

Diversity and singularity of the avifauna in the austral peat bogs of the Cape Horn Biosphere Reserve, Chile

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Abstract

Ibarra, J.T., C.B. Anderson, T.A. Altamirano, R. Rozzi, and C. Bonacic. 2010. Diversity and singularity of the avifauna in the austral peat bogs of the Cape Horn Biosphere Reserve, Chile. Cien. Inv. Agr. 37(1): 29- 43. *Sphagnum*-dominated peat bogs that are strongly embedded within the southern temperate forest matrix are increasingly being used for agriculture. Nevertheless, little is known about their biodiversity. Moreover, the remote areas of southern Chile where peat bogs are found, such as the Cape Horn Biosphere Reserve (CHBR, 54-55°S), where birds are the most diverse and best represented group of vertebrates, have not been well-investigated. With the aim to broaden this knowledge in the CHBR, we studied the diversity of the avian assemblage in peat bogs on Navarino Island. We compared the composition of avian species between wetlands with and without peat bogs to test if *Sphagnum* bogs represented a singular habitat for birds in this area. Furthermore, the 37 bird species recorded in these habitats were classified according to guild structure. The community similarity values showed that peat bogs hosted a bird composition that was different from that present in wetlands without *Sphagnum*, suggesting that peat bogs are a singular type of habitat for birds in the CHBR. The most frequently feeding groups recorded in these wetlands were insectivores (48.7%), followed by omnivores (23.1%). Our results showed that, in contrast to previous studies of birds in peat bogs, these environments constituted a distinct wetland habitat for feeding, reproduction and sheltering for some species in the CHBR. Thus, plans for the conservation and rational use of peat ecosystems should consider the high value of these habitats for biodiversity on a landscape scale, especially for birds of the southernmost extreme of the Americas.

Key words: Assemblage, Cape Horn Biosphere Reserve, Navarino Island, Patagonia, *Sphagnum* spp., wetlands.

Introduction

Sphagnum-dominated peat bogs are being increasingly used in extractive industries, such as

the removal of the organic layer of peat for agricultural uses because of its high quality as a substrate for horticulture, floriculture, fruticulture, clearings and hydroponic activities (de la Balze *et al.*, 2004). Peat is also used as a cover that improves other soils and as organic matter for the cultivation of fungi (Arroyo *et al.*, 2005). The third article of the Chilean Organic Law consid-

ers peat to be a mining resource, licensable for exploitation to any interested party (Henríquez, 2004), although anyone planning to exploit peat is now obliged to undergo an environmental impact study (Hauser, 1996). Lappalainen (1996) estimates that 1,400,000 ha of peat bogs (c. 33% of the total surface of the wetlands) are potentially exploitable in the Aysén and Magallanes Regions of southern Chile.

Peat bogs are embedded throughout the southern temperate forest matrix in southern South-America (Arroyo *et al.*, 2005), and they are the result of high precipitation and low temperatures (Roig *et al.*, 2001). Wetland environments cover 23.5% of the total surface of the Magallanes and the Chilean Antarctic Region, where peat bogs are the most representative type of wetland (Arroyo *et al.*, 2005), reaching 800,000 ha (Henríquez, 2004). In the Cape Horn Biosphere Reserve (CHBR, 54 to 55° S), vast terrestrial zones are covered by peat bogs dominated by *Sphagnum* spp., particularly the southern and western portions of the archipelago (Rozzi *et al.*, 2006).

Similarly, birds are an abundant and diverse portion of the biotic assemblage in the CHBR (Venegas and Sielfeld, 199; Anderson *et al.*, 2006). The first ornithological studies in these Sub-Antarctic environments covered different islands of the archipelago south of the Beagle Channel (e.g., Oustalet, 1891; Reynolds, 1935; Olrog, 1950; Barros 1971, 1976; Sielfeld, 1977; Venegas, 1981, 1991; Venegas and Sielfeld, 1998). However, none were focused on the ecology of birds inhabiting peat bogs. After these surveys, and principally during the last decade because of the establishment of the Omora Sub-Antarctic Bird Observatory, knowledge about forest birds has increased substantially in Cape Horn, specifically on Navarino Island (e.g., Anderson and Rozzi, 2000; Anderson *et al.*, 2002; McGehee *et al.*, 2004; Ippi and Rozzi, 2004; McGehee and Eitnienar, 2006; Brown *et al.*, 2007; McGehee and Eitnienar, 2007a, 2007b, Ippi *et al.*, 2009). Nevertheless, the bird assemblages that use peat bog habitats in this area have not yet been studied, unlike the zones north of the Magallanes Region (51° to 53° S) such as Puerto Natales and Tierra del Fuego (TDF) (e.g., Humphrey *et al.*, 1970;

Venegas, 1976; Venegas and Jory, 1979; Guzmán *et al.* 1986; Blanco *et al.*, 2004; Schlatter, 2004).

