

# Descripción morfológica del comesebo grande (*Pygarrhichas albogularis*, King 1831) en la Reserva de la Biosfera Cabo de Hornos, Chile

FERNANDO J. NOVOA<sup>1</sup>, ROCÍO F. JARA<sup>2</sup>, OMAR BARROSO<sup>3</sup>, TOMÁS A. ALTAMIRANO<sup>4</sup>, JOSÉ TOMÁS IBARRA<sup>5</sup>, JUAN RIVERO DE AGUILAR<sup>6</sup>, RODRIGO A. VÁSQUEZ<sup>7</sup>, RICARDO ROZZI<sup>8</sup>

<sup>1</sup> <https://orcid.org/0000-0002-8634-903X>

<sup>2</sup> <https://orcid.org/0000-0001-7896-7885>

<sup>3</sup> <https://orcid.org/0000-0003-0565-329X>

<sup>4</sup> <https://orcid.org/0000-0001-9839-7154>

<sup>5</sup> <https://orcid.org/0000-0002-7705-3974>

<sup>6</sup> <https://orcid.org/0000-0002-4746-5759>

<sup>7</sup> <https://orcid.org/0000-0003-4309-6789>

<sup>8</sup> <https://orcid.org/0000-0001-5265-8726>

## OPEN ACCESS

### Recibido:

21/09/2023

### Revisado:

05/12/2023

### Aceptado:

30/01/2023

### Publicado en línea:

23/04/2024

### Coeditor:

Dr. Ricardo Rozzi  
Universidad de Magallanes,  
University of North Texas

### Editora a cargo:

MSc. Marcela Valenzuela  
Saavedra  
Centro Internacional Cabo de  
Hornos (CHIC)

ISSN 0718-686X



## RESUMEN

La ecorregión subantártica de Magallanes constituye una de las áreas silvestres más prístinas y alberga los ecosistemas boscosos más australes del mundo, que están protegidos por la Reserva de la Biosfera Cabo de Hornos (RBCH), Chile. En estos bosques, las aves son el grupo de vertebrados con mayor número de especies. Sin embargo, aspectos esenciales de la ecología y la morfología de varias especies de esta región todavía han sido poco investigados. Entre estas especies, se incluye el comesebo grande (*Pygarrhichas albogularis*, King 1831), considerado un "fósil viviente" por ser la única especie viva del género *Pygarrhichas*. Además, es un furnariido endémico de los bosques templados de Sudamérica. Utilizando la base de datos de 23 años del Programa de Investigación Ornitológica a Largo Plazo del Parque Omora (54°56'S, 67°38'W), que ha realizado capturas y anillamientos de aves de bosque, describimos la morfología, longevidad y presencia del comesebo grande en la RBCH. Entre los años 2000 y 2022 se anillaron 91 individuos, incluyendo 29 recapturas que nos permitieron determinar que esta especie puede vivir al menos cinco años. Las medidas morfométricas mostraron una correlación positiva entre las medidas de pico y la longitud del tarso con las longitudes de la cola y del ala. El peso varió en cada estación anual, pero no significativamente. La mayor presencia al interior del bosque antiguo sugiere una dependencia de esta especie con los grandes árboles. Este estudio amplía el conocimiento sobre la historia natural del comesebo grande, particularmente de sus poblaciones que habitan en los bosques más australes del mundo.

**Palabras clave:** bosques, historia natural, Furnariidae, aves excavadoras, subantártico.

# Morphological description of the White-throated treerunner (*Pygarrhichas albogularis*, King 1831) in the Cape Horn Biosphere Reserve, Chile

## Author contributions:

**F.N:** Conceptualization, Investigation, Formal Analysis, Data curation, Software, Writing – original draft, Review & editing

**R.J:** Investigation, Resources, Validation, Supervision, Review & editing

**O.B:** Investigation, Data curation, Project administration, Resources, Validation

**T.A.:** Investigation, Supervision, Review & editing

**J.T.I:** Investigation, Supervision, Review & editing

**J.R:** Investigation, Project administration, Data curation, Resources, Validation, Review & editing

**R.V:** Investigation, Methodology, Project administration

**R. R:** Conceptualization, Methodology, Supervision, Funding acquisition, Project administration, Validation, Review & editing

## Conflict of interest:

Authors declare that no conflict of interest

## Funding:

ANID-Chile Basal Financing the Cape Horn International Center (CHIC ANID/BASAL FB210018)

## ABSTRACT

The sub-Antarctic Magellanic ecoregion is one of the most pristine wilderness areas remaining on the planet, and is home to the southernmost forest ecosystems in the world, which are protected by the Cape Horn Biosphere Reserve (CHBR). In these forests, birds are the group of vertebrates with the largest number of species. However, essential aspects of the ecology and morphology of several species in this region are still understudied. These species include the White-throated treerunner (*Pygarrhichas albogularis*, King 1831), considered a "living fossil" as it is the only living species of the genus *Pygarrhichas*. In addition, this Furnariid is endemic to the temperate forests of South America. Using the 23-year database of the Long-Term Ornithological Research Program of Omora Park (54°56'S, 67°38'W), based on monthly captures and banding of forest birds, we describe the morphology, longevity, and presence of the White-throated treerunner in the CHBR. Between 2000 and 2022, 91 individuals were captured, including 29 recaptures. Based on these recaptures we determined that this species can live for at least five years. Morphometric measures showed a positive correlation between bill measures and tarsus length with both tail and wing lengths. The average weight varied for each season but not significantly. The greater presence on old-growth forests sites suggests a dependence of treerunners on large trees. This study expands the knowledge about the natural history of the White-throated treerunner, particularly about its populations inhabiting the world's southernmost forests.

**Keywords:** avian excavators, sub-Antarctic, Forests, Furnariidae, natural history.

## INTRODUCTION

The sub-Antarctic Magellanic ecoregion in southwestern South America is home to the world's southernmost forests and is the only Southern Hemisphere analog to Northern Hemisphere sub-Arctic forests at this latitude (Rozzi *et al.* 2012). The sub-Antarctic Magellanic forest ecoregion extends over South of the Gulf of Penas (49°S) and the archipelagoes reaching Cape Horn (56°S), forming one of the most pristine wilderness areas remaining on the planet (Rozzi *et al.* 2006; Sandvig *et al.* 2023). At the southern limit of this region, we find the world's southernmost forested ecosystems, which are protected by the Cape Horn Biosphere Reserve (CHBR), Chile (Rozzi *et al.* 2007). These forests are dominated by trees of the genus *Nothofagus*, which include the evergreen beech (*N. betuloides*), and the deciduous beeches (*N. pumilio*, *N. antarctica*) (Rozzi *et al.* 2014). Most forest bird species occupy the whole mosaic of evergreen, mixed, and deciduous forests (Aguirre *et al.* 2021; Quilodrán *et al.* 2022; Sandvig *et al.* 2020).

