Changes in the Abundance and Distribution of Black-necked Swans (Cygnus melancoryphus) in the Carlos Anwandter Nature Sanctuary and Adjacent Wetlands, Valdivia, Chile

Authors: González, Angélica L., and Fariña, José Miguel

Source: Waterbirds, 36(4) : 507-514

Published By: The Waterbird Society

URL: https://doi.org/10.1675/063.036.0408

Changes in the Abundance and Distribution of Black-necked Swans (*Cygnus melancoryphus*) in the Carlos Anwandter Nature Sanctuary and Adjacent Wetlands, Valdivia, Chile

Angélica L. González[1,2,*] and José Miguel Fariña[2]

[1]Department of Zoology, University of British Columbia, Vancouver, Canada

[2]Departamento de Ecología, Facultad de Ciencias Biológicas, Pontificia Universidad Católica de Chile, Santiago, Chile

[*]Corresponding author; Email: agonzale@zoology.ubc.ca

Abstract.—Recently, the Carlos Anwandter Nature Sanctuary (Sanctuary) at the Cruces River, Chile, has undergone important ecosystem changes. Brazilian waterweed (*Egeria densa*), the main food resource of Black-necked Swans (*Cygnus melancoryphus*), has greatly decreased in abundance. This disappearance may have affected the abundance of Black-necked Swans within the Sanctuary; however, the variation in the Black-necked Swan population is still poorly understood. Spatiotemporal variation in population abundance and feeding/breeding ecology of Black-necked Swans was analyzed in the Sanctuary and adjacent wetlands (non-protected areas outside the Sanctuary) from 2000 to 2010. Temporal fluctuations in Black-necked Swan abundance were recorded, with increases in population size from late December to early June and decreases from late June to late September. Five main feeding grounds that were devoid of Brazilian waterweed were identified. However, several other aquatic plants were recorded on these grounds, suggesting that these areas provide alternative food resources for Black-necked Swans. Changes in the reproductive timing of Black-necked Swans throughout the 10-year study were recorded; no reproductive events occurred between 2004 and 2006, and a shortened reproductive period occurred between 2006 and 2010. In addition, there were changes in the locations of the breeding grounds as well as in the number of nests and chicks recorded during the study period. These results revealed new patterns in Black-necked Swan population trends as well as their distribution in areas both inside and outside the Sanctuary. Thus, to ensure effective conservation of this species requires the integration of protected areas within as well as non-protected areas outside the Sanctuary. *Received 4 October 2012, accepted 15 May 2013.*

Key words.—Black-necked Swan, *Cygnus melancoryphus*, distribution, population abundance, reproductive timing.

Waterbirds 36(4): 507-514, 2013

Wetlands provide several ecosystem benefits and are important habitats for waterbirds (Mitsch and Gosselink 2000). Waterbirds are a highly diverse group, exhibiting large differences in their habitat requirements (Fredrickson and Reid 1988). Nevertheless, most of these species select wetlands in relation to the location of their feeding grounds or reproduction areas (Raeside *et al.* 2007).

Chilean wetlands are complex and diverse systems (Marín *et al.* 2006; Schlatter and Sielfeld 2006; González *et al.* 2011). The Carlos Anwandter Nature Sanctuary (Sanctuary), a Ramsar wetland in Southern Chile, is considered a priority site for waterbird conservation (Risk *et al.* 2010). This wetland hosts about 119 bird species, primarily year-round residents (Schlatter and Sielfeld 2006). Among these species, the Black-necked Swan (*Cygnus melancoryphus*) is a "flagship species" in the Southern Neotropical area because it is an indicator of the quality of the wetlands (Corti and Schlatter 2002).

During the last decade, the Sanctuary has undergone degradation due to human activity in the area (Universidad Austral de Chile 2004, 2005; Jaramillo *et al.* 2007). Nevertheless, this Sanctuary is considered a source of Black-necked Swans (swans) for South America (Schlatter *et al.* 2002). The Black-necked Swan population here has shown strong yearly fluctuations (Schlatter *et al.* 2002; Lagos *et al.* 2008). Population size decreases occurred in 1997 and 2004; the former mainly driven by natural perturbations (El Niño Southern Oscillation) (Schlatter *et al.* 2002), while the later was attributed to changes in the abundance of the aquatic plant Brazilian waterweed (*Egeria densa*), which is the Black-necked Swan's major food resource in the area (Corti and Schlatter 2002). The biomass of this plant was severely reduced during 2004 (Di Marzio and McInnes 2005) and both its disappearance and the population decrease of Black-necked Swans were attributed to human activities (Universidad de Austral Chile 2004, 2005; Sepúlveda 2011).

