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RESEARCH NOTE

# Diet composition of franciscana dolphin *Pontoporia blainvillei* from southern Buenos Aires, Argentina and its interaction with fisheries

Composición de la dieta del delfín franciscana *Pontoporia blainvillei* en el sur de la provincia de Buenos Aires, Argentina y su interacción con las pesquerías

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**Abstract**.- The present study provides information about the diet composition of franciscana dolphin, *Pontoporia blainvillei*, from southern Buenos Aires coast, Argentina. From 2003 to 2011 we collected 66 franciscana dolphins that were incidentally entangled in artisanal fishing nets. We analyzed the stomach contents and estimated the prey size in order to evaluate the diet composition and the overlapping with fisheries. We identified 11 prey species in the stomach contents; only two of them were important in the diet, the striped weakfish, *Cynoscion guatucupa*, and the squid, *Loligo sanpaulensis*. Almost all the prey found in the diet of franciscana dolphins are of commercial interest. The overlapping of target species and prey that are subject to overfishing could enhance the vulnerability of franciscana by reducing food availability.

**Key words**: Prey species, *Pontoporia blainvillei*, southern Buenos Aires, fisheries

## INTRODUCTION

Commercial fisheries have fundamentally altered marine ecosystems transforming the structure and functioning of many marine food webs (Pauly *et al.* 1998, 2002) and depleting stocks of some species to near extinction (Casey & Myers 1998). Fisheries operate at all levels of marine food webs, including the lower trophic levels, potentially providing evidence of bottom-up and top-down effects (Pauly & Palomares 2005). One reason given for the move toward ecosystem-based management is concern that fisheries are overfishing fish species that are prey for many marine predators, especially marine mammals (Jensen *et al.* 2012). Thus, competition between marine mammals and fisheries for marine resources, whether real or perceived, has become a major issue for several countries (Morissette *et al.* 2012). Interactions between marine mammals and fisheries can be classified as direct or operational and indirect or ecological. In operational interactions, marine mammals come into physical contact with fishing gear (Northridge 1984). These interactions can result in the bycatch of marine mammals, recognized as the primary threat to several endangered species of marine mammals (Reeves *et al.* 2003). In ecological interaction, marine mammals and fisheries interact indirectly through trophic pathways, competing for food resources (Beverton 1985).

The franciscana, *Pontoporia blainvillei* (Gervais & d'Orbigny 1844), is an endemic dolphin of the Southwestern Atlantic Ocean, which dies incidentally in coastal fishing nets all along its geographical distribution (Corcuera 1994, Secchi *et al.* 1997, Bordino & Albareda 2004), from Itaúnas (18°25'S, 30°42'W, Brazil) (Siciliano 1994) to Península Valdés (42° 35´S, 64°48'W, Argentina) (Crespo *et al.* 1998). This species is considered the most endangered small cetacean of the Southwestern Atlantic Ocean (Secchi *et al.* 2003), seriously and immediately affected by human activities (Secchi, 2010). Consequently, franciscana dolphin is classified as Vulnerable (A3d) by the International Union for Conservation of Nature (IUCN, Reeves *et al*. 2008). Even though the International Whaling Commission establishes an upper limit of 2% of the mortality rate for the species to be sustainable (Donovan & Bjørge 1995), in Buenos Aires coast, were this study was carried out, mortality was estimated to be 2.5-3.7% of the total population of Argentina (Cappozzo *et al*. 2007, Negri *et al*. 2012).

Several studies on trophic ecology of franciscana have been performed in Brazil (Ott 1995, Di Beneditto & Ramos 2001, Bassoi 2005, Di Beneditto *et al*. 2009, Cremer *et al*. 2012), Uruguay (Fitch & Brownell 1971, Praderi 1989) and Argentina (Rodríguez *et al*. 2002). However, the diet of this dolphin from southern Buenos Aires has not currently been reported. Feeding habits studies suggest that franciscana dolphin has a generalist and opportunistic feeding behavior, being fish, cephalopods and crustaceans the most common prey feed by this dolphin (Ott 1995, Rodríguez *et al*. 2002, Di Beneditto *et al*. 2009). The diet composition of franciscanas in northern Buenos Aires province includes prey of commercial interest that are subject to overfishing, establishing a principle of potential competition for resources (Rodríguez *et al*. 2002).