Among vertebrates, the avian community includes the largest number of species in these forests (Rozzi & Jiménez, 2014), making them ideal candidates to study the potential effects of climate on life history variables within and between species (Sandvig *et al.* 2023). However, sub-Antarctic forests are characterized by a relatively simple bird assemblage compared to their northern hemisphere counterparts. The bird assemblage that occupies the forests of the CHBR is composed of some thirty species belonging to 20 families of passerine and non-passerine birds (Ippi *et al.* 2009; Jara *et al.* 2020). Among the species that inhabit sub-Antarctic forests, most are generalist species (*i.e.* those that occupy different types of forest), and a few species restricted to a certain type of forest vegetation (Ippi *et al.* 2009). In addition, distribution patterns are related to the migratory or resident status of the bird's species. Of the total number of forest-related bird species in the CHBR, 70% are resident and 30% are migratory (Ippi *et al.* 2009). Due to the oceanic effect, the sub-Antarctic Magellanic ecoregion contains a greater proportion of resident species as compared to the subarctic forest that has a continental type of climate (Rozzi *et al.* 2014; Sandvig *et al.* 2020).

Several studies on songbirds in sub-Antarctic Magellanic forests have allowed a broad understanding of the forest bird assemblage (Anderson & Rozzi, 2000; Barros, 1976; Jara *et al.* 2020; Sielfeld, 1977; Venegas & Schlatter, 1999). However, many aspects of the ecology of the bird community and the autecology of several species in this region remain understudied (Schlatter & Vergara, 2005; Sandvig *et al.* 2023). To fill this gap in knowledge, in January 2000, the research team at the Omora Ethnobotanical Park initiated a Long-Term Ornithological Research Program (LTER) that has conducted a continuous mist-netting program of forest birds (Rozzi & Jiménez, 2014). The program aims to provide answers to basic ecological questions about sub-Antarctic avifauna, including life history, diet, migration patterns, ecological epidemiology, and morphology (Brown *et al.* 2007; Jara *et al.* 2020; McGehee *et al.* 2004; Merino *et al.* 2008).

The study of morphology in birds aims to explain the functional relationship between morphological variation, ecology, and taxonomy, which would support the integration of information on phylogenetic relationships among taxa (James, 1970). The similarity in bird morphology may demonstrate that comparisons in size and shape may be related to the occupancy of similar habitats, even if they are distant. From an evolutionary perspective, habitat selection should be related to bird morphology (Robinson & Holmes, 1982). Some studies suggest that differences in habitat,

related to the structure of vegetation, may influence foraging behavior, movement, and mobility and, therefore, some morphological characteristics such as beak shape or size, wing length, and tarsus may show variations, even in similar species and among populations of the same species (Holmes & Schultz, 1988; Nebel *et al.* 2005; Revelo Hernández *et al.* 2016). Morphological and body mass data provide essential information for studies of energetics, trophic and ecological interactions in general, as well as for the analysis of latitudinal size patterns (Atkinson & Sibly, 1997). Field morphological studies of birds involve bird captures, which, if accompanied by banding associated with capture-recapture studies, also make possible to investigate essential life history variables (*e.g.* longevity, territoriality) and migratory movements of some of the bird species. This is especially relevant for the study of bird populations at high latitudes where migratory movements and morphological variations tend to be especially accentuated (Anderson *et al.* 2002).

The White-throated treerunner (*Pygarrhichas albogularis*, King 1831), is considered a “living fossil” as it is the only living species of the genus *Pygarrhichas* (Couvé *et al.* 2016; Vuilleumier, 1985). In addition, it is a poorly known Furnariid endemic to the temperate forests of South America, mainly found in central and southern regions of Chile and Argentina (Martínez & González, 2004). Among the ovenbirds, only *Pygarrhichas* pecks in wood, but all the others have the bony internasal septum as part of their rynchokinetic bill. This suggests that an initial adaptation for pecking was modified as the middle portion of the bill became more flexible and better suited for probing in internodes of bamboo, splitting vines, and probing and prying among masses of dead leaves and debris suspended among vines and branches as well as in bromeliads (Fjeldså *et al.* 2005). The White-throated treerunner, is closely related and phylogenetically basal to a group of species living in dry open habitats, the Crag Chilia (*Ochetorhynchus melanurus*), the Band-tailed Earthcreeper (*O. phoenicurus*), the Straight-billed Earthcreeper (*O. ruficaudus*) and the Rock Earthcreeper (*O. andaecola*; Chesser *et al.* 2007; Fjeldså, 2007). This divergence has been associated with the creation of dry open habitats during the Andean uplift in the Miocene (Fjeldså *et al.* 2007), in the broader context of repeated shifts from forested to open habitats in the Furnariidae (Areta & Pearman, 2009; Fjeldså *et al.* 2005; 2007).

The White-throated treerunner is one of the four species of tree cavity excavators in the temperate forest of Chile (Altamirano *et al.* 2017). This species relies on habitats with the presence of trees suitable for excavation (*i.e.* snags; Blanc & Martin, 2012) and has been suggested as a key habitat facilitator for several avian and mammalian cavity-nesting species in southern South America (Altamirano *et al.* 2017). It is an insectivorous species and actively feeds on larvae, adult insects (Altamirano *et al.* 2012; Martínez & González, 2004), and other arthropods, by removing small pieces of bark along tree trunks and branches (Couvé *et al.* 2016; Martínez & González, 2004; Fig. 1). The White-throated treerunner is strictly arboreal and annual resident of the South American temperate forests (Reid *et al.* 2002), does not fly long distances, and moves from tree to tree, climbing them vertically with its legs and tail (Couvé *et al.* 2016; Goodall *et al.* 1946). In Chile, the White-throated treerunner is distributed between Santa Inés hill (32°9'31.51"S; 71°29'32.76"W) and the Cape Horn Archipelago (55°58'59.61"S; 67°16'00.69"W, Altamirano, 2018; Martínez & González, 2004).

In this study, we explored a critical aspect on the life history of the southernmost population of White-throated treerunners. Specifically, we investigated morphological measures and patterns of capture in the sub-Antarctic Magellanic Forest. In addition, we examined longevity and site presence using the 23-year capture-recapture data set of Omora Park in the CHBR, Chile.

Fig. 1. Photographs of the White-throated tree-runner (*Pygarrhichas albogularis*) on branches of *Nothofagus* tree species, showing its ventral side (a) and its dorsal side (b). On the left side picture (a), notice the band on the right tarsus of the bird, and on the right side picture (b) notice the insect in the beak of the bird. Photographs by Omar Barroso (Omora Park Archive).