Therefore, the scarcity of knowledge about the ecology of bird assemblages that use peat bogs south of TDF, the vast extent of the peat bog environment in the area, and the availability of peat bogs for licensable exploitation makes peat bogs and their biodiversity subjects for priority study in the CHBR. It also bears mentioning that this area has been identified as one of the 24 remaining “pristine wilderness areas” in the world (Mittermeier *et al.*, 2002); however, it is under increasing pressures due to growing connectivity, urban growth, alien species invasion and tourism development (Anderson *et al.*, 2006; Rozzi *et al.*, 2006; Arango *et al.*, 2007; Ibarra *et al.*, 2009a; Schüttler *et al.*, 2010).

In this context, the objectives of this study were: i. to determine the species composition, richness, and relative abundances of birds using *Sphagnum*-dominated peat bog wetlands, ii. to explore whether bird composition in *Sphagnum* peat bogs differs from wetlands without *Sphagnum*, to determine whether peat bogs represent a distinct habitat for birds in this landscape, and iii. to carry out classification according to habitat requirements, guild structure and the most frequent activities for bird species inhabiting peat bogs in the CHBR.

Materials and methods

Study area

The study was carried out on Navarino Island (54°55'S, 67°W, 2,528 km²), which is part of the CHBR (Figure 1). The area has a mean annual temperature of 6°C and rainfall of 467.3 mm (di Castri and Hajek, 1976). The eco-region belongs to the Sub-Antarctic Magellanic forests, where the mosaic of different habitats includes: 1. evergreen forests; 2. deciduous forests; 3. high-Andean habitats; 4. tundra formations (which include *Sphagnum*-dominated peat bogs); and 5. freshwater ecosystems (Pisano, 1977).

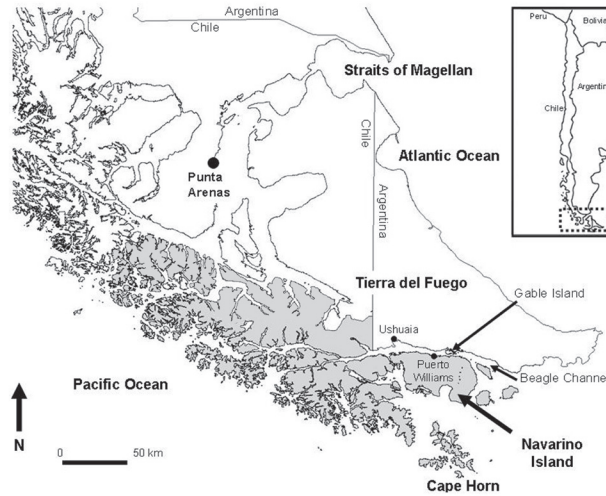


Figure 1. Map of southern South America, showing the Cape Horn Biosphere Reserve (in gray). Study sites were located on Navarino Island (54-55°S), Chile.

Regarding peat bogs, *Sphagnum magellanicum* is the dominant bryophyte species in these formations (Rozzi *et al.*, 2006). In some cases, *Nothofagus antarctica*, a tree species adapted to flooded zones, and *Marsippospermum grandiflorum*, are also present (Moore, 1983). The peat bog-forest ecotone includes tree species like *N. pumilio* and *N. betuloides*, which never reach a growth that is comparable to forest sites (Sielfeld, 1977). In peat bog-shrub ecotones, bush species like *Berberis buxifolia*, *B. ilicifolia*, *Chilotrimum diffusum*, and *Empretrum rubrum* are also present. Finally, there are several sites presenting peat bog-grassland transitions.

Bird sampling

A total of 49 wetlands were surveyed on Navarino Island in preliminary avian surveys. Next, a random subsample of 10 wetlands was selected for systematic bird sampling. These 10 wetlands

were identified as natural lentic waterbodies (“natural lentic”), following the classification system proposed by Ramírez and San Martín (2006). These authors categorized peat bogs and other types of wetlands that were exclusively freshwater and flooded. Accordingly, five wetlands surrounded by a *Sphagnum* matrix (i.e., *Sphagnum*-dominated peat bogs, wetlands 3, 4, 5, 6, and 7 in this study), and five without peat bogs (wetlands 1, 2, 8, 9, and 10) were sampled (Table 1). All sites were situated between sea level and an elevation of 379 m, and they were separated by a minimum distance of 1.5 km and a maximum distance of 7.5 km.