Dietary studies are important in understanding the ecological role of marine mammals and in formulating appropriate management plans in terms of their interactions with fisheries. Therefore, determining franciscana's preferred prey is crucial for assessing the potential competition with coastal fisheries and, most importantly, to understand its role in the ecosystem functioning (Secchi 2010). In this context, the objectives of this study were to determine the diet composition of franciscana dolphin in southern Buenos Aires coast, and to explore the potential overlap between dolphins' prey species and commercial species that are subject to overfishing.

## MATERIALS AND METHODS

From 2003 to 2011 we collected 66 franciscana dolphins (25 females and 34 males) that were incidentally entangled in artisanal fishing nets of the southern coast of Buenos Aires province in Argentina (38°37´S, 58°50´W). The study area includes four localities: Necochea (N), Claromecó (CLA), Monte Hermoso (MH) and Bahía Blanca (BB) (Fig. 1). We worked in collaboration with the artisanal fishermen who were asked not to discard the incidentally captured dolphins. Fishermen collected franciscana

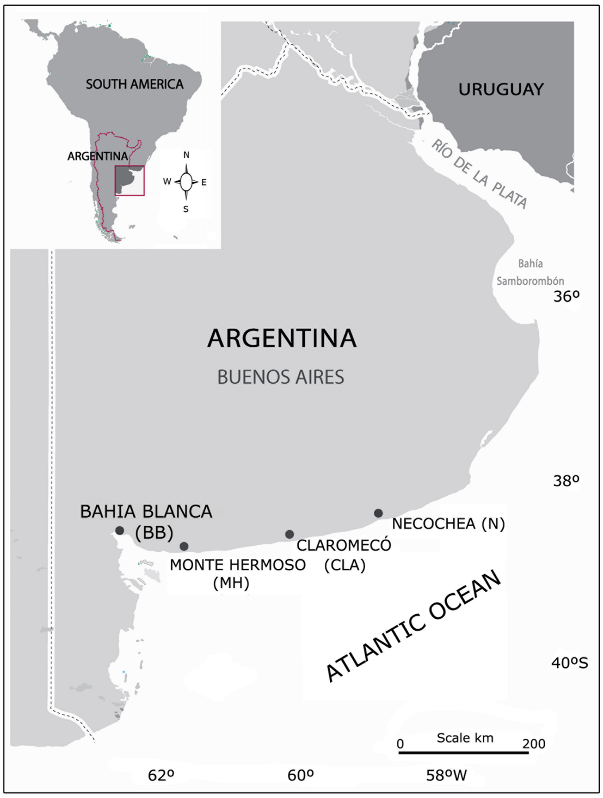


**Figure 1. Study area in southern Buenos Aires province, Argentina. Necochea (N), Claromecó (CLA), Monte Hermoso (MH) and Bahía Blanca (BB)** / Área de estudio al sur de la provincia de Buenos Aires, Argentina. Necochea (N), Claromecó (CLA), Monte Hermoso (MH) and Bahía Blanca (BB)

bycatch from gillnets and shrimpers that were set up to 50 m deep and 30 km from the coast (Negri *et al*. 2012). The animals were kept in freezers at -20°C until necropsy was performed. Total length (TL) and weight of each specimen were recorded (Norris 1961).

Diet composition was analyzed through the study of hard remains in the stomach contents, which were recovered using sieves of different mesh sizes (0.3 and 0.5 mm) and preserved in 70% ethanol. Prey items were identified to species level under stereoscopic microscope (25-40x) with laboratory catalogs and references (Pineda *et al*. 1996, Volpedo & Echeverría 2000). The relative importance of prey species was evaluated using the index of relative importance (IRI) calculated as IRI = [%N+%W] * %FO and then transformed as percentage (%IRI) (Pinkas *et al*. 1971). The frequency of occurrence (%FO) was calculated as the number of stomachs in which a prey occurred, the numerical abundance (%N) as the number of individuals of each prey type / total number of individuals of all prey types, and the reconstructed biomass (%W) as the biomass of each prey type / total biomass represented by all prey; all these indexes were expressed as percentage (Castley *et al*. 1991, Cortés 1997). Differential rates of digestion among species may bias stomach content analyses in favor of species with large and robust hard parts (Bowen 2000). Thus, diet indexes were calculated considering teleosts, cephalopods and crustaceans separately.

The total length and the prey biomass were estimated through otoliths of fish and cephalopod beaks applying the formula proposed by Pineda *et al*. (1996), Rodríguez *et al*. (2002) and Bassoi (2005). Only intact otoliths, with little erosion in both sulcus and margins, were considered for this analysis. Crustaceans were measured when whole specimen was found; otherwise total length was estimated from existing regressions (De la Garza 2003).