## MATERIALS AND METHODS

### Study Area

Our study area is located within the CHBR, in the sub-Antarctic Magellanic region (Rozzi & Jiménez, 2014), at the very southern tip of the South American continent (Sandvig *et al.* 2023). Data were collected between May 2000 and September 2022 at four study sites as part of the Cape Horn LTER network (Rozzi *et al.* 2020). The two main sites are located at the Omora Ethnobotanical Park banding stations ("Canelo site" and "Notro site"; 54°57'S; 67°39'W). Omora Park is located three km west of the town of Puerto Williams, on the north coast of Navarino Island (Sandvig *et al.* 2023; Fig. 2). Two complementary studies sites are located outside Omora Park, on the northern coast of Navarino Island: "Guerrico" (54°55'S, 67°54'W) and "Laguna Zañartu" (54°55' S, 67°38'W; Fig. 2). "Canelo site", is a broadleaf evergreen forest site located within a large patch of old-growth forests dominated by Winter's bark (*Drymis winteri*) and Evergreen Beech (*Nothofagus betuloides*). "Notro site", is a forest edge site located at the ecotone formed by a patch of mixed evergreen and deciduous forests dominated by High-deciduous Beech (*N. pumilio*) and by a shrubland dominated by Firebush (*Embothrium coccineum*), Winter's bark, Fashine (*Chiliotrichum diffusum*), Box-leafed barberry (*Berberis buxifolia*), and Prickly heath (*Gaultheria mucronata*) (Rozzi & Jiménez, 2014). At these two sites, bird banding has been conducted every month since 2000 (Anderson & Rozzi, 2002). "Guerrico" and "Laguna Zañartu" are dominated by a patch of Firebush, Box-leafed barberry, and Prickly heath. "Guerrico" is adjacent to a fire regenerated forest of Evergreen Beech and High-deciduous Beech, and near the main dirt road along the northern coast of Navarino Island. In "Guerrico" and "Laguna Zañartu", bird-banding has been conducted at least once a year since 2000. The mean annual precipitation recorded near the banding station was ~500 mm, with a mean annual temperature of 6°C, ranging from 2°C in winter (July) to 10°C in summer (January; Brown *et al.* 2007; Ippi *et al.* 2009; Rozzi & Jiménez, 2014; Rozzi *et al.* 2014).

### Mist-netting program

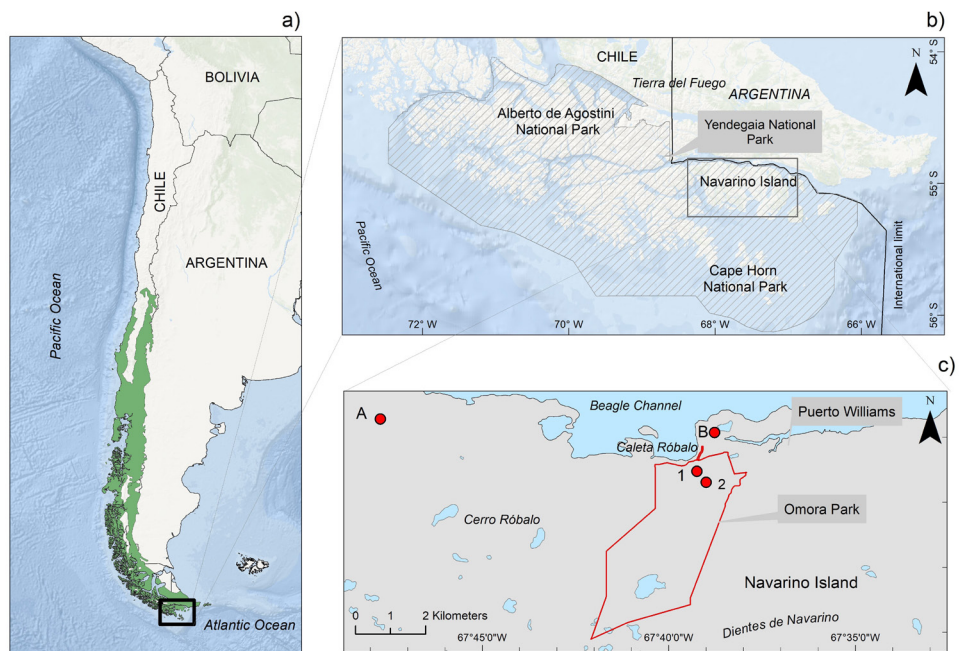
From 2000 to 2002, mist-nets were only used in spring, summer, and fall. Beginning in January 2003, mist-nets began to be used systematically throughout the year, including six consecutive days per month with a minimum of five hours each day. Two permanent sites were used: "Canelo site" and "Notro site". The six sampling days were divided into three days in each site. Mist-netting at "Guerrico" and "Laguna Zañartu" sites were conducted every year for a period of three days at least once during the reproductive season (November–March). To date, the

Fig. 2.

a) Map with the distribution of the South American temperate forests' biome, which largely coincides with the distribution area of *Pygarrhichas albogularis* (modified from Rozzi & Jiménez, 2014).

b) Map of the Cape Horn Biosphere Reserve “(area marked with diagonal lines)” that includes Navarino Island, where Omora Park is located.

c) Map of the two main study sites at Omora Park (1 = Canelo site; 2 = Notro site), and the two neighboring complementary study sites (A = Guerrico; B = Zañartu Lake) near the northern coast of Navarino Island. Figure prepared by Reinaldo Rivera.



program has produced a working database of over sixteen thousand bird captures, 91 of which were White-throated treerunner (excluding recaptures). The protocol of the banding program is as per Anderson *et al.* (2002). All procedures used comply with the laws of animal welfare in Chile (capture permit from the Servicio Agrícola y Ganadero (SAG), resolution No 2020/2023) and the bioethics protocol approved by the Universidad de Magallanes.

### Morphometric measurements

Each captured bird was identified, banded, and the following morphological measurements were taken (Fig. 3, see Pyle *et al.* 1987 and Rozzi & Jiménez, 2014 for more details):

- Tail length, defined as the length of the extended wing from the base to the tip of the longest primary feather, measured with an ornithological ruler with 1 mm accuracy.
- Full head, defined as the length the tip of the bill until the nape of the head; measured with a caliper with 0.1 mm accuracy.
- Bill length, defined as the length of the exposed culmen, measured with a caliper with 0.1 mm accuracy.
- Bill depth, defined as the height of the upper and lower mandibles measured perpendicular to the bill's length and at the anterior end of the nostrils, using a caliper with 0.1 mm accuracy,
- Bill width, defined as the width of the culmen, measured perpendicular to the bill's length and at the anterior end of the nostrils, using a caliper with 0.1 mm accuracy,

Fig. 3.  
Measurement of  
morphometric characters  
of the White-throated  
treerunner at the  
Notro site, Omora  
Ethnobotanical Park,  
Chile.



f) Tarsus length, measured with a caliper with 0.1 mm accuracy.

g) Wing length, defined as the length of the extended wing from the wrist to the tip of the longest primary feather, with the wing extended flat over (*i.e.* arch) an ornithological ruler with 1 mm accuracy.

h) Weight, measured with an electronic scale with 0.01 g accuracy or a Pesola scale of 30 g and 0.5 g accuracy for the majority of the species.

