ORNITOLOGIA NEOTROPICAL 24: 85–93, 2013

BREEDING BIOLOGY OF THE CHUBUT STEAMERDUCK (*TACHYERES LEUCOCEPHALUS*)

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Resumen. – Biología reproductiva del Pato Vapor Cabeza Blanca (*Tachyeres leucocephalus*). – El Pato Vapor Cabeza Blanca (*Tachyeres leucocephalus*) es un anátido no volador endémico de la costa marina de la Provincia del Chubut y es la especie más recientemente descripta dentro del género. Hasta el momento se cuenta con una breve y escasa descripción acerca del comportamiento y biología reproductiva, siendo la mayor parte de la información disponible referida al resto de las especies del género. A lo largo de cinco temporadas reproductivas se han colectado detalles observacionales acerca del comportamiento de cortejo, territorialidad y nidificación. Dicha información ha sido tomada de forma oportunista durante la realización de otros estudios sobre la especie. Chubut Steamerduck ha sido recientemente declarada como “Vulnerable” por la UICN Lista Roja de Especies en Peligro en base a su restringido rango de distribución y reducido tamaño poblacional. Asimismo, cabe destacar que esta particular especie habita en áreas de difícil acceso dificultando la logística para la colecta de datos. Dada la escasez de información disponible sobre esta especie y los planes de manejo que se están gestando para el desarrollo costero de sus principales áreas de reproducción, es imperioso contar con información científica valuable. De esta forma, el presente estudio contribuye a incrementar el conocimiento acerca de aspectos de la historia de vida de esta particular especie de anátido no volador, principalmente referida a su comportamiento y biología reproductiva.

Abstract. – The Chubut Steamerduck (*Tachyeres leucocephalus*) is a flightless duck endemic to the marine coast of Chubut Province and is the most recently described in the genus. Very little about their behaviour and breeding biology is detailed; most of the available information is about other species in the genus. We collected observational details on courtship, territorial behaviour and nesting habitat during 5 breeding seasons in an opportunistic way during other studies. The Chubut Steamerduck has been recently listed as “Vulnerable” on the IUCN Red List of Threatened Species based on its restricted distribution range and reduced population size. Additionally, this species lives in areas that have very difficult access and where there are many logistical difficulties with regard to collecting any data. Given the poor current knowledge of this species and the plans for coastal development in its main breeding area, there is a need to gather valuable information. In particular, this study contributes to increase the knowledge on the previously unknown life history features of this flightless waterfowl species, mainly referring to its behaviour and breeding biology. *Accepted 3 June 2013.*

Key words: *Tachyeres leucocephalus,* Anatidae, courtship, nesting, reproductive cycle, territoriality.

INTRODUCTION

Steamerducks (genus *Tachyeres*) comprise four species of diving ducks found only in southern South America (Weller 1976, Humphrey & Thompson 1981). The Flying Steamerduck (*T. patachonicus*) inhabits marine coastlines and freshwater lakes of Argentina, Chile, and the

Falkland/Malvinas Islands; the Magellanic Flightless Steamerduck (*T. pteneres*) lives in coastal Chile and the Magellanic Strait; the Falkland Flightless Steamerduck (*T. brachypterus*) is found along the marine coasts of Falkland/Malvinas Islands; and the recently described Chubut Flightless Steamerduck (*T. leucocephalus*) lives along the marine coastline of Chubut, Argentina.

Some of the breeding habits and behavioural patterns of Steamerducks have been described in previous publications. Firstly, Phillips (1922) described, among other things, the nesting habits of *Tachyeres* as if there was only one species, but suggested the possibility that more than one species of Steamerduck might exist. Murphy (1936) and Delacour (1954) recognized three different species in the genus, adding information on some general aspects of breeding and behavioural habits. In particular, Moynihan (1958) carefully described and analyzed the hostile and sexual reactions of Flying Steamerducks late in the breeding season, and Pettingill (1965) observed Falkland Flightless Steamerducks at several places in the archipelago, summarising aggressive behaviour and describing some nesting features. Meanwhile, Johnsgard (1965) described agonistic, sexual, and mating behaviours of the Falkland Flightless and Magellanic Flightless Steamerduck. While Daciuk (1976) briefly reported some breeding features and the behaviour of the Flying Steamerduck during the breeding season in some localities in Chubut Province, Weller (1976) and Johnsgard (1978) summarized the reproductive biology, behaviour, and social structure of the three species of Steamerducks during nesting, hatching, and brood-rearing periods. Nuechterlein & Storer (1985) described interspecific aggression of Flying Steamerducks late in the breeding season, while Livezey & Humphrey (1985) carefully summarized territoriality and interspecific aggression of all four species of *Tachyeres* late in the breeding season at a number of ecologically diverse localities.

