mink and kelp gull on breeding colonies of grebes in central-western Santa Cruz Province, Argentina. Over five breeding seasons between 2011 and 2015, 10 colonies were protected using a total of 755 fieldwork days. Colonies guarded throughout the breeding season had higher recruitment (0.64 juveniles/breeding pair) than colonies with little or no protection (0.39 juveniles/breeding pair).

BACKGROUND

Of the 23 recently extant grebe species (Podicipediformes), three have been declared extinct and five are threatened: two critically endangered, one endangered and two vulnerable. Three of these threatened species inhabit the Neotropics, among them the critically endangered hooded grebe *Podiceps gallardoi* (Birdlife International 2016). Invasive species pose an important threat for grebes (O'Donnel & Fjeldså 1997, Birdlife International 2016). One of the major problems is the expansion of invasive mammal species, such as the American mink *Neovison vison* (Roesler *et al.* 2012a), rats *Rattus* spp. and other mustelids *Mustela* spp. (BirdLife International 2016).

During the mid-1980s, the hooded grebe population was estimated at 3000-5000 adults (O'Donnel & Fjeldså 1997); thus in 1994 it was categorized as being of least concern/near threatened (BirdLife International 2016). More recently, an extensive study over the entire range of the breeding population in early 2010 showed a decrease of 80% in only 25 years, with only 400 breeding pairs left, concentrated at just 10 lakes (Roesler *et al.* 2012b). Proposed threats were droughts and an increase in average wind speed, as well as three invasive species: rainbow trout *Oncorhynchus mykiss*, kelp gull *Larus dominicanus* and American mink (Roesler *et al.* 2012b).

The hooded grebe has the lowest recruitment rate of the Podicipodiformes, but this is compensated by high adult survival (Fjeldså 1986). Considering these life history traits, the protection of adults and juveniles at breeding colonies is important to increase their population growth rate (Roesler 2016). The protection of nests with the aim of increasing the breeding success of species with small population size has already been shown to be an efficient conservation measure (Williams *et al.* 2012). However, in cases where the species needs to be protected from invasive species, an even greater

effectiveness is achieved if nest protection is implemented together with a control programme for the invasive species (Jansen 2005).

There are currently several wider management actions under development to protect the hooded grebe populations. The most important is a large-scale American mink control program carried out in the area of one of the study sites, the Buenos Aires Lake Plateau (Fasola & Roesler in press). This control programme proved to be very effective, achieving a complete removal of the highlands mink populations (> 600 m a.s.l.) and an approximately 50% reduction in their lowland populations (< 600 m a.s.l.), which has resulted in a lower recolonization rate of mink at the high lakes.

Considering hooded grebes life history traits and the threats they face, the colony guardian programme was designed to protect nesting attempts by grebes in colonies with the greatest breeding potential (i.e. those with the highest number of breeding pairs). In this paper, we describe the methods used to reduce the negative effects of two invasive species, American mink and kelp gull, on breeding colonies of hooded grebe on the lakes of the high plateaus in the west of Santa Cruz province, Argentina.

ACTION

Working area: In central-western Santa Cruz province, Argentina, nine highland plateaus are occupied by hooded grebe during the breeding season. The colony guardian programme was carried out on three of these plateaus, which hold the most important remaining populations of hooded grebe (Figure 1; Roesler *et al.* 2012a): 1) Buenos Aires Lake Plateau (BALP), at the lakes El Cervecero (47°09'20"S, 71°16'32"W) and Don Ferret (47°10'17"S, 71°08'16"W); 2) Strobel Lake Plateau (Strobel), at Rodríguez 9 Lake (48°28'40"S, 71°22'46"W); and 3) La Siberia plateau, at lakes C199 (49°01'31"S, 71°43'59"W) and C221 (including C02)