### Data analysis

Recapture data were examined to determine the minimum age of recaptured White-throated treerunner. Individuals were classified as at least one year old at the time of first capture unless it was a fledgling. In addition, we used capture data to determine recapture for every year and presence in each site.

Morphometric measures were compared using the Pearson correlation coefficient used for evaluating the morphological association variables among individuals. We checked for outliers using Cook's distance (D) before conducting the analyses. For tail length, tarsus length, wing length, and weight, one to two outliers (Cook's  $D > 1$ ) were identified and subsequently removed from the analysis due to their likely association with measurement errors. To evaluate differences in weight and season were compared using one-way ANOVA with a post-hoc HSD test. We performed statistical analyses and created graph using R software version 4.2.0 (R Core Team, 2021). In the analysis, "Summer" were January, February and March, "Autumn" included April, May and June, "Winter" were July, August, September, and "Spring" included October, November, December.

## RESULTS

### Morphometric measurements

Measurements exhibited differences in size among captured individuals (Table 1). The measurements showed the highest range of differentiation between individuals was for tail length (30 mm), wing length (25 mm), and full head (14.1 mm). Pearson's correlation showed a positive

Table 1.  
Mean morphological  
measurements  
( $\pm$ S.D.) of White-  
throated treerunners  
(*Pygarrhichas*  
*albogularis*) from  
Navarino Island in the  
Cape Horn Biosphere  
Reserve.

This Study\	Tail length mm	Full head mm	Bill length mm	Bill Depth mm	Bill width mm	Tarsus length mm	Wing length mm	Weight g
Mean	56.9 $\pm$ 4.5	44.8 $\pm$ 2.4	19.4 $\pm$ 2.5	5.1 $\pm$ 0.3	3.7 $\pm$ 0.4	21.1 $\pm$ 1	80.7 $\pm$ 4.1	23.8 $\pm$ 2.2
Range	40-69	40.2-54.3	14.2-28.8	4-6.5	3-4.8	17.6-23.7	63-88	19.3-29
n=142	n=111	n=87	n=120	n=112	n=115	n=116	n=131	n=131
B. Data from Rozzi & Jiménez 2014	Tail length mm	Full head mm	Bill length mm	Bill Depth mm	Bill width mm	Tarsus length mm	Wing length mm	Weight g
Mean	59.4 $\pm$ 3.6	44 $\pm$ 0.9	19.5 $\pm$ 3.0	5.2 $\pm$ 0.2	3.7 $\pm$ 0.3	22 $\pm$ 1	81.1 $\pm$ 2.5	23.5 $\pm$ 1.3
Range	52-65	42.9-45.6	16.0-23.8	4.9-5.7	3.2-4.2	20-23.7	76-86	21-26

relation between some of the head and bill measurements: Full head and bill length ( $r=0.86$ ,  $p<0.001$ ), full head and bill depth ( $r=0.87$ ,  $p<0.001$ ), full head and bill width ( $r=0.73$ ,  $p<0.001$ ), bill length and bill depth ( $r=0.74$ ,  $p<0.001$ ), bill width and bill depth ( $r=0.7$ ,  $p=2.03e-12$ ). Also, a positive relation was observed between tarsus length and both tail length ( $r=0.8$ ,  $p<0.001$ ) and wing length ( $r=0.8$ ,  $p<0.001$ ). The weight varied for each season on the captured specimens. In winter, the lowest mean weight was 23 ( $\pm 0.9$ ) g. By contrast, in Summer the highest mean weight was 25.3 ( $\pm 1.9$ ) g. No significant difference was observed in the weight of the White-throated treerunners concerning the season of the year ( $F^{(3,126)}=1.562$ ,  $p=0.2$ ; Fig. 4).

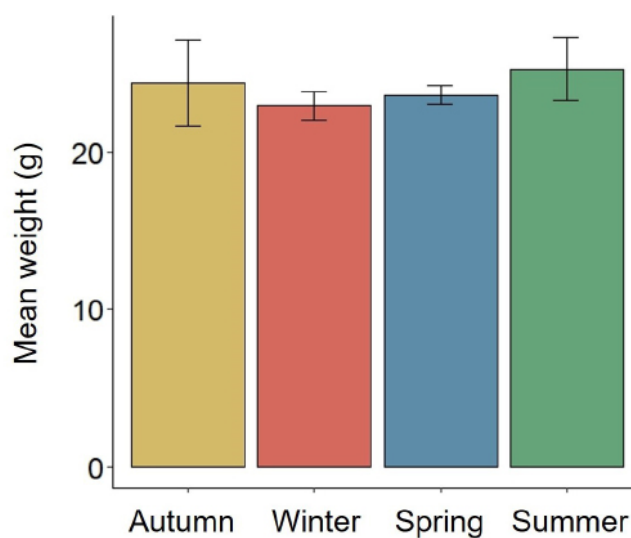


Fig. 4.  
Mean weight ( $\pm$  S.E.)  
of White-throated  
treerunners was  
compared between  
seasons  
(Autumn: Apr-  
May-Jun. Winter:  
Jul-Aug-Sep. Spring:  
Oct-Nov-Dec.  
Summer: Jan- Feb-  
Mar).



### Longevity and site presence

A total of 29 White-throated treerunner were recaptured during the 23 years of the study. Most recaptures were individuals 2 years old or less. However, several recaptures demonstrated that the White-throated treerunner of the Sub-Antarctic forests live for at least up to 5 years (Table 2). The interannual recaptures of the White-throated treerunners have been constant throughout the study period, although of the 23 years of sampling, there were no recaptures for 9 years (Table 3). The average percentage of recaptured individuals from 2000-2022 has been 35.5%. Of the total number of captures of White-throated treerunners, the highest recapture rate in a year was 58.3%. During the study years, practically all banded individuals have been recorded at the Canelo and Notro sites (Table 4). The movement of individuals between these two sites was recorded, specifically in the spring and winter periods within the same year. Canelo site presented the highest captures and recaptures of White-throated treerunners. No individuals were recorded moving from Canelo or Notro sites to the Guerrico or Laguna Zañartu sites, nor vice versa.

**Table 2.**  
Of the 91 White-throated treerunners captured in the Omora Ethnobotanical Park, 29 were individuals recaptured in more than one year. From this capture-recapture information the minimum age of individuals was determined.

Minimum age	Number of individuals
1	10
2	15
3	3
4	0
5	1
n	29

**Table 3.**  
The total White-throated treerunners captured and the number and percent that constituted recaptures during the 23-year study period.