Although there is much scientific interest in the consequences of the environmental changes in the Sanctuary, most of the studies have been focused on the Black-necked Swan population inside the protected area, but wetlands adjacent to the Sanctuary have not be considered. Further, there is very little information about foraging and behavioral responses of swans to the environmental changes occurring in this wetland (but see Schlatter *et al.* 2002). This information is crucial for Black-necked Swan conservation in the area. Based on this information, our goals were to describe: 1) spatiotemporal variation in Black-necked Swan population abundance and distribution; and 2) Black-necked Swan foraging and reproductive ecology.

METHODS

Study Site

The study area consists of the Carlos Anwandter Nature Sanctuary, which covers 48,770 km^2 of wetlands along the Cruces River, as well as 15,250 km^2 of surrounding wetland corresponding to the proposed "Río Cruces Protected Reserve" (herein "wetland complex"), which includes the rivers Cayumapu and Pichoy (Mancilla 1997) (Fig. 1). This wetland is located in the southern coastal range of the Valdivian Temperate Rain Forests Ecoregion, Chile (Schlatter 2005).

Black-necked Swan Surveys

Swan counts were conducted seasonally from May 2006 to January 2010 between 08:00 hr and 19:00 hr using binoculars. Surveys were done by boat and from fixed-point locations on the ground. On each survey, two observers recorded the number of swans, while a third observer recorded the location coordinates of groups of swans using a global positioning system (GPS). The geographical data were mapped using the software R (R Development Core Team 2011). We obtained additional data for swans in this wetland for the period between 2000 and 2005 (Chile's National Forest Corporation 2010a). As they used the same counting method, we included data from 2000 to 2010 in our analyses.

To assess the distribution of the foraging areas in the wetland, we recorded Black-necked Swans on their feeding grounds using a GPS in the same manner as above (Erwin 2005). To estimate Black-necked Swan density, we standardized the abundance of swans by the area of each zone (individual/km^2); (48,770 km^2 inside the Sanctuary and 15,250 km^2 outside the Sanctuary). We collected samples of the aquatic plants that occurred in these foraging areas using a hook. Plants were identified to the lowest taxonomic level possible

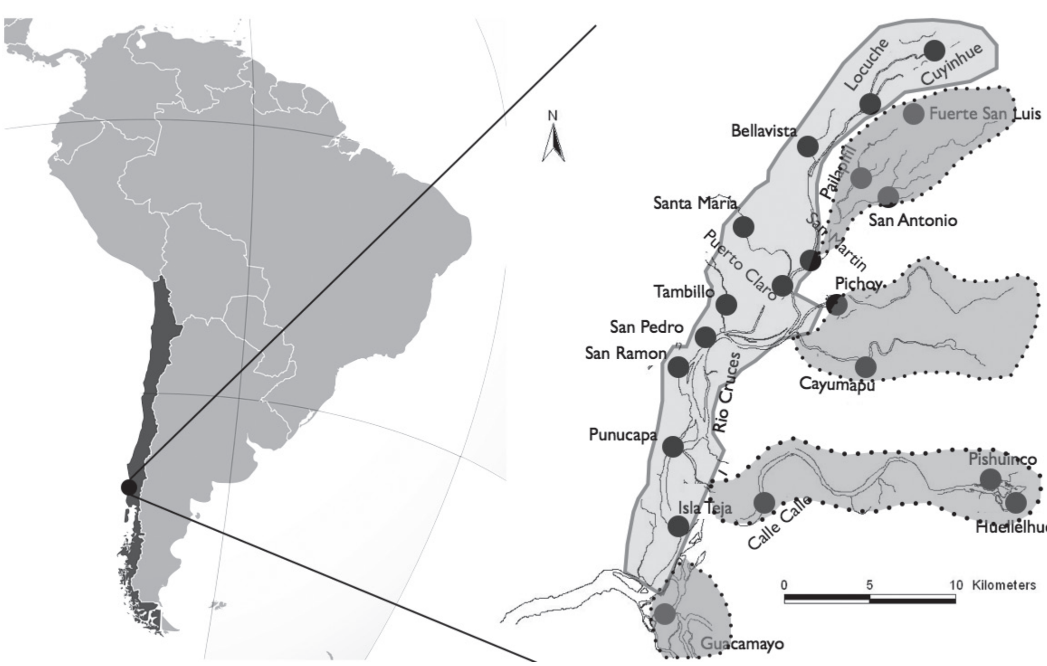

Figure 1. Map of the study area showing the "wetland complex." Black dots represent Black-necked Swan counting locations within the study area. The gray shaded portions of the map represent the areas within the Sanctuary (continuous line) and outside the Sanctuary (dotted line).

using identification guides (Ramírez *et al.* 1982; Muñoz-Pedreros 2003). We emphasize that the intent of this sampling was simply to document that Black-necked Swans were indeed feeding on plants other than Brazilian waterweed, not to provide a comprehensive analysis of plant cover or Black-necked Swan feeding preferences. Additionally, we determined the size and frequency of foraging groups in the Sanctuary during the autumn (late March to late June) and spring (late September to late December) from 2004 to 2009.