For statistical analyses we selected the main prey species found in diet composition as those with %FO > 70 and %IRI > 80. Differences in mean size of main prey between sex and among the four localities (N, CLA, MH, BB) were analyzed with the non-parametric tests, Mann-Whitney, Kruskall-Wallis and Multiple Comparisons, because the data were not normally distributed. Spearman's rank correlation coefficients were calculated to measure the strength of the association between predators' length and estimated length of prey. All statistical analyses were performed using the software Statistica 7.0 (Statsoft, Inc.) and InfoStat.Ink (Di Rienzo *et al*. 2011). It was considered as statistical significance level $P \leq 0.05$.

## Results and discussion

The mean (± SD) TL of the franciscana dolphins was 118.4 ± 19.2 cm (Range: 63-160.5 cm) (Table 1). Six individuals had only milk (TL= 78.7 to 87.7 cm) in their stomachs, one dolphin had an empty stomach and the others 59 presented solid remains. The smallest dolphin with solid food in their stomach was a male of 87.4 cm.

The diet of franciscana dolphins all along it distribution range is composed by, at least, 76 food items (Danilewicz *et al*. 2002). In Brazil, a total of 25 prey species were found in franciscanas from north of Rio de Janeiro (Di Beneditto & Ramos 2001) and 36 prey species in Rio Grande do Sul (Bassoi 2005). Finally, a total of 24 prey species were reported in the northern coast of Buenos Aires in Argentina by Rodríguez *et al*. (2002). The number of prey

**Table 1. Franciscana dolphins analyzed in southern Buenos Aires, Argentina. M= male, F= female, n= number of stomach contents/** Delfines franciscana analizados en el sur de la provincia de Buenos Aires, Argentina. M= macho, F= hembra, n= número de contenidos estomacales

| Locality | Sex | n | Range TL (cm) | Mean ± SD (cm) |
|---|---|---|---|---|
| Necochea (n= 15) | F | 8 | 100 - 149.0 | 123.4 ± 19.3 |
| | M | 7 | 103.5 - 141.5 | 117.4 ± 15.5 |
| Claromecó (n= 33) | F | 13 | 98 - 160.5 | 128.0 ± 18.4 |
| | M | 20 | 87.4 - 142.0 | 118.6 ± 11.2 |
| Monte Hermoso (n= 7) | F | 2 | 144.5 - 150.0 | 147.3 ± 3.9 |
| | M | 5 | 98.3 - 129.0 | 115.2 ± 11.8 |
| Bahía Blanca (n= 4) | F | 2 | 93.3 - 129.7 | 111.5 ± 25.7 |
| | M | 2 | 127.5 - 135.0 | 131.3 ± 5.3 |

species in the study area is considerably lower compared with those studies along it distribution range. We identified 11 prey species in the diet of franciscana dolphins from southern Buenos Aires coast: seven teleost fish, two cephalopods and two crustaceans (Table 2). However, seven species of those 11 prey species found in the diet, appeared with a very low frequency of occurrence not exceeding in each case a % FO= 9.

Teleosts were recorded in ~93% of the 59 stomachs and corresponded to 1,329 individuals. The striped weakfish, *Cynoscion guatucupa*, was the most important teleost (n= 1,073; %IRI= 87.8), whereas the remaining fish species represented about 12% of IRI. For cephalopods, the main prey species was the squid *Loligo sanpaulensis*, with a %FO = 90 (Table 2). The high number of cephalopod beaks found in stomachs (n= 3,660) in comparison with otoliths (n= 1,329) could reflect a differential rate of digestion rather than the importance in the diet; cephalopod beaks resist or are retained in the stomach longer than otoliths (Bowen 2002). Crustaceans, identified as *Artemesia longinaris* (marine shrimp) and *Pleoticus muelleri* (Argentine red shrimp), appeared in a low frequency of occurrence (~% 16). However, given the relatively quick digestion of crustaceans, their low values do not necessarily mean a minor importance of this group (Bowen 2000). All this kind of bias could be accounted with other method such as the analysis of stable isotopes, which are really effective in trophic reconstruction when used together with stomach contents (Sheffield *et al*. 2001).