During 2006, we conducted a seasonal sampling of birds to obtain the best representation of the avian assemblages because there is high bird dynamism in the area throughout the year (Ibarra *et al.*, 2009b). However, the compositional statistical analysis (i.e., a comparison between the assemblages found in wetlands that were or were not within peat bogs) was concentrated only on the breeding season, as all bird species recorded

Table 1. General characteristics of ten wetlands studied on Navarino Island, Cape Horn Biosphere Reserve, Chile.

Wetland number	Geographic position UTM ¹	Pond size, ha	<i>Sphagnum</i> peat bogs ²
1	3911991	7.38	
	594707		
2	3912036	23.84	
	586920		
3	3911164	2.44	X
	587149		
4	3910637	3.04	X
	588622		
5	3912079	1.48	X
	581337		
6	3916006	0.83	X
	566397		
7	3912282	2.93	X
	563368		
8	3912708	12.04	
	564743		
9	3912265	20.9	
	573934		
10	3906193	6.13	
	583626		

¹ Geographic position in WGS 84 (DATUM) was measured at the northern point of each wetland.

² Classification follows Ramírez and San Martín (2006).

in the breeding season were present during the non-breeding season as well.

Bird species and individuals were recorded in each wetland between 6:00 a.m. and 11:30 a.m. The number of individuals belonging to each bird species was identified and recorded by the bird vocalizations or using binoculars (10x30 and 10x42). Sampling stations with a variable radius of 25 m were used (Ralph *et al.*, 1995; González and Victoriano, 2005). To obtain a good representation of the habitats adjacent to bodies of water, the location where these habitats show if they are actually embedded in a *Sphagnum*-dominated peat bog or not, 12

sampling stations were arranged per wetland. These stations were configured systematically and separated by a distance of at least 100 m, to avoid recording of the same individuals in neighboring stations (Bibby *et al.*, 1992; Rozzi *et al.*, 1996a). Sampling stations were arranged in four 200 m transects, starting from the edge of each body of water, established according to the cardinal points. Therefore, the first station was placed in each transect at the edge of the water surface (north, south, east and west), and from that station the other two stations were established at 100 and 200 m from the edge of the body of water inwards. Wetlands were actually considered “*Sphagnum*-dominated peat bogs”

if at least 70% of the stations at 100 and 200 m from the shore were established over *Sphagnum* spp. The remaining sampling stations (<30%) of *Sphagnum*-dominated peat bog wetlands were mainly present in either bog-forest, bog-shrub or bog-grassland ecotones.

Birds heard or observed from the center of the station were recorded during a period of 5 min, and their activity was described as: resting or swimming, flying, alarming, feeding, fighting, courting or vocalizing, (Ralph *et al.*, 1995; Rozzi *et al.*, 1996b). The vocalizing (i.e., sound record) category was attributed to a species when it was only identified by its vocalization, without determining its specific activity. A total of 2,400 min of bird sampling were completed.

Finally, guild structure of the assemblage was determined for aquatic and aquatic/terrestrial birds recorded in peat bogs. Microhabitat associations were determined by means of direct observation (species present on shores, sea-coasts, open waters or rushes at the moment of its registration). Feeding habits for these species were described according to field observations and the available literature (Rottmann, 1995; Araya and Millie, 1996; Ippi *et al.*, 2003; Martínez and González, 2004; McGehee and Eitnienar, 2006; McGehee and Eitnienar, 2007a, 2007b).

Statistical analysis

The bird species composition, richness and relative abundances, in terms of the total number of individuals recorded in all wetlands within a *Sphagnum*-dominated peat bog, were determined. The Shannon-Weaver (H') diversity index was calculated (Zar, 1984). A Student's *t* test was performed to determine if the richness and abundance values of birds in peat bogs were

different from those obtained in other types of wetlands (Scheiner and Gurevitch, 1993).

The Jaccard (Cj) index of taxonomic similarity was calculated to explore how similar wetlands and their respective matrices were in terms of their bird-specific compositions (Magurran, 1988). Jaccard values range between 0 and 1, where 1 indicates complete similarity (equal clustering of species) and 0 indicates dissimilarity (no common or shared species) (Schemnitz, 1980). With this information, the difference in the levels of similarity was tested both within and between two different habitat types, *Sphagnum*-dominated peat bog wetlands and wetlands without peat bog. A one-way analysis of variance (ANOVA) was performed, and the means were separated according to the Posthoc Tukey's test (Koenen and Gale, 2000). All analyses were performed with the program SPSS 10.0 (SPSS, Chicago, USA, 1999).