The distribution of Black-necked Swan reproductive areas was recorded and analyzed using the same methods as the feeding grounds. We characterized reproductive timing, occurrence of Black-necked Swan pairs, and nests and chicks between 2000 and 2010.

Statistical Analyses

We used a two-tailed t-test to compare the population abundance of Black-necked Swans between 2000-2004 and 2005-2010. To compare the density of swans between areas, we included only the overlapped dates of swan surveys from December 2004. These data were compared with one-tailed t-tests. All variables were transformed where necessary to meet assumptions of homogeneity of variance and normality. Significance levels were set at $\alpha = 0.05$ for the t-test (Gotelli and Ellison 2004). All statistical analyses were done using the software R (R Development Core Team 2011).

RESULTS

Temporal Variation in Black-necked Swan Abundance

The temporal population abundance of the Black-necked Swans and their distribution in the Sanctuary and adjacent areas changed from 2000 to 2010. The strongest population size variation was between the years 2004 to 2005 ($t = 28.58$; $P < 0.001$; Fig. 2). During the last 2 years of study, population abundance was still lower than before 2004 (Fig. 2). The Black-necked Swan population showed strong seasonal variation in abundance between January-June (summer-autumn) and decreases between July-November (winter-spring).

Spatial Variation in Black-necked Swan Abundance

Between 2000 and 2004, Black-necked Swans were concentrated in a few sites of relatively high population abundance (> 1,200 individuals) (Fig. 3A). At the same time, most

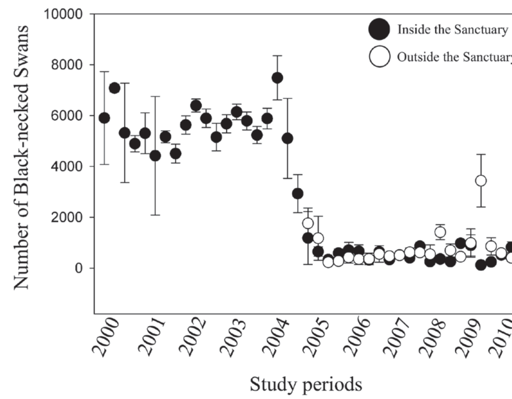

Figure 2. Mean number of Black-necked Swans per season (± SE) in the Carlos Anwandter Nature Sanctuary (black circles) and outside the Sanctuary (white circles) during 2000-2010 (Chile's National Forest Corporation 2010b). No data available outside the Sanctuary between 2000 and 2004.

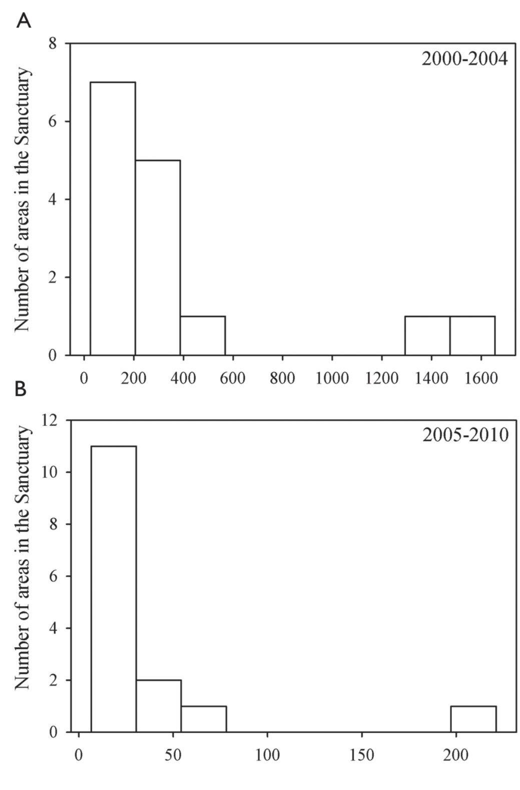

Figure 3. Histogram of the number of Black-necked Swans in the Carlos Anwandter Nature Sanctuary (inside Sanctuary) during 2000-2004 (A), and in areas inside and outside the Carlos Anwandter Nature Sanctuary during 2005-2010 (B).