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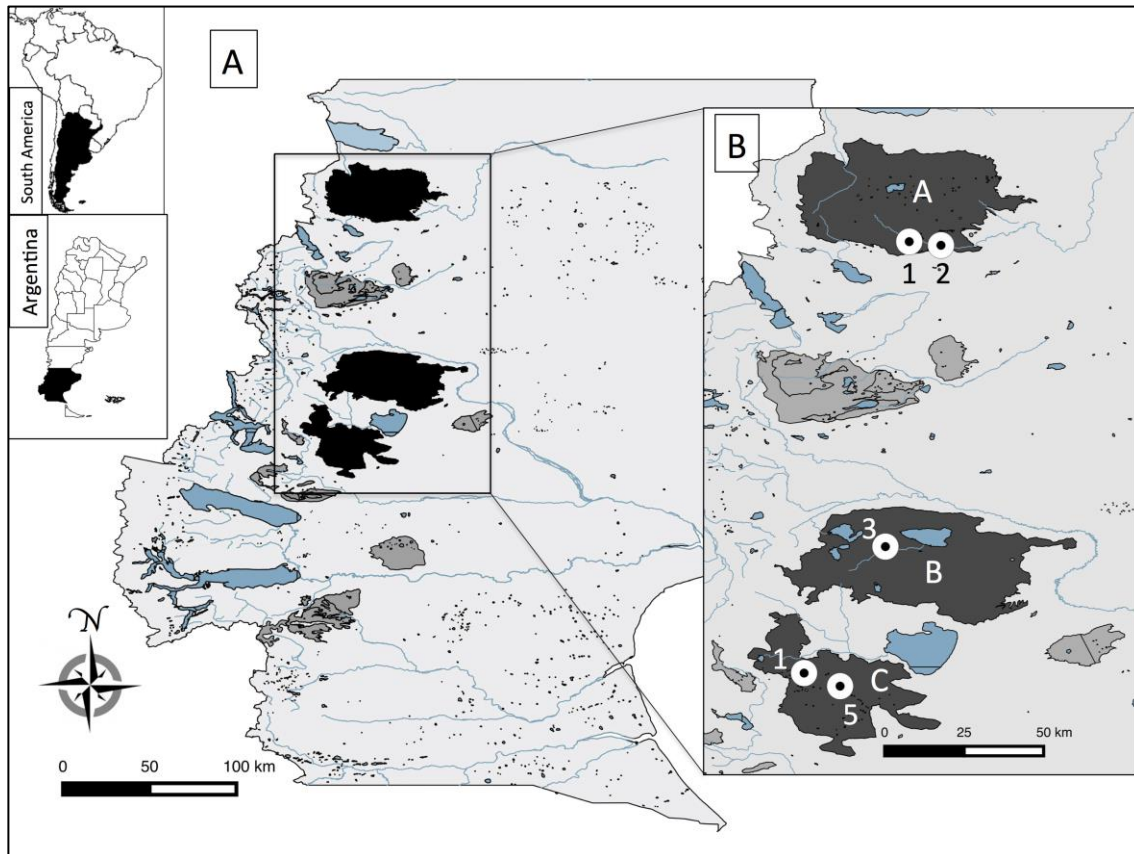


Figure 1. Colony guardians' working area. A) Working area showing the important plateaus: in black plateaus covered in this work and dark grey other important plateaus. B) Detailed working area showing plateaus (A, Buenos Aires Lake Plateau; B, Strobel Lake Plateau; C, La Siberia Plateau) and lakes (1, El Cervecero; 2, Don Ferret; 3, Rodríguez 9; 4, C199; 5, C221).

(49°05'00"S, 71°34'36"W). These three plateaus comprise a vast area, covering approximately 24,000 km². All lakes at which we worked were between 5 and 36 ha in extent (Roesler 2016).

Species characteristics: The hooded grebe is one of the species of the Podicipedidae family with the longest chick-rearing period (approximately 11 weeks; Roesler 2016). Clutch size is two eggs and in 98% of the cases only one chick hatches. Both parents rear the chick together while moulting, and therefore, for approximately one month they are unable to leave the lakes where they breed. Although hooded grebe can re-lay eggs following nest failure (e.g. after destruction of nests by storms, desiccation of lakes, etc.), they do not re-lay following the loss of chicks or juveniles (Roesler 2016). This species has been defined as naïve, lacking anti-predatory behaviour against mammals (Roesler *et al.* 2012a), since its few known natural predators are birds (Beltrán *et al.* 1992).