Results

A total of 56 bird species were recorded in the peat bogs and other types of wetlands present on Navarino Island. From the total number of bird species found in these sub-Antarctic wetlands, 66.1% (37 species) were recorded in *Sphagnum*-dominated peat bog wetlands (Table 2), which constitutes 7.9% of the birds found in Chile (Martínez and González, 2004) and 23.8% of the species recorded south of the Beagle Channel (Couve and Vidal, 2000). The species richness values varied between 13 and 21 for peat bog wetlands, while the abundance ranged from 102 to 244 individuals per station and diversity was between 2.29 and 2.68 (Table 2). All three of these variables (richness, abundance and diversity) did not show significant differences ($p > 0.05$) between *Sphagnum*-dominated peat bogs and wetlands without peat.

Table 2. Composition, number, relative abundances and species diversity indexes for five peat bog wetlands in the Cape Horn Biosphere Reserve. Additionally, species not registered in *Sphagnum*-dominated peat bogs but only in other wetland types are indicated.

Family	Scientific name	<i>Sphagnum</i> dominated wetland					TOTAL	Relative value
		Nº 3	Nº 4	Nº 5	Nº 6	Nº 7		
Anatidae	<i>Anas flavirostris</i>	3	10	3	6	0	22	0.025
	<i>Anas georgica</i>	0	20	11	0	0	31	0.035
	<i>Anas sibilatrix</i>	2	0	0	0	0	2	0.002
	<i>Chloephaga picta</i>	9	10	25	+	18	62	0.069
	<i>Chloephaga poliocephala</i>	0	2	0	0	0	2	0.002
	<i>Lophonetta specularioides</i>	0	2	3	0	0	5	0.006
	<i>Tachyeres patachonicus</i>	2	2	0	0	0	4	0.004
Ardeidae	<i>Nycticorax nycticorax</i>	0	0	+	0	0	0	0.000
Threskiornithidae	<i>Theristicus melanopus</i>	0	4	0	+	0	4	0.004
Falconidae	<i>Caracara plancus</i>	+	7	4	2	4	17	0.019
	<i>Falco sparverius</i>	1	0	2	0	0	3	0.003
	<i>Milvago chimango</i>	8	6	8	5	7	34	0.038
Charadriidae	<i>Charadrius modestus</i>	0	0	0	0	4	4	0.004
	<i>Vanellus chilensis</i>	0	8	2	0	0	10	0.011
Scolopacidae	<i>Gallinago paraguaiiae</i>	0	0	0	2	0	2	0.002
Laridae	<i>Larus dominicanus</i>	2	1	1	0	0	4	0.004
Psittacidae	<i>Enicognathus ferrugineus</i>	2	+	1	0	0	3	0.003
Picidae	<i>Campephilus magellanicus</i>	5	1	0	2	0	8	0.009
Furnariidae	<i>Aphrastura spinicauda</i>	54	42	35	49	17	197	0.220
	<i>Cinclodes fuscus</i>	0	0	0	+	+	0	0.000
	<i>Cinclodes patagonicus</i>	0	3	1	0	+	4	0.004
	<i>Pygarrhichas albogularis</i>	4	0	0	3	0	7	0.008
Rhynocriptidae	<i>Scytalopus magellanicus</i>	0	0	0	2	0	2	0.002
Tyrannidae	<i>Anairetes parulus</i>	2	1	4	7	0	14	0.016
	<i>Colorhamphus parvirostris</i>	0	0	0	2	0	2	0.002
	<i>Elaenia albiceps</i>	12	7	3	7	1	30	0.034
	<i>Lessonia Rufa</i>	0	0	0	0	0	0	0.000
	<i>Muscisaxicola maclovianus</i>	0	+	+	+	0	0	0.000
	<i>Xolmis pyrope</i>	4	6	4	10	14	38	0.043
Hirundinidae	<i>Tachycineta meyeri</i>	8	22	1	10	1	42	0.047
Troglodytidae	<i>Cistothorus platensis</i>	0	0	0	3	0	3	0.003
	<i>Troglodytes musculus</i>	6	8	7	21	6	48	0.054
Turdidae	<i>Turdus falckandii</i>	27	37	11	10	3	88	0.098
Emberizidae	<i>Phrygilus patagonicus</i>	21	20	10	12	5	68	0.076
	<i>Zonotrichia capensis</i>	9	20	16	13	15	73	0.082
Icteridae	<i>Curaeus curaeus</i>	0	0	0	3	0	3	0.003
Fringillidae	<i>Carduelis barbata</i>	11	5	22	13	7	58	0.065
	Species richness	20	23	21	20	13		
	Total number of birds	192	244	174	182	102		
	H' (log _e)	2.46	2.68	2.56	2.50	2.29		

Not registered in *Sphagnum* bogs but in other wetland types:

Anatidae	<i>Anas platalea</i>
	<i>Chloephaga hybrida</i>
	<i>Tachyeres pteneres</i>
Podicipedidae	<i>Podiceps major</i>
	<i>Rollandia rolland</i>
Phalacrocoracidae	<i>Phalacrocorax atriceps</i>
	<i>Phalacrocorax brasilianus</i>
Accipitridae	<i>Accipiter bicolor</i>
	<i>Geranoaetus melanoleucus</i>
Rallidae	<i>Fulica armillata</i>
Haematopodidae	<i>Haematopus leucopodus</i>
Scolopacidae	<i>Tringa melanoleuca</i>
Stercorariidae	<i>Stercorarius chilensis</i>
Laridae	<i>Leucophaeus scoresbii</i>
	<i>Sterna hirundinacea</i>
Hirundinidae	<i>Pygochelidon cyanoleuca</i>
Motacillidae	<i>Anthus correndera</i>
Emberizidae	<i>Melanodera xanthogramma</i>
Icteridae	<i>Sturnella loyca</i>

+, indicates presence but out of the systematic sampling.

The highest similarity values were obtained between wetlands 4 and 5 (0.769) and wetlands 3 and 5 (0.640) (all *Sphagnum*-dominated peat bogs). In contrast, the lowest values were obtained between wetlands 1 and 10 (0.250) (wetland 1 was

near the sea). Overall, the community similarity values between wetlands indicated that the bird composition in *Sphagnum*-dominated peat bogs significantly differed from that in wetlands without peat ($F_{2,42} = 9.028$; $p = 0.0005$) (Figure 2).

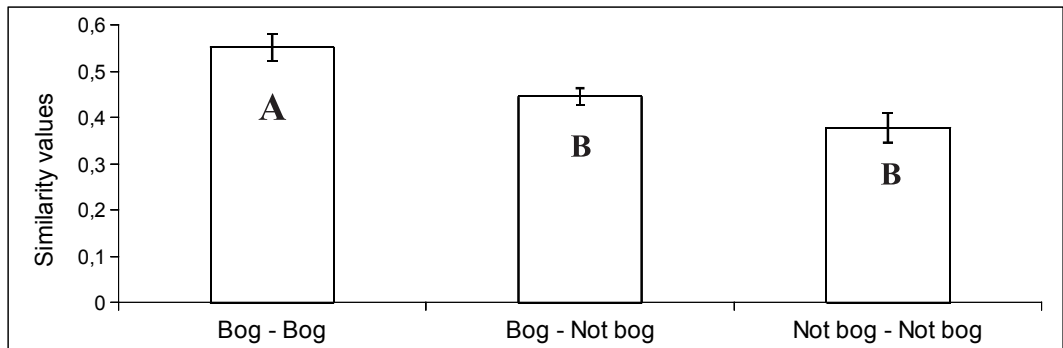


Figure 2. Similarity values (Jaccard Index) for the bird community compositions in wetlands with and without *Sphagnum*-dominated peat bogs. Bars with distinct letters were significantly different according to the Posthoc analysis of Tukey ($F_{2,42}=9.028$; $p=0.0005$). Small bars are \pm standard deviation.

a lagoon and 10 was a pond at 379 m.a.s.l.) and wetlands 2 and 10 (0.250) (wetland 2 was a lake

Regarding the guild structure of aquatic and aquatic/terrestrial birds in terms of feeding habits

and microhabitat association, the most abundant categories were the omnivores that were associated with open waters (n=5: *Anas flavirostris*; *A. georgica*; *Larus dominicanus*; *Lophonetta specularioides*; and *Tachyeres patachonicus*), followed by the omnivores that were associated with shores (n=3: *Charadrius modestus*; *L. dominicanus*; and *Vanellus chilensis*) (Table 3).

Table 3. Habitat, feeding habits and microhabitat for birds in peat bogs of the Cape Horn Biosphere Reserve.