of the areas within the Sanctuary maintained less than 400 individuals of swans (Fig. 3A). From 2005 to 2010, we observed that most areas in the wetland complex maintained a low number of individuals (i.e., < 80); meanwhile, most Black-necked Swans (~200 individuals) were concentrated in a single area (Fig. 3B). The two sites with the highest Black-necked Swan numbers between 2000 and 2004 supported close to 60% of the population, which was significantly higher than the site containing the next higher abundance of Black-necked Swans ($t = 3.41$; $P < 0.01$; Fig. 4A). From 2005 to 2010, the area with the highest number of swans supported on average more than the 42% of the population, which was significantly higher than the site containing the second higher abundance of Black-necked Swans ($t = 2.56$; $P < 0.01$; Fig. 4B). Overall, population densities inside the Sanctuary were lower (0.1 individuals/ha) than outside the Sanctuary (0.5 individuals/ha) during 2005-2010 ($t = 2.46$; $P < 0.01$).

Foraging Ecology

We identified five principal feeding grounds for Black-necked Swans in the wetland complex (Fig. 5). Brazilian waterweed was present in some areas inside and outside the Sanctuary, but the biomass of other aquatic plants, such as parrot feather water milfoil (*Myriophyllum aquaticum*) and pondweed (*Potamogeton* sp.) was greater than that of Brazilian waterweed. Other areas of the wetland showed high cover of the green algae *Spirogyra* sp. and the floating aquatic Amazon frog bite (*Limnobium laevigatum*), both co-occurring in San Antonio, whereas floating pennywort (*Hydrocotyle ranunculoides*) was present in the Cayumapu (Fig. 5). During the summers of 2008 to 2010 (end of December-end of March), Cayumapu showed some cover of Brazilian waterweed, while only two locations (i.e., Pishuinco and Huellelhue) had high percent cover of Brazilian waterweed throughout the entire study period (Fig. 5). However, they were not important as foraging areas for the Black-necked Swans.

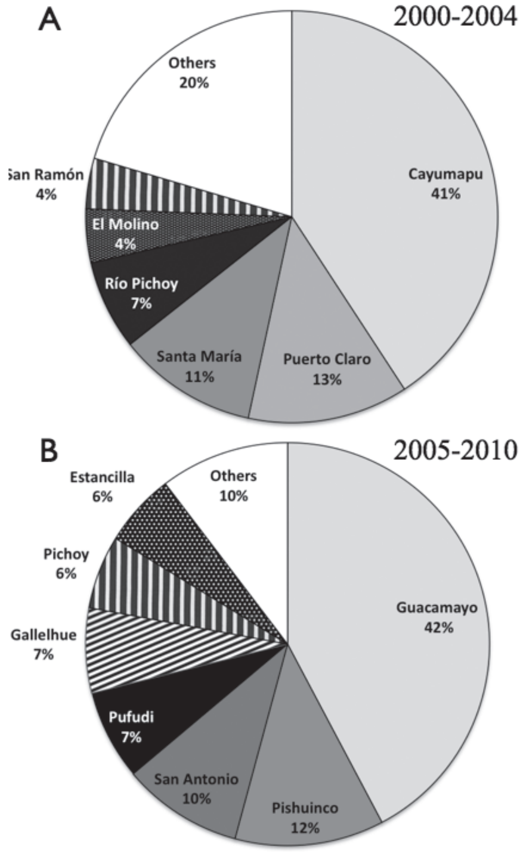

Figure 4. Primary Black-necked Swan concentration sites during 2000-2004 (A) and during 2005-2010 (B) in areas inside and outside the Carlos Anwandter Nature Sanctuary.

Reproductive Ecology

Long-term records of Black-necked Swan reproduction showed that swans started nesting in early June (Fig. 6). Between 2004 and 2006, there were no records of Black-necked Swan reproduction in the wetland. During the last three reproductive seasons (2007-2008, 2008-2009, and 2009-2010), Black-necked Swans showed a pattern of breeding increasingly earlier, evidencing a reproductive phenology similar to that before 2004. The total number of swan nests and chicks recorded between 2000 and 2004 were > 2,000 nests and about 11,000 chicks (Table 1). The nests and chicks of Black-necked Swans were recorded in seven main areas in the Sanctuary (Table 1). During 2004-2006, there were no nests and chicks,