Specifically, for the Chubut Steamerduck, few breeding habits have been generally described for a reduced number of individuals, and only at one location (Weller 1976, Humphrey & Livezey 1985). More recently, Agüero *et al.* (2010) described nesting habitats based on 170 nests, and Svagelj *et al.* (2012) reported egg size variation along the distribution range of the species. However, features concerning behaviour and breeding biology of the Chubut Steamerduck remain unknown. In this paper, we present information on previously unreported aspects of the behaviour and breeding biology of the Chubut Steamerduck and compare this with the information available for the other three species of the genus *Tachyeres*.

The Chubut Steamerduck has been recently listed as "Vulnerable" on the IUCN Red List of Threatened Species based on its restricted distribution range and reduced population size (Agüero *et al.* 2012). Therefore, the information presented is critical to provide important insights into the ecology and biology of this species and to support further conservation efforts.

METHODS

We surveyed 337 km of mainland coast and 104 km of island and islets coast throughout the distribution of the Chubut Steamerduck looking for individuals and nests (Fig. 1), from Playa Unión (43°21'S, 65º03'W) to the Chubut-Santa Cruz provincial boundary (46º00'S, 67º36'W). Data were collected during five breeding seasons from 2004 to 2009 (September to February).

Behavioural data were taken by one observer in an opportunistic way during other studies, using focal observations on 41 pairs in the water. We recorded the presence of a