Species	Habitat ¹	Feeding habits ²	Micro-habitat
<i>Anas flavirostris</i>	A	O	Open waters
<i>Anas georgica</i>	A	O	Open waters
<i>Anas sibilatrix</i>	A	H	Open waters
<i>Chloephaga picta</i>	A/T	H	Shores/Open waters
<i>Chloephaga poliocephala</i>	A/T	H	Shores/Open waters
<i>Lophonetta specularioides</i>	A	O	Open waters
<i>Tachyeres patachonicus</i>	A	O	Open waters
<i>Nycticorax nycticorax</i>	A/T	C	Shores/Coasts
<i>Theristicus melanopus</i>	T	I	
<i>Caracara plancus</i>	T	C	
<i>Falco sparverius</i>	T	C-I	
<i>Milvago chimango</i>	T	C-I	
<i>Charadrius modestus</i>	A/T	O	Shores/Coasts
<i>Vanellus chilensis</i>	A/T	O	Shores
<i>Gallinago paraguaiaea</i>	A/T	I	Rushes
<i>Larus dominicanus</i>	A/T	O	Shores/Coasts/Open waters
<i>Enicognathus ferrugineus</i>	T	H	
<i>Campephilus magellanicus</i>	T	I	
<i>Aphrastura spinicauda</i>	T	I	
<i>Cinclodes fuscus</i>	A/T	I	Shores
<i>Cinclodes patagonicus</i>	A/T	I	Shores/Coasts
<i>Pygarrhichas albogularis</i>	T	I	
<i>Scytalopus magellanicus</i>	T	I	
<i>Anairetes parulus</i>	T	I	
<i>Colorhamphus parvirostris</i>	T	I	
<i>Elaenia albiceps</i>	T	I	
<i>Lessonia rufa</i>	T	I	
<i>Muscisaxicola maclovianus</i>	T	I	
<i>Xolmis pyrope</i>	T	I	
<i>Tachycineta meyeri</i>	T	I	
<i>Cistothorus platensis</i>	A/T	I	Rushes
<i>Troglodytes musculus</i>	T	I	
<i>Turdus falckandii</i>	T	O	
<i>Phrygilus patagonicus</i>	T	H	
<i>Zonotrichia capensis</i>	T	H	
<i>Curaeus curaeus</i>	T	O	
<i>Carduelis barbata</i>	T	H	

¹ A: aquatic, T: terrestrial.

² C: carnivores, H: herbivores (including granivores), I: insectivores and other invertebrates, O: omnivores.

Considering all of the recorded species, including the aquatic, aquatic/terrestrial and terrestrial birds, the most frequent feeding habit was that of the insectivores (48.7%), followed by the omnivores (23.1%), herbivores (17.9%), and carnivores (10.3%) (Table 3).

In relation to the categories of activity, birds were observed flying in 40% of the cases. *Anas sibilatrix*, *Caracara plancus*, *Carduelis barbata*, *Encicognathus ferrugineus* and *L. dominicanus* were the species that presented the highest proportion of birds performing this activity, reaching 74% of the records. The second most represented category, in relative terms, was the sound record (23%). *Colorhamphus parvirostris*, *Elaenia albiceps*, *Pygarrhichas albogularis* and *Scytalopus magellanicus* were detected in high proportions by means of their vocalization (>74%). Resting (15%) was the third most represented category: *A. georgica*, *Curaeus curaeus*, and *T. patachonicus* showed this activity in more than 63% of the cases. Two species, *Aphrastura spinicauda* and *T. patachonicus*, often showed an alarm behavior (>32%). *Campephilus magellanicus* (38%), *Cinclodes patagonicus* (33%), *L. specularioides* (50%) and *V. chilensis* (50%) were the four species with the highest dedication to feeding. Only one species, *Chloephaga poliocephala* (33%), was observed fighting. Finally, only *Cistothorus platenses* (20%) presented courting behavior during the sampling (Table 4).

Discussion

This work provides new information on the natural history, diversity and community structure of the birds that inhabit *Sphagnum*-dominated peat bogs in the CHBR. Our results show that, unlike previous works on the avifauna present in peat bogs in other zones in Patagonia (Sielfeld, 1977; Venegas, 1976, 1981, 1991; Guzmán *et al.* 1986; Venegas and Sielfeld, 1998; Blanco *et al.*, 2004; and Schlatter, 2004), these environments shelter a significant portion of the avian diversity found on Navarino Island in the Cape Horn Biosphere Reserve. Our records of species richness ($n = 37$) in peat bogs is much higher than those obtained in studies conducted farther north in the Magallanes Region (e.g., Venegas, 1976, $n = 3$ species; Guzmán *et al.*, 1986, $n = 6$

species; Blanco *et al.*, 2004, $n = 6$ species; and Schlatter, 2004, $n = 25$ species). In general, the previously mentioned studies consisted of specific samplings of a few days during one season (except Schlatter 2004), which could explain the lower numbers of species recorded, and in turn highlight the value of long-term research programs (Anderson *et al.*, 2008). Furthermore, ecotone zones were considered in our study (e.g., bog-forest, bog-shrub and bog-grassland), and freshwater birds were included; both of these aspects could have influenced the high number of species observed in this study.

The increasing exploitation and consecutive isolation of peat lands have been reported as main factors affecting bird diversity at the landscape scale (Calmé and Desrochers, 2000). In contrast, in the CHBR the mosaic of different habitat types represents a very rare example of the non-fragmented areas in the world (Rozzi *et al.*, 2006). This characteristic of the study area, in addition to our results showing a higher diversity of birds in peat bogs within the CHBR than in other nearby areas, suggests that the importance of peat bog ecosystems for a particular area is probably contingent on the matrix of habitats found in the broader landscape. Consequently, in the CHBR, where peat bogs are more abundant and connected with other heterogenic and undisturbed habitats, this environment could occupy a more prominent role in determining the landscape-level species assemblages of avifauna. Therefore, landscape measures are necessary, but probably not sufficient, to describe the patterns of bird diversity found in the CHBR.