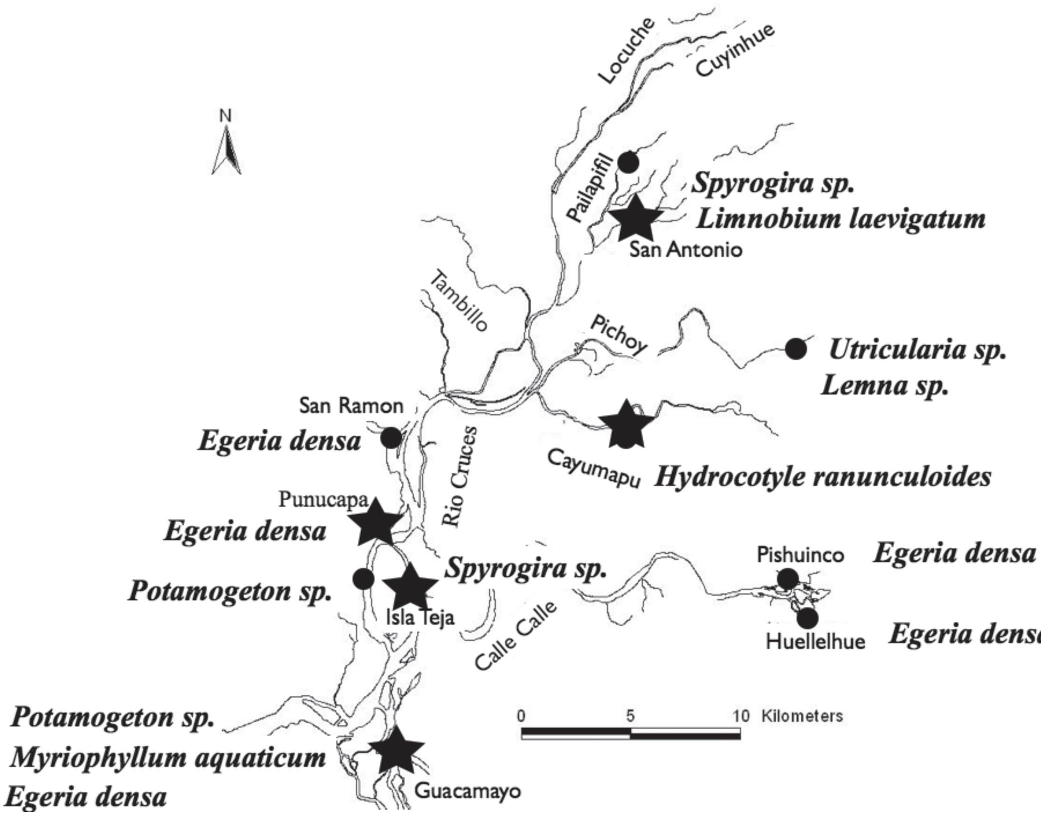

Figure 5. Primary Black-necked Swan foraging grounds in areas inside and outside the Carlos Anwandter Nature Sanctuary. Black circles show areas in the Sanctuary, and black stars show the five main feeding locations.

whereas from 2006 to 2010 the number of swan nests and chicks increased (Table 1); most of these were found in the Sanctuary.

DISCUSSION

Our results showed large spatiotemporal variation of the Black-necked Swan population size and its distribution in the wetland complex of the Cruces River. During the study period, the Black-necked Swan population showed increases in its abundance during the summer-autumn and decreases during the winter-spring. These findings are contrary to those reported previously for Black-necked Swans in this wetland complex (Schlatter *et al.* 2002; Schlatter 2005). These previous studies showed population increases during the spring-summer and decreases during the autumn-winter, and these changes were related to precipitation levels. The differences between our results and Schlatter *et al.* (2002) and Schlatter (2005) may be due to differences in the temporal series analyzed by them (1985 to 2000). During this period, there were two population increases (1988-1991 and 1995-1998); these increases were concordant with La Niña phase that can cause desiccation of shallow wetlands and trigger bird migrations from northern to southern Chile (Vilina *et al.* 2002; Schlatter 2005). Overall, precipitation seasonality influences the hydrology of the wetland, affecting Black-necked Swan population abundance and food availability (Schlatter *et al.* 2002; Schlatter 2005). In fact, during the winter, high precipitation may also cause a decrease in Black-necked Swan populations in the Sanctuary, whereas the opposite pattern is common during the summer (Schlatter *et al.* 2002). Black-necked Swan population size was less variable during the spring,