The American mink is a mammal with amphibious habits, native to North America. It feeds on terrestrial and aquatic prey depending on their availability (Fasola *et al.* 2009). Mink were introduced to central Patagonia in the 1940s following escapes from fur farms, which continued until the late 1970s (Fasola *et al.* 2009). Its distribution in Patagonia has spread in recent decades, reaching areas inhabited by the hooded grebe (Roesler *et al.* 2012a, Fasola & Valenzuela 2014). It has been declared a plague species in Santa Cruz Province, which has allowed the development of control actions in the provincial territory.

The kelp gull, is a native predator of nests and juvenile waterbirds in Santa Cruz, but was previously thought to occur in the highland plateaus only sporadically and at low densities (Beltrán *et al.* 1992, O'Donnel & Fjeldsa 1997). However, kelp

gull populations have expanded in Patagonia in the last few decades (Yorio *et al.* 1998) and currently there are at least two breeding colonies on the plateaus (Roesler 2016). Consequently, the overlap between this species and the hooded grebes is now high (Roesler *et al.* 2012b, Roesler 2016). Feeding behaviour of gulls varies between individuals (Fazio *et al.* 2012), meaning control actions need to be focused on individuals that show clear interest in waterbirds (e.g. individuals that remain for long periods at a lake, and that make direct attacks on grebe colonies, nests or chicks, and harass other waterbirds).

Colony guardians: The colony guardian programme involved full-time personnel being present at breeding colonies of grebes from the beginning until the end of their breeding season (December or January to late April). A colony guardian team comprised at least two people (one expert technician and a volunteer), with radio or satellite phone communication, to ensure personal security when working in this isolated area. They were trained in advance in waterbird census techniques, handling of firearms (for killing kelp gull and American mink), setting and baiting of 'Tomahawk' live traps, and searching for and identifying American mink tracks and scats. Each team stayed at one base camp for 10-15 days, after which they were taken to a different lake to prevent boredom and maintain enthusiasm. After every shift at a lake the team rested for 2-5 days at the biological station 'Juan Mazar Barnett'. During the rotation of personnel at sites, the base camp was re-stocked with fresh provisions, ammunition and bait for the traps.

The fieldwork consisted of four basic activities: (1) monitoring the grebe breeding colony; (2) baiting and monitoring live traps for mink; (3) searching for signs of

Table 1. Colony guardian programme effort applied and recruitment for each of the hooded grebe colonies monitored. Guardians: number of people involved in lake work during the season. Recruitment expressed as juveniles/breeding pair.

Season	Lake	Fieldwork days	Guardians	Recruitment	Dead adults*	Dead juv.*	Mink removed	Gulls removed
2010-2011	Cervecero	0	0	0.00	33	0	0	0
2011-2012	Cervecero	45	10	0.70	0	0	0	1
2012-2013	Cervecero	45	15	0.45	17 ^a	3 ^a	1	7
2012-2013	C199	45	15	0.33	12 ^a	10 ^a	1	5
2013-2014	Cervecero	99	16	0.64	0	0	2	6
2013-2014	C199	79	16	0.00	0	0	0	0
2013-2014	Don Ferret	96	16	0.73	0	0	0	9
2014-2015	Cervecero	115	38	0.73	0	0	0	0
2014-2015	C199	87	38	0.52	0	0	0	0
2014-2015	C02	77	38	0.46	0	0	0	2
2014-2015	Rodriguez 9	67	38	0.67	0	4 ^b	0	3

*Cause of mortality: ^a American mink; ^b Flying steamer duck.