Based on our findings, we put forward that *Sphagnum*-dominated peat bogs represent a unique wetland habitat for a significant portion of the avian community in the CHBR. This position is supported by the fact that the assemblages found in these peat bogs are highly divergent from those of other wetland types (Similarity index, Figure 2). At the same time, the species composition within peat bogs tends to be the very uniform (i.e., displaying a high degree of similarity among these peat bogs). This result could be interpreted at least in two different ways: (1) when the rest of the wetlands are grouped as "of other type", their intrinsic variability is not being

Table 4. Relative frequency of activity categories for each bird species recorded in peat bogs of the Cape Horn Biosphere Reserve.

Species	n	Fighting	Feeding	Flying	Alarming	Courting	Resting or swimming	Vocalizing record	Total
<i>Anairetes parulus</i>	14		0.18	0.36				0.45	1
<i>Anas flavirostris</i>	22			0.47			0.53		1
<i>Anas georgica</i>	31			0.36			0.64		1
<i>Anas sibilatrix</i>	2			1.00					1
<i>Aphrastura spinicauda</i>	197		0.10	0.17	0.47			0.26	1
<i>Campephilus magellanicus</i>	8		0.38	0.50				0.13	1
<i>Caracara plancus</i>	17			0.75			0.19	0.06	1
<i>Carduelis barbata</i>	58		0.04	0.76			0.08	0.12	1
<i>Charadrius modestus</i>	4			0.50			0.50		1
<i>Chloephaga picta</i>	62		0.05	0.55			0.40		1
<i>Chloephaga poliocephala</i>	2	0.33		0.33			0.33		1
<i>Cinclodes fuscus*</i>	0								0
<i>Cinclodes patagonicus</i>	4		0.33	0.50			0.17		1
<i>Cistothorus platensis</i>	3		0.20	0.40		0.20	0.20		1
<i>Colorhamphus parvirostris</i>	2							1.00	1
<i>Curaeus curaesus</i>	3						1.00		1
<i>Elaenia albiceps</i>	30			0.09				0.91	1
<i>Enicognathus ferrugineus</i>	3			1.00					1
<i>Falco sparverius</i>	3			0.67			0.33		1
<i>Gallinago paraguaiiae</i>	2			0.50			0.50		1
<i>Larus dominicanus</i>	4			1.00					1
<i>Lessonia rufa*</i>	0								0
<i>Lophonetta specularioides</i>	5		0.50				0.50		1
<i>Milvago chimango</i>	34			0.71			0.14	0.14	1
<i>Muscisaxicola maclovianus *</i>	0								0
<i>Nycticorax nycticorax *</i>	0								0
<i>Phrygilus patagonicus</i>	68		0.07	0.66	0.03			0.24	1
<i>Pygarrhichas albogularis</i>	7		0.25					0.75	1
<i>Scytalopus magellanicus</i>	2							1.00	1
<i>Tachycineta meyeni</i>	42		0.19	0.71			0.05	0.05	1
<i>Tachyeres patachonicus</i>	4				0.33		0.67		1
<i>Theristicus melanopsis</i>	4			0.67			0.33		1
<i>Troglodytes musculus</i>	48		0.08	0.15	0.21		0.03	0.54	1
<i>Turdus falckandii</i>	88		0.02	0.34	0.27		0.23	0.14	1
<i>Vanellus chilensis</i>	10		0.50	0.25	0.25				1
<i>Xolmis pyrope</i>	38		0.06	0.44			0.25	0.25	1
<i>Zonotrichia capensis</i>	73		0.21	0.34			0.25	0.21	1
Total number of birds	894								

* Species recorded out of systematic counts.

considered, as the different types of associated habitats (shrubs, rushes, forest, grassland, etc.) should be considered; this information would

in turn define different types of assemblages that do not necessarily need to be similar; or (2) that peat bogs actually tend to be more similar

to each other than do “other types” of wetlands in terms of their specific composition. Consequently, and regardless the first alternative, our study indicates that peat bogs represent a distinct habitat within the sub-Antarctic landscape matrix whose biodiversity is insufficiently studied and has previously been unappreciated. However, the underlying mechanisms explaining the biodiversity present in peat bogs, and the organization and processes involved, still need to be further studied (Arroyo *et al.* 2005).