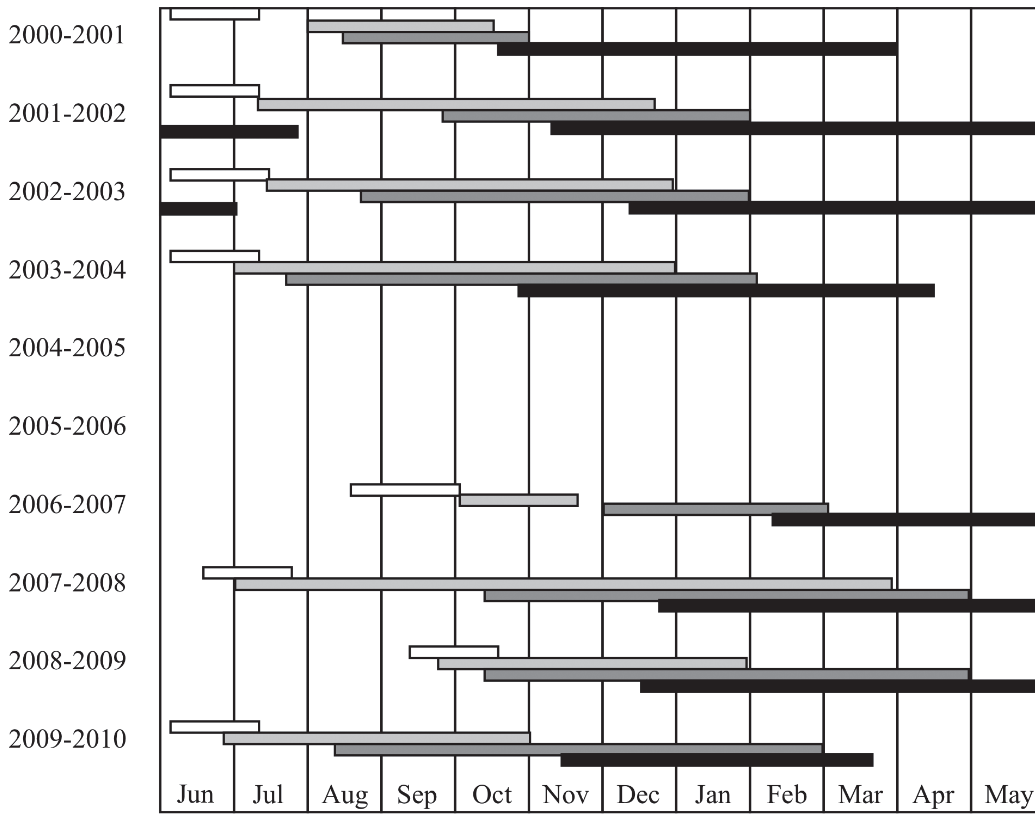

Figure 6. Reproductive timing of Black-necked Swans in areas inside and outside the Carlos Anwandter Nature Sanctuary; data collected between 2000 and 2010. Different rectangle colors show distinct reproductive stages: mating pair formation (white rectangles), nesting (light gray rectangles), chicks (dark gray rectangles) and juveniles (black rectangles). Reproductive season 2009-2010 was still developing when this study was finished.

and we speculate that the presence of chicks, and consequently their parents, may explain this pattern; this phenomenon occurs from August to March each year and is related to more stable environmental conditions in the wetland (Schlatter 1998).

Our spatial analyses showed that a few sites within the wetland host the largest number of Black-necked Swans. This pattern may be explained by the differences in microhabitat conditions within the wetland, such as food availability, shelter or reproductive areas (Brown *et al.* 1995). Although our study design does not allow us to infer cause-effect relationships, the largest and most stable Black-necked Swan populations were in Cayumapu River, San Antonio, and particularly in Guacamayo during the last 2 years of the study (2009-2010). This suggests that environmental conditions within the wetland have changed and might be responsible for the dynamics of Black-necked Swans.

The reproductive timing of birds may be strongly affected by energetic constraints, suggesting that food availability is the main factor influencing the nesting timing of different populations (Chastel *et al.* 2003). Black-necked Swans showed no reproduction between 2004 and 2006. We believe this behavior was due to the decrease in their main food resource. After 2006, Black-necked Swans delayed reproductive timing, when Brazilian waterweed was absent from the wetland. This suggests that Black-necked Swans may be using other aquatic plants as food resources (see Ramírez *et al.* 1982; Corti and Schlatter 2002).

Table 1. Summary of the number and main locations of Black-necked Swan nests and chicks recorded during the breeding periods between June 2000 and January 2010 in the Carlos Anwandter Nature Sanctuary and outside the Sanctuary in Valdivia, Chile. ND indicates no data available. Data provided by Chile's National Forest Corporation (2010b).

