

OSPREY ECOLOGY IN THE MANGROVES OF SOUTHEASTERN BRAZIL

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The Osprey (*Pandion haliaetus*) is a widely distributed raptor found in every continent but Antarctica. The Eurasian nominate and North American subspecies (*P. h. carolinensis*) make extensive migrations, the latter being a trans-equatorial migrant wintering in United States (Florida), Mexico, Central America and South America from Colombia to Argentina and Chile (Poole 1989, del Hoyo et al. 1994, Martell et al. 2001).

In Brazil, Ospreys have been recorded in almost every state and month, but most records were made between September and April (Sick 1997). The Amazon basin, where reports are most common, seems to be the main wintering area for Ospreys in the country, but there are also clusters of records in coastal localities (Sick 1997, Olmos and Silva e Silva 2001). Band recoveries made in Brazil show the birds come from the Mid-Atlantic and northeastern USA (Poole and Agler 1987).

Despite being a well-known species in its breeding grounds (del Hoyo et al. 1994), there is little information on the wintering ecology of Ospreys in South America (Saggese et al. 1996), although detailed studies have been made in Africa (Prevost 1982, Boshoff and Palmer 1983). Ospreys spend most of the year (six or more months) in their wintering grounds, so information on their ecology during this period is crucial for a clearer understanding of their life-histories and the pressures faced by the birds outside the breeding season. Here, we provide an account of the ecology of Ospreys using a mangrove ecosystem in southeastern Brazil, the first such study in South America.

STUDY AREA AND METHODS

The study was conducted in the mangrove ecosystem that covers the estuarine area between São Vicente Island and the mainland, in the coast of São Paulo state, southeastern Brazil (ca. 23°53'S, 46°23'W). This area, belonging to the Santos and Cubatão counties, is part of the major mangrove ecosystem located in the region known as Baixada Santista, covering 120 km², and located in one of the most populated and developed areas in Brazil (Lamparelli 1999). The local climate is hot and humid, with annual rainfall ranging from 2000 to over 2500 mm.

Winter is the driest season, the lowest rainfall occurring in July–August, the highest values occurring between September–March (Olmos and Silva e Silva 2001). For a general description of the area's geography and environment, see CETESB (1991) and Olmos and Silva e Silva (2001).

The main feature in the study area is a channel (Piaçaguera channel) bisecting it and connecting Santos Bay to the estuarine area inland. This broad (ca. 1 km wide) channel is mostly man-made and regularly dredged to allow for the passage of cargo ships serving the local steel and fertilizer plants. Because of dredging and silting, there are large mudflats along the channel. Ten navigation buoys and six concrete towers dot the entire length of the channel and are used as perches by feeding Ospreys. Prey remains accumulate on top of these buoys and towers, making collecting the collection of dietary data simple. Three rivers (Quilombo, Casqueiro, and Cubatão) empty into the channel.

Diet and behavioral data were collected as part of a broader study of the mangrove avifauna conducted from March 1994–July 2000 during 231 field-days (Olmos and Silva e Silva 2001). Data on Osprey abundance throughout the year and habitat use were gathered between August 1995–November 1996, when we made 36 standardized bird censuses by boat along a 19.25 km transect covering all habitats present (Olmos and Silva e Silva 2001).

Habitat classification was adapted from the mapping made by São Paulo state's environmental agency (CETESB 1991) and represents a gradient of mangrove tree cover. Habitat categories sampled were: mangrove forest with mostly touching canopies and complete cover, degraded mangrove with many gaps between trees making a patchwork of clearings, mangrove degraded by pollution, groups of mangrove trees, and large areas of herbaceous growth dotted by dwarfed mangroves, a mosaic of mudflats (with scattered mangrove trees), and exposed mudflats without any tree cover. For a detailed description of habitats see Olmos and Silva e Silva (2001).

Feeding Ospreys were observed opportunistically with the help of spotting scopes and binoculars with the aim of identifying the captured prey. Prey remains accumulated on buoys and towers were recovered during regular checks and identified to the lowest possible taxonomic level by comparison to reference material.