	Captures N	Recaptures #	Recaptures %
2000	3	1	33.3
2001	0	0	0
2002	4	1	25
2003	8	1	12.5
2004	12	7	58.3
2005	6	2	33.3
2006	11	4	36.4
2007	3	0	0
2008	2	0	0
2009	2	0	0
2010	2	0	0
2011	3	1	33.3
2012	8	1	12.5
2013	8	1	12.5
2014	9	5	55.6
2015	5	0	0

2016	16	7	43.8
2017	14	5	35.7
2018	4	2	50
2019	2	0	0
2020	1	0	0
2021	1	0	0
2022	18	10	55.6

Table 4.  
The total White-throated treerunners captured. The number and percent that constituted recaptures in each study site.

Site	Captures	Recaptures #	Recaptures %	Number of Individuals
Canelo	96	37	38.54	59
Notro	32	10	31.25	28
Guerrico	4	0	0	4
Zañartu	1	0	0	1

## DISCUSSION

These data expand our understanding of a poorly known species inhabiting the sub-Antarctic forests. This study is particularly helpful as baseline information about populations of the White-throated treerunner inhabiting the southern extreme of its distribution range in the CHBR. However, detailed studies of the life history of this species are lacking in other parts of the Chilean and Argentinian temperate forests for comparative purposes. Two articles describe in general terms the morphometric measurements on the White-throated treerunner but correspond to the first years of sampling of the same research program from which the data for this publication were obtained (see Anderson *et al.* 2002; Rozzi & Jiménez, 2014). In this article, we updated data based on 23 years of captures, expanding upon these previous studies to Anderson *et al.* (2002), who considered two years, and Rozzi & Jiménez (2014), who considered 10 years in their study. Noticeably, the mean values of the morphological measurements did not change, but the range of values for each of the measurements did expand in our broader set of data (Table 1).

Different characteristics of bird species can be directly or indirectly related to aspects of bird ecology. For example, wing and tarsal morphology, in particular, is related to aspects of mobility in general (Luther & Greenberg, 2014) and habitat utilization (Pierre, 1994). Concerning morphometrics, James (1970) suggests that the minimum variable and the most valid indicator of body size for intra and interspecific comparisons in birds is wing length, but tail and tarsus length are better indicators of variation in proportions (Zink & Remser, 1986). The positive correlation between tarsus length and both tail and wing length in White-throated treerunners, indicates a balanced ratio in the body measurements of individuals in sub-Antarctic forests.

The ability of any organism to use its environment depends strongly on its ability to detect and obtain resources (Hardin, 1960), in addition to its ability to maneuver through the habitat (Schoener, 1974), which is influenced by wing and tail morphology (Brown & Wilson, 1956). White-throated treerunner is a strictly arboreal species, does not fly long distances, and moves from

tree to tree, climbing them vertically with its legs and tail. Its morphology was adapted to live in forest areas (Fjeldså *et al.* 2005; Goodall *et al.* 1946; Reid *et al.* 2002). Reif *et al.* (2015) determined that birds living in open or sparsely vegetated environments have large wings that allow them increased maneuverability in flight (Harvey & Haber, 1999). On the other hand, the morphology in the forest zone is similar to short-flying birds with short and broad wings, which are related to closed spaces with dense vegetation where they can have quick availability of food; due to the high maneuverability, they have because of their short wings and long tails (Jaroslaw *et al.* 2014; Revelo Hernández *et al.* 2016; Viscor & Fuster, 1987).

Morphometric variables are good indicators of possible differences in patterns of geographic variation in birds as well as possible differences between species coexisting in ecological communities (Weatherhead & Dufour, 2005). They also serve as a reference element to determine the impact of diseases, toxic agents, and nutritional stress (Miller *et al.* 1988; Rodríguez & Acosta, 2007). Anderson *et al.* (2002) described only four measures that could be compared (wing length, bill length, tarsus length, and weight) and showed results similar to those obtained in this study, evidencing that there are no changes that can be observed over time. Due to the close relationship between morphology and habitat characteristics, habitat alterations have the potential to change the morphology characteristics of assemblages (Revelo Hernández *et al.* 2016).

These are the only years' interval data that make it possible to determine the longevity of White-throated treerunner in the extreme south, where one recaptured individual has lived in the CHBR for at least five years. This information exceeds the record by Rozzi & Jiménez (2014), who describe a longevity of three years for this species. In addition, recaptured specimens demonstrate a high precision in habitat selection at the same sites. Importantly, Omora Park's mist-netting program has used almost the same locations for its mist nets since 2000. Therefore, the fact that the Canelo site presented the highest captures and recaptures of White-throated treerunners indicates the evident dependence on large trees for this species. For example, Fontúrbel & Jiménez (2014) describe the White-throated treerunner as a large-tree user and is abundant species in stands dominated by *Araucaria araucana* and *Nothofagus dombeyi*, which consist of characteristically tall canopy trees and relatively open understories. Also, Gantz *et al.* (2015) described the White-throated treerunner appears to have a disproportionate use for *Nothofagus dombeyi* as a feeding substrate in Los Lagos Region (40°54'S; 72°41'W). Similar characteristics are present in the "Canelo site" at Omora Park, an old-growth forest site dominated by Winter's bark and Evergreen Beech with an open understory. In contrast, the "Notro site" at Omora Park is a forest edge site formed by mixed evergreen, deciduous forests and shrubland. Probably the explanation for the lower presence of White-throated Treerunner in the Notro site is habitat type because this species is the only passerine species that is an obligate inhabitant of the forest interior, being absent from shrubland and open habitats (Ippi *et al.* 2009).

The use of old trees is a common pattern in the bark feeding bird guild (Gantz *et al.* 2015). Some references have suggested that White-throated Treerunner use old trees for feeding and nest building (Díaz *et al.* 2005; Wilson *et al.* 2005). The closed canopy stands offer a great quantity and richness of insects (Spagarino *et al.* 2001), which cover many of the food requirements for small bird species such as White-throated Treerunner (Lencinas *et al.* 2005). Feeding technique consists in lifting the tree bark in search of invertebrates and, occasionally, perforating the bark (Gantz *et al.* 2015; Ippi & Trejo, 2003). This feeding characteristic suggests the evolutionary character

of the White-throated Treerunner as the only ovenbird that pecks in at wood by modifying its bill (Fjeldså *et al.* 2005). We show that this feeding habit is related to the morphological characteristics evaluated, as there is a positive relation between bill measurements because bill length and shape have implications for foraging behavior (Durant *et al.* 2003), microhabitat selection (Grant, 1968), and diet (Durant *et al.* 2003; Grant, 1968).

Some species are detected as resident during the winter season on Navarino Island in the CHBR. Among them, during winter the White-throated treerunner form mixed flocks with Thorn-tailed Rayadito (*Aphrastura spinicauda*), and continue to search for larvae or insects inside the bark of trees for feeding (Lencinas *et al.* 2005). In winter, there may be a lower abundance of insects and other prey which may affect the use of substrates. This reduced food availability in winter is corroborated by the increased frequency, speed, and distance of flights and the high number of forest patches visited by each flock (Ippi & Trejo, 2003). This behavior on the White-throated treerunner suggests the continuous movement recorded between capture sites during winter periods. In Spring, however, White-throated treerunners can be observed in monospecific groups of up to seven individuals in the pre-breeding season (Ippi & Trejo, 2003).