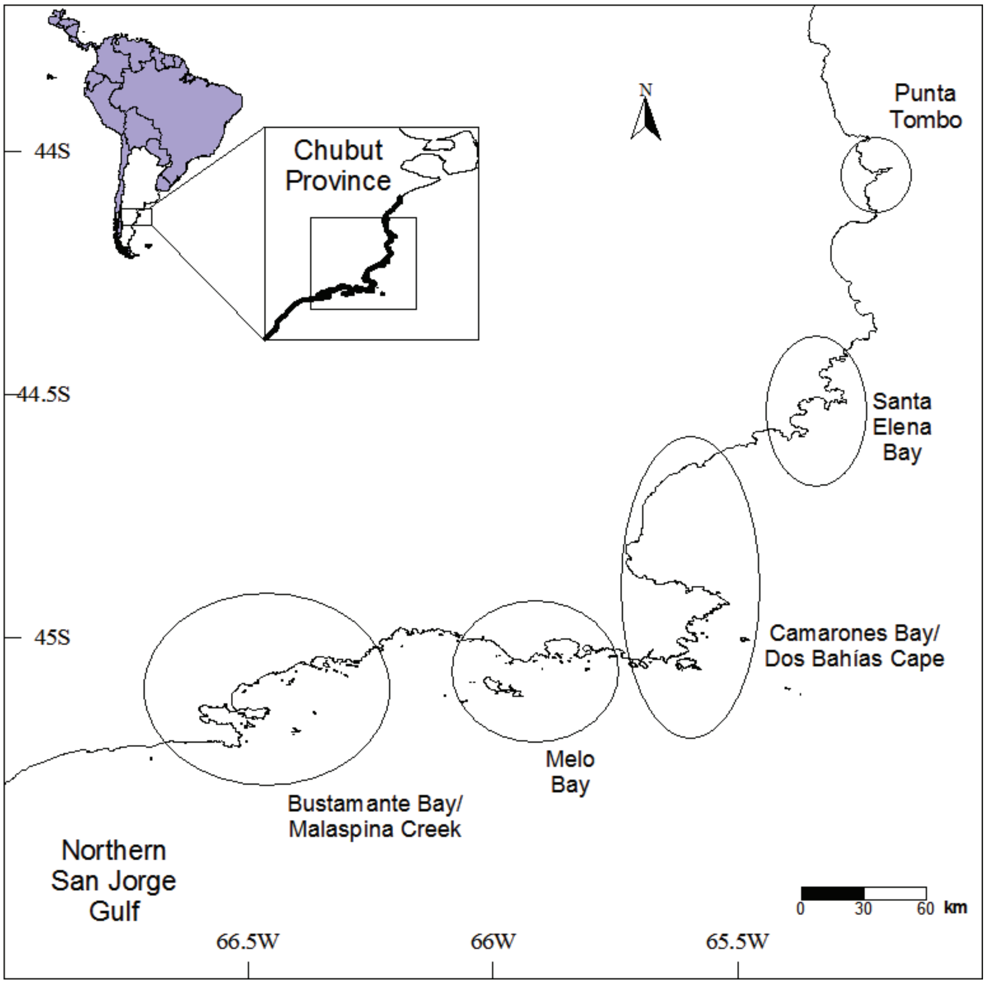

FIG. 1. Coastal map showing the five main breeding locations of the species where data were collected. In the inset map, breeding distribution in the Chubut Province is shown as a thick line.

particular behaviour (courtship, mating or territorial) when started. Due to logistical constraints, we could not register time spent performing each behaviour. Observations were conducted from a fixed point on the coastline, between 15 and 20 m away from Steamerduck individuals, allowing visual access to the sampled pairs while avoiding being detected by them. We observed 29 pairs weekly during a period of seven weeks (non-consecutives) within the breeding season of 2007 (October–December). At each observation session, pairs were observed for a period of one hour, registering data for periods of 10 min separated by non-observational intervals of 5 min using binoculars (10x40) and a telescope (25–40x), resulting in a total of 280 min of observation. This sampling protocol was designed to gather information on foraging behaviour (Agüero *et al.* in prep). However, the other 12 pairs were observed during coastal surveys (see Agüero *et al.* 2012) with-out any behavioural sampling protocol within the breeding seasons of 2004, 2006, and 2008 (September–February).

We collected data on nesting habitat at Punta Tombo, Camarones Bay/Dos Bahías Cape, Melo Bay, and Bustamante Bay/ Malaspina Creek, where we found a total of 188 nests (Fig. 1; see Agüero *et al.* 2010, 2012 for details on methodology). We recorded their location using a GPS and measured each nests dimensions, including external diameter (distance between external borders), internal diameter (distance between internal borders of the nest), external height (distance from the ground to the top of the nest) and depth (distance from the top to bottom of the nest bowl). We measured the dimension of the opening in the bush (used as an access to the nest) and we also recorded nesting material and identified bush type under which the nests were placed.

We recorded orientation of the nest opening (considering the north orientation as 0º) and direction of the nest opening to the nearest water for 186 nests, respectively, using a compass Suunto KB-14/360R. Four categories were assigned to categorize orientation: north (315–45º); east (46–135º); south (136–225º); and west (226–314º). Orientation to the north and direction to water were analyzed by the Rayleigh test (Zar 1996).

RESULTS

Courtship and territoriality. We observed eight courtship displays in the water early in September, when we started collecting data, but we were unable to confirm whether that behaviour started before our observations. Displays between pairs were few and simple. Both birds stretch their necks upwards and sometimes forward, which is accompanied by a low vocalization and wing flapping.

We saw five copulations, which all took place on the water. Four of them occurred early in September, with only one in late October. Males and females were swimming around the territory, within a few meters of one another, dipping their bills into the water. After some minutes, the dipping gradually became faster, and the whole head and neck were dipped under the water. Both birds assumed the "alert" posture (see below) between dips. Unlike the "alert" posture, in courtship no vocalisations are displayed.

Both dips and alternate "alert" postures became pronounced and the female started to submerge the fore-part of the body during her dipping. The male rapidly swam to the female and mounted her. After copulation, both birds assumed the "alert" posture and swam apart.

When facing an alarming situation, both sexes apparently perform different behaviour patterns. Females often initiate displays by "false drinking", giving a low groaning call. The first movement is a dipping of the bill into the water, then the head is usually lifted after the bill-dipping, and the bill is pointed diagonally upward. Finally, an extreme stretch posture is taken, while the head and bill were pointed straight upward. However, males respond with an "alert" posture. Firstly, males adopted an upright posture of the neck, exposed their wing knobs, and then raised the curled central tail feathers.

Immediately before a territorial dispute, we could observe males adopting an extreme form of the "alert" posture, stretching the neck upward and slightly backward, raising the breast slightly out of the water and holding the head horizontally or pointing the bill slightly upward. Tail feathers were spread and raised and curled very high while the wings were partially spread and the bird gave intense rasping grunts.