American mink; and (4) surveillance of grebe nests and chicks. The main aim was to prevent, or respond immediately to, attacks by invasive species and to prevent and reduce interactions between native species (e.g. coots *Fulica spp.* or flying steamer-ducks *Tachyeres patachonicus*) and grebes, by scaring off these other species when required. Colony guardians counted all waterbird species each day, as well as the numbers of attacks on them by invasive species. Observations of the breeding colony took place throughout most of the daytime (07:00 to 19:00 h) from fixed elevated observation sites, which facilitated detection of kelp gulls passing by.

Colony guardians' equipment consisted of a spotting scope (20-60x), binoculars (10x42), LED flashlights (> 500 lumens), a firearm (12x70 gauge) and 9 (2.1 mm) or 8 (2.3 mm) cartridges, which increased the ability to kill kelp gulls. In addition, these firearms produced a loud noise, which could be used to scare off other native waterbirds without the need for lethal control.

The guardians searched the entire lake perimeter every day, searching an area within 10 m of the water for footprints or scats of American mink. From mid-February onwards, periodic dusk and night-time patrols were carried out (two or three times a week) to search for mink using spotlights and a firearm. If the presence of mink was detected by means of fresh signs or direct sighting of an individual, patrols were subsequently conducted on a daily basis until the individual was shot. Culling was achieved by two people, one blinding the animal with a spotlight so the second could shoot it. Live traps ('Tomahawk') were set up every 200-300 m in rocky sites, that provided potential mink dens, and that were within 20 m of the lake shore. These were hidden among rocks, generously baited with canned fish and filled with vegetation for insulation. Traps were checked daily, to prevent suffering of captured animals until release (in the case of bycatch of native species) or removal (American mink).

During the first two breeding seasons (2011-2012 and 2012-2013), the work was carried out daily from the start of egg-laying in the colony until the last chick hatched, which represented approximately 45 fieldwork days. In these years we regularly monitored the colonies, but without a full-time guardian at the lake. In the following breeding seasons (2013-2014 and 2014-2015) the period was extended until the time when juveniles abandoned the lakes; this ranged from 67 to

115 fieldwork days on different lakes. The variation in the number of days was related to the detection date of the colony and the availability of personnel at the moment of detection. A total of 79 people worked during the seasons of 2011-2012 and 2014-2015, with rotating work shifts among the protected lakes. During the season of 2014-2015, where the number of protected colonies as well as the number of fieldwork days was greatest, 38 people were needed to enable full protection of the lakes (Table 1).

CONSEQUENCES

Control of American mink and kelp gulls: We removed four American mink, three at El Cervecero Lake (one during the breeding season 2012-2013, and two during the 2013-2014 breeding season) and one on C199 Lake (during the 2012-2013 breeding season) (Table 1). Both removals during the 2012-2013 season took place at times where the lake guardians had detected predation on hooded grebes. All mink were captured by active searching and firearms. We did not capture any mink in live traps. During the season of 2012-2013, we trapped three Patagonian skunk *Conepatus humboldtii* at El Cervecero Lake, which were released uninjured within 24 hours.

A total of 33 kelp gulls were killed (Table 1). The number of gulls removed was higher during the first season, with a maximum at Don Ferret Lake (season of 2013-2014), where nine individuals were removed.

Hooded grebes: Since the breeding season of 2011-2012, 10 colonies of the hooded grebe were protected by a total of 755 fieldwork days (Figure 2). Nine of these colonies survived until migration time of adults and juveniles. Only Lake C199 lacked a breeding colony due to destruction by strong wind-storms in 2013-2014 season. There was a significant positive correlation between the number of days spent protecting a colony and the recruitment rate of the colony (Spearman $r = 0.69$; $p = 0.03$) (Figure 2). Those colonies guarded all through the breeding cycle showed high recruitment (median of 0.64 juveniles/breeding pair), while unprotected colonies or colonies protected for less than 60 days showed lower recruitment (median of 0.39 juveniles/breeding pair). We only detected the death of adult and juvenile grebes by invasive