The bird assemblage that used peat bogs and their ecotones included mainly insectivores (e.g., *G. paraguayiae*) but also species from a complete suite of other feeding guilds, including omnivores (e.g., *C. modestus*), herbivores (e.g., *C. picta*), granivores (e.g., *Phrygilus patagonicus*) and carnivores (e.g., *Nycticorax nycticorax*). Community composition is known to be strongly related to food availability (Cody, 1981), a factor that might be relevant for birds in the *Sphagnum* wetlands as well (Guzmán *et al.*, 1986). This finding also agrees with what has been reported by Schiavini (2000), who associates the presence of birds in peat bogs mainly to food searching.

In general, in peat bog systems small birds (insectivores) are predominant; these species must feed frequently and, therefore, must have a food source that allows them to feed at regular intervals (Griffiths *et al.*, 1982; Guzmán *et al.* 1986). The presence of a high proportion of small birds in peat bogs may indicate that these environments have a reliable food source, at least for the predominant insectivorous species. These species form the dominant feeding guild in sub-Antarctic wetlands during the coldest months, when wetlands are completely frozen (Ibarra *et al.*, 2009b). In the case of the herbivorous species (excluding the granivorous species such as *P. patagonicus* or *C. barbata*) and omnivores species, fundamentally the Anatidae, food is frequently obtained from the open waters or shores where there might be a higher production of food resources, in contrast to the fact that Magellanic peat bogs have been considered to be a system of low productivity where plant species present scarce palatability (Pisano, 1977).

In the case of reproduction, Matteazzi (1997) and Schiavini (2000) pointed out that the peat

bog-forest ecotone is a nesting site for non-passeriform species such as *C. picta* and *G. paraguayiae*. *C. picta* usually nests in inland peat bog wetlands in the CHBR (Ibarra *et al.*, 2009b), while *G. paraguayiae* was commonly recorded in peat bogs during the spring and summer seasons, in twilight, performing nuptial flights with a characteristic buzz that is made with the tail. This reproductive behavior is characteristic for this Scolopacidae (Rottmann, 1995). The results for the activity categories also allowed for the identification of *C. platensis* while performing courting activity and *C. poliocephala* while fighting for territory during the breeding season. Likewise, the records of *C. magellanicus* were obtained in a transition bog-forest, even though this species is always associated with the presence of old-growth trees. This Picidae is usually found in the old-growth forests of Cape Horn (Arango *et al.*, 2007), which constitute the main matrix of *Sphagnum*-dominated peat bogs in the Magallanes (Arroyo *et al.*, 2005).

In light of the fact that, currently, *Sphagnum*-dominated peat bogs are under a growing pressure for extraction in southern South America, conservation-oriented policies and policies for sustainable use should consider their high value for feeding, reproduction and sheltering for an important diversity of birds. According to Arroyo *et al.* (2005), peat bogs and forests are intrinsically linked at the ecosystem level in austral South America; therefore, the destiny for peat bogs will determine the future of Southern temperate forests, and vice versa.

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Resumen

Ibarra, J.T., C.B. Anderson, T.A. Altamirano, R. Rozzi y C. Bonacic. 2010. Diversidad y singularidad de la avifauna en turberas esfagnosas australes de la Reserva de Biosfera Cabo de Hornos, Chile. Cien. Inv. Agr. 37(1):29-43. Las turberas esfagnosas que se encuentran fuertemente embebidas en la matriz de bosques templados australes, se utilizan de forma creciente en agricultura. Sin embargo, el conocimiento de su biodiversidad es escaso. Más aún, zonas remotas del sur de Chile donde se encuentran las turberas, como la Reserva de Biosfera Cabo de Hornos (RBCH, 54-55° S), donde las aves constituyen el grupo de vertebrados más diverso y representativo, aún han sido escasamente estudiadas. Con el objetivo de aportar en su conocimiento en la RBCH, se estudió la diversidad del ensamble de aves en turberas esfagnosas de la isla Navarino. Se exploró si su composición específica es igual al de los humedales sin turbera, probando si las turberas constituyen o no un hábitat singular para las aves. También se clasificó a las 37 especies de aves registradas en estos hábitats de acuerdo a la estructura de gremios. Los valores de similitud taxocenótica señalaron que la composición de aquellos con turbera difirió de aquellos sin turbera, sugiriendo que este hábitat es singular para las aves. El tipo de alimentación más frecuente fue la insectivoría (48,7%), seguido por la omnivoría (23,1%). Los resultados muestran que, a diferencia de lo señalado en trabajos previos sobre aves de turberas, estos ambientes constituyen un humedal-hábitat singular para la alimentación, reproducción y refugio de algunas especies en la RBCH. De esta manera, la conservación y uso racional de turberas debe considerar el valor que tienen como hábitat para la biodiversidad a escala de paisaje, especialmente para las aves del extremo sur americano.

Palabras clave: Ensamble, humedales, isla Navarino, Patagonia, Reserva de Biosfera Cabo de Hornos, *Sphagnum* spp.

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