We saw 15 intraspecific disputes, mainly during the incubation period, where males were patrolling territories. Five males swam toward the opponent (other male), gradually

TABLE 1. Bushes' attributes used by Chubut Steamerduck to nest.

	Maximum diameter (m)	Minimum diameter (m)	Height (m)
Mean ± SE	2.2 ± 0.08	1.6 ± 0.06	0.8 ± 0.02
Range	0.3-5.5	0.1-4.1	0.1–1.6
N	188	188	188

sinking in the water until only the neck, bill, a small part of the back, and the tail feathers were visible, preparing to attack from underneath. However, other males "steamed" across the surface flapping their wings toward juveniles and females invading their territories (n = 10). When fighting face-to-face, males grasped the head or neck and beat the opponent with their wing knobs. One fight observed lasted for 20 or 30 s, and one of the males was seriously injured, bleeding over his head and neck.

Nesting habitat. All nests were hidden under vegetation, which ranged in height from 0.1 to 1.62 m (Table 1). Most nests (86.7%, n = 188) were under bushes of *Atriplex* spp. (60.64%) and *Lycium* spp. (26.06%). To a minor extent, Chubut Steamerducks nested under *Stipa* spp. (6.91%), *Suaeda divaricata* (3.72%), *Grindelia chiloensis* (2.13%), and *Senecio* spp. (0.53%). Nests themselves were placed on the ground. Chubut Steamerducks built shallow nest bowls by digging the soil, which were covered with grass, twigs, algae, shell fragments, and a good portion of down feathers. On average, nests were 33.5 cm in diameter and 8.6 cm in depth (Table 2). The access to the nest was through an opening in the bush ranging from 25.6 to 37.7 cm (Table 2). Only seven nests (n = 188) had two openings.

The orientation of the nest opening (Z = 4.7, P = 0.009, Rayleigh test) and its direction to the nearest water (Z = 35.4, P < 0.05, Rayleigh test) were not by chance. Over 60% of the nests were oriented to the ENE quadrant (mean vector = 69.9º, SE = 18.5º), and 71% were oriented toward the sea (mean vector = 10.5º, SE = 3.2º, range = 045º). From the nests facing the water, most of them were oriented to ENE (19%, n = 25 nests) followed by NNE (17%, n = 23 nest), WSW (14%, n = 19 nests), ESE (12%, n = 16 nests), SSE (11%, n = 15 nests), NNW (10%, n = 14 nests), SSW (10%, n = 13 nests), and WNW (7%, n = 9 nests). Likewise, most of the nests not facing the water (29%, n = 54 nests) were oriented to the ENE and NNE quadrant (10% and 8%, respectively).

Compared to other seabirds of the area, the Chubut Steamerducks' egg laying is asynchronous and occurs from September to December, with the bulk of the eggs laid in the middle of October or early November (Fig. 2). Only females incubate, and males patrol the territory in shallow water in front of the nest (observed in 55%, n = 188).

The Steamerducks hatching period takes place from mid-October until early February (Fig. 2). In the water, the youngsters were guarded by both adults, but were huddled beside or beneath the female diving for food while parents were swim patrolling. All ducklings dive in a relatively synchronized way, staying under water for about 16 s (718 s, n = 16 ducklings from 3 broods), and gradually increase their diving times as they grow older.

We saw three attacks by Kelp Gulls on newly-hatched ducklings, but none was successful. The youngsters reacted to the alert calling from the female by diving, whereas both adults croaked and circled in an "alert" posture.

DISCUSSION

Steamerducks show sexual dimorphism in bill and head colour (Johnsgard 1965), are

TABLE 2. Nest dimensions of Chubut Steamerducks.

	Nests dimensions (cm)				Opening dimensions (cm)	
	External diameter	Internal diameter	External height	Depth	Maximum diameter	Minimum diameter
Mean ± SE	33.6 ± 0.3	20.7 ± 0.3	4.1 ± 0.09	8.6 ± 0.2	37.7 ± 0.7	25.7 ± 0.6
Range	20–44	10–38	1–9	2–16	20–69	10–52
N	187	186	173	177	168	166

monogamous, and form lasting, perhaps lifelong pair bonds (Murphy 1936). Our description of the mutual reactions between mated pairs for Chubut Steamerducks was consistent with those recorded by Moynihan (1958) and Johnsgard (1978) for Flying Steamerducks. Additionally, we found that the courtship period of Chubut Steamerducks began in August or September, which is similar to that which was described for the Magellanic Steamerducks in Chiloé (Johnsgard 1978), located at the same latitude but in the Pacific coast. Consistent with Moynihan (1958), who described copulations on Flying Steamerducks late in the breeding season, our observations showed that this behavioural pattern is almost identical in our studied species.