## CONCLUSION

The analysis of morphological data presented above provides valuable baseline information for understanding the life history of the White-throated treerunner in sub-Antarctic forests, and to enable future comparisons with other populations of this species. In the future it would be valuable to define methods to determine sex and age to gain insights into other aspects of the White-throated treerunner's life history, behavior, and ecology the temperate and sub-Antarctic forests of South America. Until now, most observations have been anecdotal and here we have provided a first quantitative analysis of *Pygarrhichas albogularis*' morphology. Additional quantitative data on habitat associations, and the abundance of the species essential for its conservation would be valuable clarify the sensitivity to anthropogenic disturbances of the White-throated treerunner.

## ACKNOWLEDGMENTS

We would like to thank the numerous researchers, students, and volunteers who have participated in the Long-Term Ornithological Research Program of the sub-Antarctic Forests of Cape Horn was created at the Omora Ethnobotanical Park since January 2000, particularly to Steven McGehee, Sebastián Dardanelli, and Ronnie Reyes. Support was provided by the Universidad de Magallanes Doctoral Program in Sub-Antarctic and Antarctic Sciences, and Cape Horn International Center (CHIC ANID/BASAL FB210018), a Center of Technological Excellence of ANID-Chile Basal Financing. JTI also acknowledges the support from the Center of Applied Ecology and Sustainability-CAPES (ANID PIA/BASAL FB0002). We thank the reviewers who provided helpful comments on earlier drafts of the manuscript.

## LITERATURE CITED

Aguirre, F., Squeo, F.A., López, D., Crego, R., Buma, B., Carvajal, D., Jaña, R., Casassa, G., & Rozzi, R. (2021). Gradientes climáticos y su influyente rol sobre los ecosistemas terrestres de la Reserva de Biosfera Cabo de Hornos, Chile. *Anales del Instituto de la Patagonia*, 49: <https://doi.org/10.22352/AIP202149012>

- Altamirano, T.A. (2018). Comesebo grande (*Pygarrhichas albogularis*). Atlas de las aves nidificantes de Chile. In F. Medrano, R. Barros, H.V. Norambuena, R. Matus & F. Schmitt (Eds.), *Atlas de las aves nidificantes de Chile* (pp. 424-425). Red de Observadores de Aves y Vida Silvestre de Chile.
- Altamirano, T.A., Ibarra, J.T., Martin, K., & Bonacic, C. (2017). The conservation value of tree decay processes as a key driver structuring tree cavity nest webs in South American temperate rainforests. *Biodiversity and Conservation*, 26(10): 2453–2472. <https://doi.org/10.1007/s10531-017-1369-x>
- Altamirano, T., Ibarra, J.T., Hernández, F., Rojas, I., Laker, J., & Bonacic, C. (2012). *Hábitos de nidificación de las aves del bosque templado andino de Chile*. Fondo de Protección Ambiental, Ministerio del Medio Ambiente. Serie Fauna Australis, Facultad de Agronomía e Ingeniería Forestal, Pontificia Universidad Católica de Chile.
- Anderson, C.B., & Rozzi, R. (2000). Avian communities in the southernmost forests of the world: Methodological variations for determining species composition. *Anales del Instituto de la Patagonia*, 28: 89-100.
- Anderson, C.B., Rozzi, R., Elphick, C., & McGehee, S. (2002). El programa Omora de anillamiento de aves en los bosques subantárticos: La estandarización del tamaño de anillos apropiados para las aves de la Región de Magallanes. *Boletín Chileno de Ornitología*, 9: 2–11.
- Areta, J.I., & Pearman, M. (2009). Natural history, morphology, evolution, and taxonomic status of the Earthcreeper *Upucerthia saturator* (Furnariidae) from the Patagonian Forests of South America. *Condor*, 111(1): 135–149. <https://doi.org/10.1525/cond.2009.080009>
- Atkinson, D., & Silby, R.M. (1997). Why are organisms usually bigger in colder environments? Making sense of a life history puzzle. *Trends in Ecology & Evolution*, 12: 235-239.
- Barros, A. (1976). Nuevas aves observadas en las Islas Picton, Nueva, Lennox y Navarino oriental. *Anales del Instituto de la Patagonia*, 7: 190–193.
- Blanc, L.A., & Martin, K. (2012). Identifying suitable woodpecker nest trees using decay selection profiles in trembling aspen (*Populus tremuloides*). *Forest Ecology and Management*, 286: 192–202. <https://doi.org/10.1016/j.foreco.2012.08.021>
- Brown, W.L., & Wilson, E.O. (1956). Character displacement. *Systematic Zoology* 5: 49–64.
- Brown, C.E., Anderson, C.B., Ippi, S., Sherriffs, M.F., Charlin, R., McGehee, S., & Rozzi, R. (2007). The autoecology of the Fio-Fio (*Elaenia albiceps* Lafresnaye & D’Orbigny) in subantarctic forests of the Cape Horn Biosphere Reserve, Chile. *Anales del Instituto de la Patagonia*, 35 (2): 29–40.
- Chesser, R.T., Barker, F.K., & Brumfield, R.T. (2007). Fourfold polyphyly of the genus formerly known as *Upucerthia*, with notes on the systematics and evolution of the avian subfamily Furnariinae. *Molecular Phylogenetics and Evolution*, 44(3): 1320–1332. <https://doi.org/10.1016/j.ympev.2007.04.014>
- Couvé, E., Vidal, C., & Ruiz, J. (2016). *Aves de Chile: sus islas oceánicas y península Antártica*. Editorial Fantástico Sur.
- Díaz, I.A., Armesto, J.J., Reid, S., Sieving, K.E., & Willson, M.F. (2005). Linking forest structure and composition: Avian diversity in successional forests of Chiloé Island, Chile. *Biological Conservation*, 123 (1): 91–101. <https://doi.org/10.1016/j.biocon.2004.10.011>
- Durant, D., Fritz, H., Blais, S., & Duncan, P. (2003). The functional response in three species of herbivorous Anatidae: effects of sward height, body mass and bill size. *Journal of Animal Ecology*, 72 (2): 220–231.
- Fjeldså, J. (2007). The relationship between biodiversity and population centres: The high Andes region as an example. *Biodiversity and Conservation*, 16 (10): 2739–2751. <https://doi.org/10.1007/s10531-007-9204-4>
- Fjeldså, J., Irestedt, M., & Ericson, P.G. (2005). Molecular data reveal some major adaptational shifts in the early evolution of the most diverse avian family, the Furnariidae. *Journal of Ornithology*, 146 (1): 1–13. <https://doi.org/10.1007/s10336-004-0054-5>
- Fontúrbel, F.E., & Jiménez, J.E. (2014). Does bird species diversity vary among forest types? A local-scale test in southern Chile. *Naturwissenschaften*, 101 (10): 855–859. <https://doi.org/10.1007/s00114-014-1222-y>
- Gantz, A., Yañez, M., Orellana, J.I., Sade, S., & Valdivia, C.E. (2015). Tree species by White-throated treerunner (*Pygarrhichas albogularis* King) in a secondary native forest of southern Chile. *Iheringia - Serie Zoologia*, 105 (2): 193–198. <https://doi.org/10.1590/1678-476620151052193198>