Period	Nests	Chicks	Sites
2000-2001	~450	~3,800	Punucapa, San Ramon, San Pedro, Puerto Claro, San Martin, Santa Maria and Bellavista
2001-2002	~600	~3,600	Punucapa, San Ramon, San Pedro, Puerto Claro, San Martin, Santa Maria and Bellavista
2002-2003	~900	~2,500	Punucapa, San Ramon, San Pedro, Puerto Claro, San Martin, Santa Maria and Bellavista
2003-2004	~400	~1,100	Punucapa, San Ramon, San Pedro, Puerto Claro, San Martin, Santa Maria and Bellavista
2004-2005	0	0	Punucapa, San Ramon, San Pedro, Puerto Claro, San Martin, Santa Maria and Bellavista
2005-2006	0	0	Punucapa, San Ramon, San Pedro, Puerto Claro, San Martin, Santa Maria and Bellavista
2006-2007	6	15	Punucapa, San Ramon, San Pedro, Puerto Claro, San Martin, Santa Maria and Bellavista
2007-2008	ND	70	San Antonio, Cayumapu and Guacamayo
2008-2009	ND	~200	San Antonio, Cayumapu and Guacamayo
2009-2010	ND	~310	San Antonio, Cayumapu and Guacamayo

The environmental changes recorded in this wetland have been related to human activities, specifically a pulp mill, which has caused the disappearance of Brazilian waterweed (Jaramillo *et al.* 2007) and triggered massive Black-necked Swan migration out of the area and mortality due to starvation and high levels of iron and other chemicals in the water (Universidad Austral de Chile 2004, 2005; Mulsow and Grandjean 2006; Sepúlveda 2011). Although the observed patterns showed significant changes in the population dynamics of the Black-necked Swans between 2004 and 2005, we cannot infer cause-effect relationships between Brazilian waterweed disappearance and the decrease in Black-necked Swan numbers. However, the correlation between these two phenomena seems to be strong (Sepúlveda 2011). Overall, the distributional patterns of swans in the Sanctuary and outside this protected area provide useful information about the spatial scale over which Black-necked Swans distribute. This information should be considered in biodiversity conservation and the design of protected areas (see Schlatter *et al.* 2002).

Acknowledgments

Thanks to La Corporación Nacional Forestal (CONAF) Valdivia and particularly to Luis Miranda, CONAF park guard. We thank Carlos Garín and Martín Escobar for their help in the field. This study was performed under the contract PUC-Arauco. Thanks to Matt Barbour and Ross Whippo for their comments on earlier drafts of this manuscript.

Literature Cited

Brown, J. H., D. W. Mehlman and G. C. Stevens. 1995. Spatial variation in abundance. Ecology 76: 2028-2043.

Chastel, O., A. Lacroix and M. Kersten. 2003. Pre-breeding energy requirements: thyroid hormone, metabolism and the timing of reproduction in house sparrows *Passer domesticus*. Journal of Avian Biology 34: 298-306.

Chile's National Forest Corporation. 2010a. Informe mensual de las actividades realizadas en el Santuario de la Naturaleza del Humedal del Río Cruces (Enero). Valdivia, Chile.

Chile's National Forest Corporation. 2010b. Informe mensual de las actividades realizadas en el Santuario de la Naturaleza del Humedal del Río Cruces (Febrero). Valdivia, Chile.

Corti, P. and R. P. Schlatter. 2002. Feeding ecology of the Black-necked Swan *Cygnus melancoryphus* in two wetlands of Southern Chile. Studies on Neotropical Fauna and Environment 37: 9-14.

Di Marzio, W. and R. McInnes. 2005. Informe de misión Santuario Carlos Anwandter (Río Cruces), Chile. Misión Consultiva Ramsar, Santiago, Chile.

Erwin, M. R. 2005. Management, monitoring, and protection protocols for colonially nesting waterbirds at Cape Hatteras National Seashore, North Carolina. Unpublished report, U.S. Department of the Interior, U.S. Geological Survey, Patuxent Wildlife Research Center, Laurel, Maryland.

Fredrickson, L. H. and F. A. Reid. 1988. Waterfowl use of wetland complexes. Pages 1-6 *in* Waterfowl Management Handbook (D. H. Cross and P. Vohs, Eds.). U.S. Department of the Interior, Fish and Wildlife Service, Fort Collins, Colorado.

González, A. L., M. A. Vukasovic and C. F. Estades. 2011. Variación temporal en la abundancia y diversidad de aves en el humedal del Río Itata, region del Bío-Bío, Chile. Gayana 75: 170-181.

Gotelli, N. and A. M. Ellison. 2004. A primer of ecological statistics. Sinauer Associates, Sunderland, Massachusetts.

Jaramillo, E., R. P. Schlatter, H. Contreras, C. Duarte, N. Lagos, E. Paredes, J. Ulloa , G. Valenzuela, B. Peruzzo and R. Silva. 2007. Emigration and mortality of Black-necked Swans (*Cygnus melancorypphus*) and disappearance of the macrophyte *Egeria densa* in a Ramsar wetland site of southern Chile. Ambio 36: 607-609.

Lagos, N. A., P. Paolini, E. Jaramillo, C. Lovengreen, C. Duarte and H. Contreras. 2008. Environmental processes, water quality degradation, and decline of waterbird populations in the Rio Cruces wetland, Chile. Wetlands 28: 938-950.