RESULTS

Ospreys were first recorded along the Piaçaguera channel in 1986 (Olmos 1989). Interestingly, the species was not found there earlier in the 20th century (Luederwaldt

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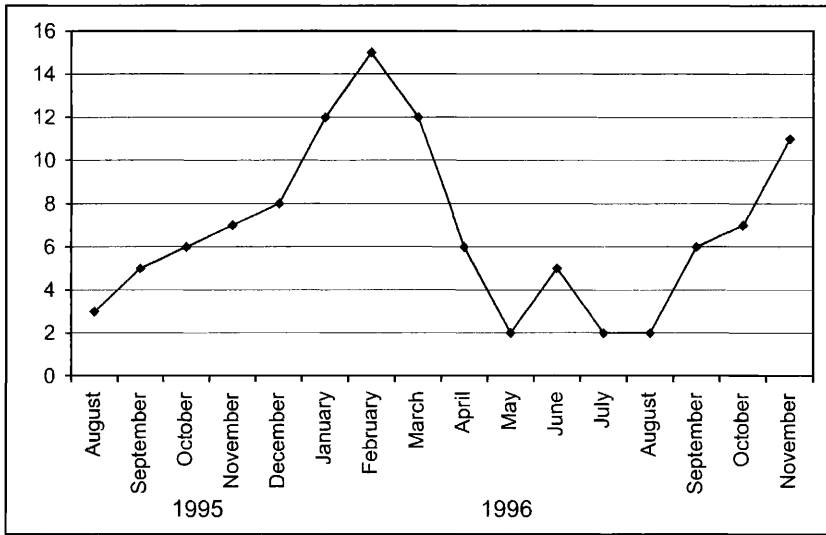


Figure 1. Monthly numbers of Ospreys censused in the Santos-Cubatão mangroves, southeastern Brazil, between August 1995–November 1996.

1919). It is almost impossible to tell adult birds from young ones under field conditions (Boshoff and Palmer 1983), but we never observed newly-fledged Ospreys, with their characteristic speckled plumage.

Ospreys are recorded in Santos-Cubatão throughout the year. Census data show a peak during the austral summer and a minimum of three birds during the winter (Fig. 1). Most (47%) records made during the censuses were along the Cascalho River, where channel margins are dominated by mangroves degraded by pollution (Olimos and Silva e Silva 2001).

Table 1. Prey items of wintering Ospreys in the mangroves of Santos and Cubatão, Brazil. Unidentified fish were excluded.

SPECIES	N	PERCENT
Mullet		
<i>Mugil</i> sp.	69	76.7
Rhomboid mojarra		
<i>Diapterus rhombeus</i>	16	17.8
Snooks		
<i>Centropomus</i> sp.	2	2.2
Common trahita		
<i>Hoplias malabaricus</i>	1	1.1
Brazilian mojarra		
<i>Eugerres brasiliensis</i>	1	1.1
Brazil geophagus		
<i>Geophagus brasiliensis</i>	1	1.1
Total	90	100

From year-round census data, Ospreys had higher linear densities along rivers bordered by mangrove forest ($\bar{x} = 0.71$ birds/km) and mangroves degraded by pollution (0.70 birds/km) compared to mudflats (0.2 birds/km) and degraded mangrove (0.01 birds/km, $F_{3,140} = 14.09$, $P < 0.0001$). Densities in mangrove forest and mangrove degraded by pollution were not different, as well as differences in densities between mudflats and degraded mangroves (Tukey HSD test, both $P < 0.001$).

Most fish seem to be captured alive, but in November 1996, we did record an Osprey taking a dead fish floating on the surface. The most important prey were mullets (*Mugil* spp.) (76.7%) and rhomboid mojarra (*Diapterus rhombeus*) (17.8%; Table 1). Only two freshwater fish, common trahita (*Hoplias malabaricus*) and Brazil geophagus (*Geophagus brasiliensis*) were recorded. One mullet (*Mugil platamus*) left whole on a tower was 41.5 cm TL and weighed 590 g, while a *Diapterus rhombeus* found in the same circumstances was 30 cm and 490 g. Based on prey remains and observations, fish smaller than 20 cm TL seem to be rare in the diet of Ospreys in southeastern Brazil.

We rarely observed Ospreys hovering or flying low over the water before capturing a fish. Once, an Osprey caught a dying fish on the surface while "hovering." In most instances, the birds would soar over the water and plunge dive rapidly after locating a fish. It was common for the birds to abort several dives (up to nine in a row) before actually touching the water.

Ten out of 14 plunge dives by different birds were successful (71%), with nine fish carried away and one falling back to the water. After taking a fish, the birds would fly

to one of the available towers, buoys, trees, or when the prey was too heavy, even a mudflat. All fish were eaten head first, discarding opercula and gills. Mullet viscera were also discarded. Usually only the tail would remain but, sometimes, we would find the posterior half of a large mullet. After feeding, the bird would fly dragging its feet in the water for over 10 m. Sometimes up to three birds were seen fishing in the same small area. When one was successful the others would chase it amid much calling, trying to steal its fish.