- Goodall, J., Johnson, A. W., & Philippi, R.A. (1946). *Las aves de Chile: su conocimiento y sus costumbres* (1st ed). Platt Establecimientos Gráficos S.A.
- Grant, P.R. (1968). Bill size, body size and the ecological adaptations of bird species to competitive situations on islands. *Systematic Zoology*, 17: 319–333.
- Hardin, G. (1960). The competitive exclusion principle. *Science*, 131: 1292–1297.
- Harvey, C., & Haber, W. (1999). Remnant trees and the conservation of biodiversity in Costa Rica pastures. *Agroforestry System*, 44: 37–68.
- Holmes, R.T., & Schultz J.C. (1988). Food availability for forest birds: effects of prey distribution and abundance on bird foraging. *Canadian Journal of Zoology*, 66: 720–728.
- Ippi, S., Anderson, C.B., Rozzi, R., & Elphick, C.S. (2009). Annual variation of abundance and composition in forest bird assemblages on Navarino Island, Cape Horn Biosphere Reserve, Chile. *Ornitología Neotropical*, 20 (2): 231–245.
- Ippi, S., & Trejo, A. (2003). Dinámica y estructura de bandadas mixtas de aves en un bosque de lenga (*Nothofagus pumilio*) del noroeste de la Patagonia argentina. *Ornitología neotropical*, 14: 353–362.
- James, F.C. (1970). Geographic size variation in birds and its relationship to climate. *Ecology*, 51: 365–390.
- Jara, R.F., Crego, R.D., Samuel, M.D., Rozzi, R., & Jiménez, J.E. (2020). Nest-site selection and breeding success of passerines in the world's southernmost forests. *PeerJ*, 8:e9892 <https://doi.org/10.7717/peerj.9892>
- Jaroslaw, K.N., Justyna, S.D., & Remisiewicz, M. (2014). The further the flight, the longer the wing: relationship between wing length and migratory distance in Old World reed and bush Warblers (Acrocephalidae and Locustellidae). *Ornis Fennica*, 91: 178–186.
- Lencinas, M.V., Pastur, G.M., Medina, M., & Busso, C. (2005). Richness and density of birds in timber *Nothofagus pumilio* forests and their unproductive associated environments. *Biodiversity and Conservation*, 14 (10): 2299–2320. <https://doi.org/10.1007/s10531-004-1665-0>
- Luther, D., & Greenberg, R. (2014). Habitat type and ambient temperature contribute to bill morphology. *Ecology and Evolution*, 4 (6): 699–705.
- Martínez, D., & González, G. (2004). Las aves de Chile, nueva guía de campo. Santiago, Chile: Ediciones del Naturalista.
- McGehee, S., Rozzi, R., Ippi, S., Anderson, C., Vásquez, R., & Woodland, S. (2004). Late-Summer presence of the Patagonian Tyrant, *Colorhamphus parvirostris* (Darwin) in Navarino Island, Cape Horn County. *Anales del Instituto de la Patagonia* 32: 25–33.
- McGehee, S., Rozzi, R., Ippi, S., Anderson, C., Vásquez, R., & S. Woodland, S. (2004). Late-Summer presence of the Patagonian Tyrant, *Colorhamphus parvirostris* (Darwin) in Navarino Island, Cape Horn County. *Anales del Instituto de la Patagonia* 32: 25–33.
- Merino, S., Moreno, J., Vásquez, R., Martínez, J., Sánchez-Monsálvez, I., Estados, C., ... & McGehee, S. (2008). Haematozoa in forest birds from southern Chile: Looking for latitudinal gradients in prevalence and parasite lineage richness. *Austral Ecology*, 33(3): 329–340. <https://doi.org/10.1111/j.1442-9993.2008.01820.x>
- Miller, S.L., Gregg, M.A., Kuritsubo, A.R., Combs, S.M., Murdock, M.K., Nilsson, J.A., ... & Botzler, R. G. (1988). Morphometric variation in Tundra Swans: relationships among sex and age classes. *Condor*, 90: 802–815.
- Nebel, D.L., Jackson, R., & Elner, W. (2005). Functional association of bill morphology and foraging behaviour in calidrid sandpipers. *Animal Biology*, 55 (3): 235–243.
- Pierre, J.P. (1994). Effects of sexual dimorphism on feeding behaviour of the bartailed godwit (*Limosa lapponica*) at a Southern Hemisphere wintering site. *New Zealand Natural Sciences*, 21: 109–112.
- Pyle, P., Howell, S.N.G., Yunick, R.P., & Desante, D. F. (1987). *Identification Guide to North American Passerines*. Slate Creek Press.
- Quilodrán, C.S., Sandvig, E.M., Aguirre, F., Rivero-de-Aguilar, J., Barroso, O., Vasquéz, R.A., & Rozzi, R. (2022). The extreme rainfall gradient of the Cape Horn Biosphere Reserve and its impact on forest bird richness. *Biodiversity and Conservation* 31: <https://doi.org/10.1007/s10531-022-02353-5>