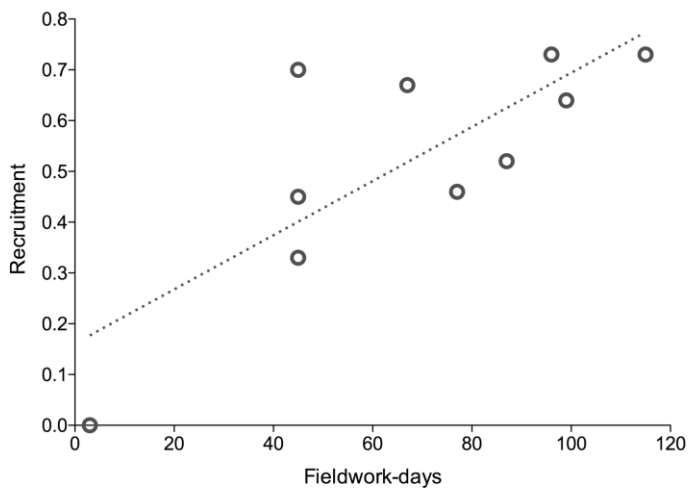


Figure 2. Relationship between recruitment rates (juveniles/ breeding pair) of hooded grebe colonies and fieldwork days at each monitored colony.

species on non-protected, or unprotected, lakes (Table 1). The sole event of massive juvenile death (four dead juveniles) on a highly protected lake took place on Rodriguez 9 Lake (2014-2015), and it was caused by a native species, the flying steamer-duck. On lakes that were highly protected, we did not detect any predation event by American mink or kelp gull.

DISCUSSION

The protection of hooded grebe colonies throughout their complete breeding season showed a positive effect on recruitment, with an increase of 0.16 juveniles/ breeding pair in highly protected colonies compared to non- or low-protection colonies. The average of 0.37 juveniles/ breeding pair in colonies without, or with low, protection is similar to the average of 0.32 juveniles/ breeding pair originally detected for the hooded grebe without control of invasive species (Fjelds  1986). The higher survival on the lakes with high protection (0.53 juveniles/ breeding pair) could potentially foster a population increase.

The negative impacts of American mink and kelp gulls on hooded grebe population are very important. The American mink has the greatest negative impact since, in the absence of protection of colonies from mink, colonies can produce no young, and also suffer a high loss of adults, as occurred on El Cerveceros Lake during 2010-2011, where 33 grebes were killed by one juvenile mink (Roesler *et al.* 2012a). As regards kelp gulls, their effect is less severe, although it can result in egg or chick losses and even the abandonment of whole grebe colonies (see Beltr n *et al.* 1992). Although the protection of colonies during nesting or early chick stages was efficient in reducing the effects of kelp gulls, it did not prevent the loss of young and adult hooded grebes through predation by American mink during early stages of the colony guardian program: 2011-2012 and 2012-2013.

During the four years of the programme the number of mink and kelp gulls removed each year has declined. The possible explanation for this may differ between species. In the case of American mink, the colony guardian programme took place at the same time as a large-scale American mink control program carried out on the BALP (Fasola & Roesler in press). However, the linear relationship between guardian days and

recruitment (Figure 2) suggests that the guardian programme has been effective in protecting grebe in addition to the large-scale mink control programme.

The decrease in attacks on grebe colonies by kelp gulls could be attributed to the removal of individual gulls which fed on waterbird colonies in the lakes where hooded grebes breed. Individual kelp gulls differ in their foraging behaviour and can learn from others the location of food sources (Fazio *et al.* 2012). The case of Don Ferret Lake, where nine gulls were removed, was probably due to the fact that this hooded grebe colony was located only 2.5 km far from the largest breeding colony of kelp gulls on the high plateaus. The distance between gull breeding colonies and hooded grebe colonies has a direct effect on the number of gulls visiting the grebe colony (Roesler 2016).