Steamerducks are renowned for their pugnacity and territoriality, particularly during the breeding season, which is thought to be important in defending the nest site, food, and broods (Weller 1972, 1976). Both sexes are involved in territorial disputes, although males are the primary combatants, especially during laying, incubation, and hatching (see also Livezey & Humphrey 1985). We observed that all aggressive and display attacks by Chubut Steamerducks were confined to territorial disputes among conspecifics. However, Nuechterlein & Storer (1985) and Livezey & Humphrey (1985) described severe attacks toward other species, i.e., Red Shoveler, Kelp Goose, Crested Duck, and Neotropic Cormorant.

Hostile displays and aggressive behavioural pattern displays by Chubut Steamerducks were apparently similar to those described for Flying Steamerducks (Moynihan 1958) and Falkland and Magellanic Steamerducks (Weller 1976, Johnsgard 1978), although a detailed photographic and vocalisation study would be useful to detect differences. However, a slight difference in the "degree of curl" of the tail feathers during "alert" posture was detected. Flying Steamerducks usually raise the elongated and curled central tail feathers to some slight extent (Moynihan 1958). However, Chubut Steamerducks raise their tails very high, just like Magellanic Steamerducks (see also Moynihan 1958).

The nesting behaviour of the Chubut Steamerduck is similar to the other three congeneric members. Nests are invariably placed on the ground and are very well hidden under vegetation. Selection of dense cover for nest sites is typical of the genus *Tachyeres.* In particular, Falkland Flightless Steamerducks prefer to use grass, dry kelp (*Macrocystis pyrifera*), "diddle-dee" (*Empetrum*), or tussock grass (*Poa*) (Johnsgard 1978); however, "jume" brush (*Suaeda divaricata*), grass, and dead branches of woody brush have been reported for Flying Steamerducks (Johnsgard 1978). Magellanic Steamerducks nest under shrubbery and even nearby the impenetrable forest in Chile (Murphy 1936, Johnson 1965). As stated in previous studies (Humphrey & Livezey 1985, Agüero *et al.* 2010), vegetation

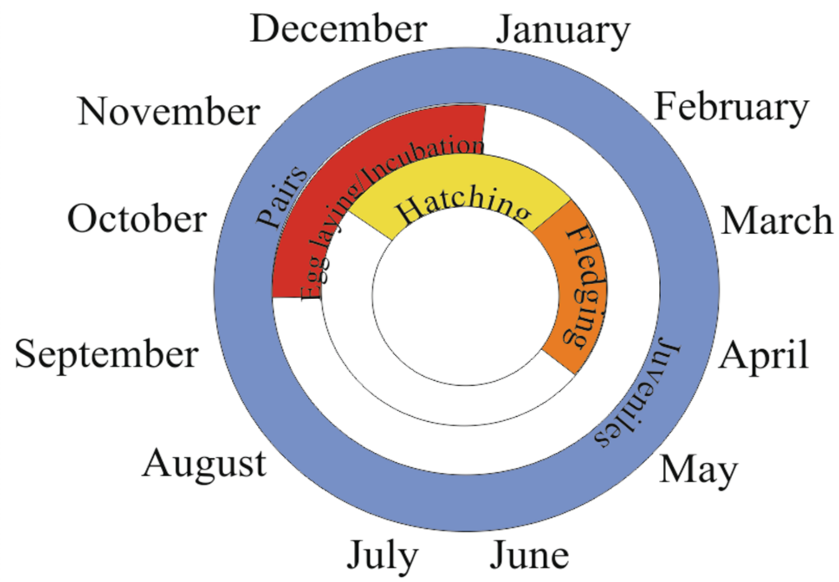

FIG. 2. Timing for stages in and out the breeding season. Filled circles show the extent of each stage.

cover is a key variable in nest-site selection by Chubut Steamerducks. Our study showed that this species also builds their nests under *Lycium* spp. in addition to *Atriplex* spp. as reported by Humphrey & Livezey (1985). On the other hand, our bush size estimates were very similar to those reported by these authors for five nests on one island.