- R Core Team (2021). R: *A language and environment for statistical computing*. R Foundation for Statistical Computing. <https://www.Rproject.org/>
- Reid, S., Cornelius, C., Barbosa, O., Meynard, C., Silva-García, C., & Marquet, P.A. (2002). Conservation of temperate forest birds in Chile: implications from the study of an isolated forest relict. *Biodiversity and Conservation*, *11*: 1975–1990.
- Reif, J., Hořák, D., Křístín, A., Kopsová, L., & Devictor, V. (2015). Linking habitat specialization with species' traits in European birds. *Oikos*, *125*: 405–413.
- Revelo Hernández, C., Felipe, J., Ospina, C., José, J., Zerrato, G., & Murillo García, O.E. (2016). Morphometric Variation in the Assembly of Passerine Birds Present in Two Zones of Tropical Forest with Different Degrees of Disturbance. *Revista de Ciencias*, *20*: 125–137.
- Robinson, S.K., & Holmes, R.T. (1982) Foraging behaviour of forest birds: the relationship among search tactics, diet and habitat structure. *Ecology*, *63*: 1918–1931.
- Rodríguez, A., & Acosta, M. (2007). Morfometría y dieta del Guareo (Aramus guarauna) en dos zonas arroceras de Cuba. *Journal of Caribbean Ornithology*, *20*: 40–44.
- Rozzi, R., & Feinsinger, P. (2006). Desafíos para la conservación biológica en Latinoamérica. In R. Primack, R. Rozzi, P. Feinsinger, R. Dirzo, & F. Massardo (Eds.), *Fundamentos de Conservación Biológica: Perspectivas Latinoamericanas* (2nd ed.) (pp. 661–688). México: Fondo de Cultura Económica.
- Rozzi, R., Armesto, J.J., Gutiérrez, J.R., Massardo, F., Likens, G.E., Anderson, C.B., ... & Arroyo, M. T. K. (2012). Integrating ecology and environmental ethics: Earth stewardship in the southern end of the Americas. *Bioscience*, *62*: 226–236. <https://doi.org/10.1525/bio.2012.62.3.4>
- Rozzi, R., Massardo, F., Mansilla, A., Anderson, C. B., Berghöfer, A., Mansilla, M., ... & Barros, P. (2007). La Reserva de Biosfera Cabo de Hornos: un desafío para la conservación de la biodiversidad e implementación del desarrollo sustentable en el extremo austral de América. *Anales del Instituto de la Patagonia*, *35*: 55–62.
- Rozzi, R., Jiménez, J.E., Massardo, F., Torres-Mura, J.C., & Rijal, R. (2014). El Programa de Investigación Ornitológica a Largo Plazo del Parque Omora: sitios de estudio y métodos. In R. Rozzi & J. E. Jiménez (Eds.), *Ornitología subantártica de Magallanes: primera década de estudios de aves en el Parque Etnobotánico Omora, Reserva de Biosfera Cabo de Hornos* (pp. 3–39). Ediciones Universidad de Magallanes, Chile - University of North Texas Press.
- Rozzi, R., & Jiménez, J. E. (2014). *Magellanic sub-Antarctic ornithology: First decade of long-term bird studies at the Omora Ethnobotanical Park, Cape Horn biosphere reserve, Chile*. University of North Texas Press.
- Rozzi, R., Crego, R. D., Contador, T., Schüttler, E., Rosenfeld, S., Mackenzie, R., ... & Massardo, F. (2020). Un centinela para el monitoreo del cambio climático y su impacto sobre la biodiversidad en la cumbre austral de América: la nueva red de estudios a largo Plazo Cabo de Hornos. *Anales del Instituto de la Patagonia*, *48*: 4581.
- Sandvig, E.M., Quilodrán, C.S., Aguirre, F., Rivero De Aguilar, J., Barroso, O., Vásquez, R.A., & Rozzi, R. (2020). Patrones de distribución de la avifauna de los bosques de la Reserva de la Biosfera Cabo de Hornos: Un antecedente básico para la planificación del aviturismo sustentable. *Anales del Instituto de la Patagonia*, *48* (3): 169–183. <https://orcid.org/0000-0002-4180-000X>
- Sandvig, E.M., Quilodrán, C.S., Altamirano, T.A., Aguirre, F., Barroso, O., Rivero de Aguilar, J., ... & Rozzi, R. (2023). Survival rates in the world's southernmost forest bird community. *Ecology and Evolution*, *13* (6). <https://doi.org/10.1002/ece3.10143>
- Schlatter, R.P., & Vergara, P. (2005). Magellanic woodpecker (*Campephilus magellanicus*) sap feeding and its role in the Tierra del Fuego forest bird assemblage. *Journal of Ornithology*, *146*: 188–190.
- Schoener, T.W. (1974). Resource partitioning in ecological communities. *Science*, *185*: 27–39.
- Spagarino, C., Martínez Pastur, G., & Peri, P. (2001). Changes in Nothofagus pumilio forest biodiversity during the forest management cycle. 1. Insects. *Biodiversity and Conservation*, *10*: 2077–2092.
- Sielfeld, W.H. (1977). Reconocimiento macro-faunístico terrestre en el área de Seno Ponsonby (Isla Hoste). *Anales del Instituto de la Patagonia*, *8*: 275–297.

- Venegas, C., & Schlatter, R.P. (1999). Efecto de la intervención silvícola en bosques de *Nothofagus pumilio* sobre sus ensamblajes avifaunísticos estivales en Tierra del Fuego (Chile). *Anales del Instituto de la Patagonia*, 27: 41-50.
- Viscor, G., & Fuster, J. F. (1987). Relationships between morphological parameters in birds with different flying habits. *Comparative Biochemistry and Physiology*, 87 (2): 231-49.
- Vuilleumier, F. (1985). Forest Birds of Patagonia: Ecological Geography, Speciation, Endemism, and Faunal History. *Ornithology Monographs*, 35: 255-304.
- Weatherhead, P.J., & Dufour, K.W. (2005). Limits to sexual size dimorphism in Red-winged Blackbirds: the cost of getting big? *Biological Journal of the Linnean Society*, 85: 353-361.
- Willson, M.F., Sieving, K.E., & De Santo, T.L. (2005). Aves del bosque de Chiloé: diversidad, amenazas y estrategias de conservación. In C. Smith-Ramirez, J. J. Armesto & C. Valdovinos (Eds.), *Historia, biodiversidad y ecología de los bosques costeros de Chile* (pp. 468-476). Editorial Universitaria.
- Zink, R.M., & Remsen, J.V. Jr. (1986). Evolutionary processes and patterns of geographic variation in birds. *Current Ornithology*, 4: 1-69.

Apéndice: Afiliación declarada por cada uno de los autores

Afiliación	Nombre de la institución y/u organización Afiliación
a	Cape Horn International Center for Global Change Studies and Biocultural Conservation (CHIC), Universidad de Magallanes, Puerto Williams, Chile ✉ fjnovoagalaz@gmail.com
b	ECOS ( <i>Ecosystem-Complexity-Society</i> ) Co-Laboratory, Center for Local Development (CEDEL), Villarrica Campus, Pontificia Universidad Católica de Chile, Villarrica, Chile
c	National Audubon Society, Audubon Americas, Chile
d	Department of Ecosystems and Environment, Faculty of Agriculture and Natural Systems & Center of Applied Ecology and Sustainability (CAPES), Pontificia Universidad Católica de Chile, Santiago, Chile
e	Departamento de Ciencias Ecológicas, Facultad de Ciencias, Instituto de Ecología y Biodiversidad (IEB), Universidad de Chile, Santiago, Chile
f	Sub-Antarctic Biocultural Conservation Program, Department of Philosophy and Religion and Department of Biological Sciences, University of North Texas, Denton, Texas, USA

Autor	Afiliación
Fernando J. Novoa	a, b*
Rocio F. Jara	a, b
Omar Barroso	a
Tomás A. Altamirano	a, b, c
José Tomás Ibarra	a, b, d
Juan Rivero de Aguilar	a
Rodrigo A. Vásquez	a, e
Ricardo Rozzi	a, f