The colony guardian programme has proved to be an effective means of removing invasive species and increasing the recruitment rate of hooded grebes. However, the costs of the programme were high, consisting of the installation of base camps, provision of food for over three months, long distances travelled by people, training of personnel (up to 38 in the season of 2014-2015), as well the costs of equipment of great value and important security measures (communication and first aid). These financial and logistical factors make it important that resources are focused on the most profitable colonies (i.e. greatest potential number of juveniles). In regions like Patagonia, where work areas are large, distances between sites can be large and the weather is extreme, it is important to rely on a network of local contacts (local stakeholders) as well as a highly developed and functional communication system. Nevertheless, it is important to note that currently the protection of breeding colonies of hooded grebes is a high conservation priority, since the appearance of invasive species could have a devastating effect on its global population. In just three events of mink attack on colonies of hooded grebes 62 adults and 13 young were killed (Roesler 2016). This number represents roughly 10% of the global population of hooded grebes. An absence or low level of protection of a colony does not necessarily lead to the loss of adults or a decrease in populations, but this study showed that protection efforts applied to colonies with a high probability of occurrence of invasive species could overcome their negative impact.

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Idea Wild. This is the #9 scientific publication of the Proyecto Macá Tobiano.

REFERENCES

- Beltrán J., Bertonatti C., Johnson A., Serret A. & Sutton P. (1992) Actualizaciones sobre la distribución, biología y estado de conservación del Macá Tobiano (*Podiceps gallardoi*). *Hornero*, **013**, 193–199.
- BirdLife International (2016) Species Factsheet, <http://www.birdlife.org>
- Fasola L. & Roesler I. (in press) Invasive predator control program in Austral Patagonia for endangered bird conservation. *European Journal of Wildlife Research*.
- Fasola L., Chehébar C., Macdonald D.W., Porro G. & Cassini M.H. 2009. Do alien North American mink compete for resources with native South American river otter in Argentinean Patagonia? *Journal of Zoology*, **277**, 187–195.
- Fasola L. & Valenzuela A.E.J. (2014) Invasive carnivores in Patagonia : defining priorities for their management using the American mink (*Neovison vison*) as a case study. *Ecologia Austral*, **24**, 173–182.
- Fazio A., Bertellotti M. & Villanueva C. (2012) Kelp gulls attack Southern right whales: A conservation concern? *Marine Biology*, **159**, 1981–1990.
- Fjeldsá J. (1986) Feeding ecology and possible life history tactics of the Hooded Grebe *Podiceps gallardoi*. *Ardea*, **74**, 40–58.
- Jansen W.P. (2005) Rat *Rattus* control at nests of the endangered kakapo *Strigops habroptilus* on Codfish Island, New Zealand. *Conservation Evidence*, **2**, 1–2.
- O'Donnel C. & Fjeldsá J. (1997) *Grebes: Status Survey and Conservation Action Plan*. IUCN/SSC Grebe Specialist Group.
- Roesler I. (2016) *Conservación Del Macá Tobiano (Podiceps Gallardoi): Factores Que Afectan La Viabilidad de Sus Poblaciones*. Universidad de Buenos Aires.
- Roesler I., Imberti S., Casañas H. & Volpe N. (2012a) A new threat for the globally Endangered Hooded Grebe *Podiceps gallardoi*: the American mink *Neovison vison*. *Bird Conservation International*, **22**, 383–388.
- Roesler I., Imberti S., Casañas H., Mahler B. & Rebores J.C. (2012b) Hooded Grebe *Podiceps gallardoi* population decreased by eighty per cent in the last twenty-five years. *Bird Conservation International*, **22**, 371–382.
- Williams D.R., Pople R.G., Showler D.A., Dicks L. V, Child M.F. & Sutherland W.J. (2012) *Bird Conservation - Global Evidence for the Effects of Interventions*. Pelagic Publishing, Exeter.
- Yorio P., Bertellotti M., Gandini P. & Frere E. (1998) Kelp Gulls *Larus dominicanus* on the Argentine coast: population status and relationship with coastal management and conservation. *Marine Ornithology*, **26**, 11–18.