The tunnel entrances in dense bush that we reported for Chubut Steamerducks nests were also noted for Falkland Flightless Steamerducks (Cawkell & Hamilton 1961); however, there were no available data on measures or orientation to make comparisons with ours. Our study showed that the nest entrances of Chubut Steamerducks were mostly oriented to the ENE quadrant and towards the sea. In the Patagonian steppe, the predominant winds are from the southwest with wind speeds averaging 45 km/h, but gusting up to 140 km/h (Camacho 1979). Vegetation cover and orientation of the nest opening may provide protection from strong winds to eggs and the females. Moreover, placing the nest opening facing the sea presumably makes it easier for Chubut Steamerducks to escape, and for the chicks to move to the water after hatching.

Nest bowls of Chubut Steamerducks were similar to those of the other three species: shallow depressions in the soil lined with a good deal of down, grass, twigs, and shell fragments (Phillip 1922, Johnsgard 1978, Humphrey & Livezey 1985). Besides, nest dimensions reported for Chubut Steamerducks (see Boswall & McIver 1979, Humphrey & Livezey 1985) and Magellanic Steamerducks (see also Humphrey *et al.* 1970) were similar to those recorded in our study.

The breeding phenology reported herein for Chubut Steamerducks resembles the other Steamerduck species (Phillips 1922, Daciuk 1976, Johnsgard 1978, Humphrey & Livezey 1985). The specific incubation period is completely unknown for the Chubut Steamerduck, but considering the fact that the egg size of Chubut Steamerducks closely approximates that of Falkland Flightless Steamerducks (Humphrey & Livezey 1985, Livezey & Humphrey 1992, see also Svagelj *et al.* 2012), the incubation period would probably last between 28 to 40 days (Schmidt 1969). As in the other *Tachyeres* species (Phillips 1922, Pettingill 1965, Johnsgard 1978), while the female incubates, the male will be found invariably between the nest and the sea or swimming in shallow water in front of the nest.

Steamerduck ducklings leave the nest two or three days after hatching, and the female drives them to the shallow water in front of the nest (Carboneras 1992). Data from Weller (1976) and Humphrey & Livezey (1985) and our own observations substantiate that biparental attendance of broods is typical in *Tachyeres* spp. This contributes to reduce chick mortality caused by avian predators, because foraging ducklings are vulnerable to attack by several species including Kelp Gull (*Larus dominicanus*), Skua (*Catharacta skua*), and Giant Petrel (*Macronectes giganteus*) (see also Pettingill 1965). The fledging period has not been estimated for this flightless steamerduck. However, we suggest that hatchlings require about 12 weeks to fledge as reported for Falkland Flightless Steamerducks (Pettingill 1965, Weller 1972). Additionally, we suspect that young of Chubut Steamerducks are displaced out of the territory by both parents after fledging (see also Humphrey & Livezey 1985) and gather in large flocks with other immature birds foraging in coastal waters or resting on the beaches, as reported by Agüero *et al.* (2012).

The species lives in areas that are very difficult to access and where there are many logistical difficulties surrounding the collection of data, including navigation conditions that are frequently very extreme. Given the poor current knowledge of this species and the plans for coastal development in its main breeding area, there is an urgent need for gathering valuable information on its natural history. In particular, this study contributes to increase the knowledge on previously unknown life history features of this flightless waterfowl species, mainly referring to its behaviour and breeding biology. Efforts are needed to assure that this information will be used in protected area management plans, and that the latter will be implemented effectively. Future studies should allow the development of recommendations to minimise conflicts between anthropogenic activities and this flightless bird in key breeding and foraging areas.

ACKNOWLEDGMENTS

Research was funded by grants from OAK Foundation Grant in Marine Conservation - Duke University Marine Lab, Rufford Small Grants Foundation, Wildlife Conservation Society, Chubut Province Government, and Neotropical Bird Club. We thank Soriano S.A., Dirección de Fauna y Flora Silvestre, Secretaría de Turismo de la Provincia del Chubut, L. Reyes, L. Musmeci, and F. Abril and his family for logistical support. PGB thanks Luc Hoffmann for the continuous support to his work. We are grateful to D. Villarreal, N. Ortiz, R. Vera, M. Agüero, N. Lisnizer, A. Gatto, A. Fernández Ajó, M. Píngaro, V. Roggio, M. Dherete, L. López, M. Mendez, P. Galesi, C. Owen, H. Hernández, and J. and S. Kriegel for field assistance.

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