A curious behavior was observed on 22 August 1997, at the Piaçaguera channel. One Osprey, while holding a tree branch, was seen flying and calling after another individual. The second bird would perch, also calling. The first bird flew out of sight but came back quickly, always calling, without the branch. Both birds then began to soar, always calling, making several aborted dives. After one Osprey finally captured an unidentified fish, it flew away being followed by the other bird. An Osprey flying while holding a tree branch was also seen on 18 July 2000; this bird was chasing a Crested Caracara (*Polyborus plancus*), but we soon lost sight of them.

Contrary to the behavior reported in some wintering areas (Boshoff and Palmer 1983), Ospreys were very vocal in Santos-Cubatão throughout the year, especially when two birds came close to each other. It was common to see two Ospreys soaring together with Black Vultures (*Coragyps atratus*) while calling. They would also call when we approached the perch of a feeding bird, which caused it to fly with its prey.

Yellow-headed Caracaras (*Milvago chimachima*) benefit from Ospreys by scavenging fish remains from the feeding perches, sometimes waiting beside a feeding Osprey. Crested Caracaras are more aggressive and actively try to steal fish from the Ospreys; sometimes up to four caracaras may join in a chase after an Osprey carrying a fish, but we never saw them being successful. Interestingly, Great Egrets (*Casmerodius albus*) would expel Ospreys from their feeding perches, while Kelp Gulls (*Larus dominicanus*), known to steal Ospreys' food in South Africa (Boshoff and Palmer 1983), ignore them in Brazil.

Ospreys did not seem to be actively persecuted by local people and the many fishermen using the mangroves. Nevertheless, on 26 December 1996, a female was found with a wounded wing, perhaps the result of being shot. This bird is now in the ornithological collection of the Museu de Zoologia da Universidade de São Paulo (MZUSP 74346).

DISCUSSION

The lack of records of newly-fledged Ospreys with their characteristic speckled plumage suggests only birds over 1 yr-old migrate to the study area. The year-round presence of Osprey in Brazil raises the possibility the birds might breed in South America, but no evidence has been found so far (Sick 1997). Nevertheless, nesting in a wintering area has been documented in South Africa (Dean

and Tarboton 1983). The presence of Ospreys in Brazil during April–August show non-breeders, juveniles, stay in their wintering range.

Although Sick (1997) attested, without details, that Ospreys sometimes take mammals and birds when wintering, the only documented food items of Ospreys in Brazil were fish, making the diet seem less diverse compared to breeding areas (Wiley and Lohrer 1973). Mullet are detritus-eating fish abundant in Brazilian estuaries, where they gather in shoals year-round (Menezes 1983). Their abundance, size, and the habit of sunning close to the surface make them ideal prey for a plunge diver like the Osprey. In fact, the only former report of a prey taken by an Osprey in Brazil refers to a mullet (*Mugil incisilis*) (Martuscelli 1992), also taken in a mangrove area in southern São Paulo state. Mullet was also the main prey taken by wintering Ospreys in mangroves and estuaries in Senegal (Prevost 1982) and South Africa (Boshoff and Palmer 1983). The availability of mullet may probably explain why Ospreys seem to be the most common in coastal areas, especially estuaries and mangroves (Haverschmidt and Mees 1994). Fish were also the only prey recorded as taken by Ospreys in freshwater habitats in Peru (Willard 1985) and Argentina (Saggese et al. 1996), the detritus-eating *Prochilodus* sp. being reported by both studies. We observed a high capture success (71%) for a limited number of foraging attempts on fish, but not outside the 40–70% range reported by studies elsewhere (Poole 1989, del Hoyo et al. 1994).

There is no direct or intensive persecution of Ospreys in southeast Brazil. Nevertheless, their reliance on detritus-eating fish might be problematical. The Santos-Cubatão estuary receives the discharges of one of the major industrial areas in Brazil, well-known in the 1980s for its high pollution levels (Gutberlet 1996). Despite improvements, the sediments still hold high levels of heavy metals and organochlorines such as Hexachlorobenzene (HCB) and Polycyclic aromatic hydrocarbons (PAHs). For example, sediments from the Piaçaguera channel hold 109.200 to 733.700 µg/kg of benzopyrene, some of the largest concentrations in the world (CETESB 2001). These contaminants may be ingested by fish like mullet, feeding on detritus and benthic algae, and accumulated and transferred to piscivores like Ospreys. Thankfully, most contaminants seem to be trapped in the sediment and mullet samples generally have small concentrations (CETESB 2001), although this situation may change if dredging makes the compounds available again in the water column.