Mancilla, V. Y. 1997. Lineamientos para el manejo del Santuario de la Naturaleza y propuesta Reserva Nacional del río Cruces en Valdivia (Chile). Tesis de Grado, Facultad de Ciencias Forestales, Universidad Austral de Chile, Valdivia, Chile.

Marín, V., L. Delgado and I. Vila. 2006. Sistemas acuáticos, ecosistemas y cuencas hidrográficas. Pages 13-19 *in* Macrófitas y vertebrados de los sistemas límnicos de Chile (Vila, I., A. Veloso, R. P. Schlatter and C. Ramírez, Eds.) Editorial Universitaria, Santiago, Chile.

Mitsch, W. J. and J. G. Gosselink. 2000. Wetlands, 3rd ed. John Wiley and Sons, Inc., New York, New York.

Mulsow, S. and M. Grandjean. 2006. Incompatibility of sulphate compounds and soluble bicarbonate salts in the Rio Cruces waters: an answer to the disappearance of *Egeria densa* and Black-necked Swans in a RAMSAR sanctuary. Ethics in Science and Environmental Politics 2006: 5-11.

Muñoz-Pedreros, A. 2003. Guía de los Humedales del río Cruces. CEA Ediciones, Valdivia, Chile.

R Development Core Team. 2011. R: a language and environment for statistical computing, v. 2.14.1. R Foundation for Statistical Computing, Vienna, Austria. http://www.r-project.org, accessed 17 November 2012.

Raeside, A. A., S. A. Petrie and T. D. Nudds. 2007. Waterfowl abundance and diversity in relation to season, wetland characteristics in South Africa. African Zoology 42: 80-90.

Ramírez, C., R. Godoy, D. Contreras and E. Stegmaier. 1982. Guía de plantas acuáticas y palustres valdivianas. Instituto de Botánica, Facultad de Ciencias, Universidad Austral de Chile, Valdivia, Chile.

Risk, M. J., M. Burchell, K. de Roo, R. Naim, M. Tubrett and G. Forsterra. 2010. Trace elements in bivalve shells from the Río Cruces, Chile. Aquatic Biology 10: 85-97.

Schlatter, R. P. 1998. El cisne de Cuello Negro (*Cygnus melancoryphus*) en Chile. Pages 121-131 *in* La Conservación de la Fauna de Chile, Logros y Perspectivas (E. Valverde, Ed.). CONAF, Ministerio de Agricultura, Santiago, Chile.

Schlatter, R. P. 2005. Distribución del cisne de cuello negro en Chile y su dependencia de hábitats acuáticos de la cordillera de la Costa. Pages 498-504 *in* Historia, Biodiversidad y Ecología de los Bosques Costeros de Chile (C. Smith-Ramírez, J. J. Armesto and C. Valdovinos, Eds.). Editorial Universitaria S. A., Santiago, Chile.

Schlatter, R. P. and W. Sielfeld. 2006. Avifauna y mamíferos acuáticos de humedales en Chile. Pages 141-187 *in* Macrofitos y Vertebrados de los Sistemas Límnicos de Chile (I. Vila, A. Veloso, R. Schlatter and C. Ramírez, Eds.). Editorial Universitaria S. A., Santiago, Chile.

Schlatter, R. P., R. A. Navarro and P. Corti. 2002. Effects of El Niño southern oscillation on numbers of Black-necked Swans at Río Cruces Sanctuary, Chile. Waterbirds 25 (Suppl.): 114-122.

Sepúlveda, C. 2011. Verdad y reparación en el desastre del Río Cruces en Valdivia. El Mostrador, Santiago, Chile. http://www.elmostrador.cl/opinion/2011/11/09/verdad-y-reparacion-en-el-desastre-del-rio-cruces-en-valdivia/, accessed 28 February 2012.

Universidad Austral de Chile. 2004. Primer informe sobre "Estudio sobre origen de mortalidades y disminución de aves acuáticas en el Santuario de la Naturaleza Carlos Anwandter, en la Provincia de Valdivia". Valdivia, Chile.

Universidad Austral de Chile. 2005. Segundo informe sobre "Estudio sobre origen de mortalidades y disminución de aves acuáticas en el Santuario de la Naturaleza Carlos Anwandter, en la Provincia de Valdivia". Valdivia, Chile.

Vilina, Y. A., H. Cofré, C. Silva-García, M. D. García and C. Pérez-Friedenthal. 2002. Effects of El Niño on abundance and breeding of Black-necked Swans on El Yali Wetland in Chile. Waterbirds 25: 123-127.