RESUMEN.—Las águilas pescadoras (*Pandion haliaetus*) son registradas todo el año en los manglares de Santos-Cubatão al suroriente del Brasil, con un pico de abundancia entre diciembre y marzo. Las aves usan todos los hábitat del manglar pero las densidades lineares mas altas ocurren a lo largo de ríos bordeados por bosques de manglar ($\bar{x} = 0.71$ aves/km) y manglares degradados por polu-

ción (\bar{x} = 0.70 aves/km). Las águilas pescadoras fueron registradas comiendo únicamente pescado y mostraron una alta tasa de éxito (71% de los intentos). Los salmónetes (*Mugil* spp.) fueron el ítem de comida mas común (77%), seguido por las mojarras romboides (*Diapterus rhombeus*) (18%). A pesar de la historia de alta polución industrial del área, los niveles de contaminantes en las especies presa consumidos por el águila pescadora fueron bajos, y la especie no fue perseguida por los pobladores locales.

[Traducción de César Márquez]

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LITERATURE CITED

- BOSHOF, A.F. AND N.G. PALMER. 1983. Aspects of the biology and ecology of the osprey in the Cape Province, South Africa. *Ostrich* 54:189–204.
- COMPANHIA ESTADUAL DE TECNOLOGIA E SANEAMENTO AMBIENTAL. 1991. Avaliação do estado de degradação dos ecossistemas da Baixada Santista. São Paulo, Brazil.
- . 2001. Levantamento da contaminação ambiental do sistema estuarino Santos/São Vicente. CETESB, São Paulo, Brazil.
- DEAN, W.R.J. AND W.R. TARBOTON. 1983. Ospreys breeding records in South Africa. *Ostrich* 54:238–239.
- GUTBERLET, J. 1996. Cubatão: desenvolvimento, exclusão social, degradação ambiental. Edusp/Fapesp, São Paulo, Brazil.
- DEL HOYO, J., A. ELLIOTT, AND J. SARGATAL (EDS.). 1994. Handbook of the birds of the world. Vol. 2. New world vultures to guineafowl. Lynx Edicions, Barcelona, Spain.
- HAVERSCHMIDT, F. AND G.F. MEES. 1994. Birds of Suriname. Vaco Press, Paramaribo, Suriname.
- LAMPARELLI, C.C. 1999. Mapeamento dos ecossistemas costeiros do estado de São Paulo. Secretaria do Meio Ambiente/CETESB, São Paulo, Brazil.
- LIEDERWALDT, H. 1919. Os manguesaes de Santos. *Rev. Mus. Paulista* 11:310–409.
- MARTELL, M.S., C.H. HENNY, P.E. NYE, AND M.J. SOLENSKY. 2001. Fall migration routes, timing, and wintering sites of North American Ospreys as determined by satellite telemetry. *Condor* 103:715–724.
- MARTUSCELLI, P. 1992. Notas sobre aves pouco conhecidas do estado de São Paulo. Pages 82–83 in Anais do VI Encontro Nacional de Anilhadores de Aves, EDUCAT, Pelotas, Brazil.
- MENEZES, N.A. 1983. Guia prático para conhecimento e identificação das tainhas e paratis (Pisces, Mugilidae) do litoral Brasileiro. *Rev. Brasil. Zool.* 2:1–12.
- OLMOS, F. 1989. A avifauna da baixada do pólo industrial de Cubatão. *Rev. Bras. Biol.* 49:373–379.
- AND R. SILVA E SILVA. 2001. The avifauna of a southeastern Brazilian mangrove swamp. *Int. J. Ornithol.* 4:137–207.
- POOLE, A.F. 1989. Ospreys: a natural and unnatural history. Cambridge Univ. Press, Cambridge, U.K.
- AND B. AGLER. 1987. Recoveries of Ospreys banded in the United States, 1914–84. *J. Wildl. Manage.* 51: 148–155.
- PREVOST, Y.A. 1982. The wintering ecology of Ospreys in Senegambia. Ph.D. dissertation, University of Edinburgh, Scotland.
- SAGGESE, M.D., E.R. DE LUCCA, S.F. KRAPOVICKAS, AND E.H. HAENE. 1996. Presencia del aguila pescadora (*Pandion haliaetus*) en Argentina y Uruguay. *Hornero* 14:44–49.
- SICK, H. 1997. Ornitologia Brasileira. Editora Nova Fronteira, Rio de Janeiro, Brazil.
- WILEY, J.W. AND F.E. LOHRER. 1973. Additional records of non-fish prey taken by Ospreys. *Wilson Bull.* 85:468–470.
- WILLARD, D.E. 1985. Comparative feeding ecology of twenty-two tropical piscivores. *Ornithol. Monogr.* 36: 788–797.

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