**Table 2. Diet composition of franciscana dolphins from southern Buenos Aires, Argentina** / Composición de la dieta del delfín franciscana del sur de la provincia de Buenos Aires, Argentina

| Prey item | Common name | %FO | n | %N | %W | IRI | %IRI |
|---|---|---|---|---|---|---|---|
| Teleosts | | 93 | 1329 | | | | |
| *Cynoscion guatucupa* | Striped weakfish | 73.7 | 1073 | 80.7 | 60.2 | 10383 | 87.8 |
| *Trachurus lathami* | Rough scad | 31.6 | 84 | 6.3 | 20 | 831.2 | 7 |
| *Engraulis anchoita* | Argentine anchovy | 31.6 | 69 | 5.2 | 12.6 | 562.1 | 4.7 |
| *Micropogonias furnieri* | White croacker | 5.3 | 53 | 4 | 1.3 | 28 | 0.2 |
| *Porichthys porosissimus* | Lantern midshipman | 1.7 | 15 | 1.1 | 4.8 | 10.3 | 0.1 |
| *Raneya fluminensis* | Curk-eels | 5.3 | 11 | 0.8 | 1.1 | 10.2 | 0.1 |
| *Percophis brasiliensis* | Brazilian flathead | 1.7 | 1 | 0.1 | | | |
| N.i | | | 23 | 1.7 | | | |
| Cephalopods | | 89.5 | 3660 | | | | |
| *Loligo sanpaulensis* | Long finned-squid | 89.5 | 3654 | 99.8 | 99.8 | 9140.7 | 99.9 |
| *Octopus tehuelchus* | Tehuelche octopus | 1.7 | 6 | 0.2 | 0.2 | 0.4 | 0.01 |
| Crustaceans | | 15.8 | 88 | | | | |
| *Artemesia longinaris* | Marine shrimp | 8.8 | 61 | 69.3 | 36.5 | 927.9 | 74.8 |
| *Pleoticus muelleri* | Argentine red shrimp | 3.5 | 24 | 27.3 | 61.9 | 312.9 | 25.2 |
| Penaeidae | | | 3 | | | | |

N.i= number of unidentified otoliths

We estimated prey size from all prey species in the diet (Table 3). The sizes of main fish correspond to juveniles in *C. guatucupa* and *Micropogonias furnieri,* and to adults in *Engraulis anchoita* and *Trachurus lathami* (Cousseu & Perrotta 2004). In other areas of distribution, preference for small sizes or juvenile fish was also observed (Ott 1995, Bassoi 2005, Cremer *et al.* 2012). On the other hand, franciscana does appear to select larger squids, because most cephalopods consumed in southern Buenos Aires were mature individuals (67%= 11-13 cm ML). This species concentrate in the area in highest abundances of mature animals for breeding purposes between October and December (Castellanos *et al.* 1968, Vigliano 1985). Correlation coefficients showed no association between dolphins TL and prey TL (*C. guatucupa* and *L. sanpaulensis*) ($r$ = 0.1, $P$ > 0.05 and $r$ = 0.06, $P$ > 0.05, respectively).

We did not find significant differences in mean size of *C. guatucupa* or *L. sanpaulensis* between male and female dolphins (U= 0.43, $P$ > 0.05; U= 1.66, $P$ > 0.05, respectively). However, mean size of *C. guatucupa* consumed by franciscana differed significantly between geographical areas (H= 14.17, $P$= 0.003). *C. guatucupa* consumed near Bahía Blanca estuary and Monte Hermoso (Mean ± SD = 6.6 ± 1.6 cm) were significantly smaller than those consumed in Necochea (13.8 ± 1.1 cm) ($P$= 0.007, $P$= 0.029, respectively). Bahía Blanca estuary and surrounding waters are an important nursery ground for *C. guatucupa*, where juveniles remain during their first year of life (TL less than 20 cm) (López-Cazorla 2000). Fish aged between The fact that fish aged between 2 and 4 years were not found in the estuary (López Cazorla 2000), maybe explain the significant small size of fish consumed in the estuary of Bahia Blanca and Monte Hermoso. Also, we did not find significant differences in the mean size of *L. sanpaulensis* between areas (H= 3.04, $P$ > 0.05).

**Table 3. Prey size (TL) of franciscana dolphin from southern Buenos Aires, Argentina. Range, mean ± SD and commercial size (cm) (Cousseau & Perrota 2000)** / Talla de las presas (LT) del delfín franciscana del sur de la provincia de Buenos Aires, Argentina. Rango, media ± DS y talla comercial (cm) (Cousseau & Perrota 2000)

| Prey item | n | Range TL | Mean TL or ML ± SD | Commercial size |
|---|---|---|---|---|
| Teleosts | | | | |
| *Cynoscion guatucupa* | 295 | 2.8 – 28.1 | 8.7 ± 5.1 | 35 - 45 |
| *Trachurus lathami* | 56 | 7.6 – 21.5 | 14.1 ± 3.2 | 8 - 23 |
| *Engraulis anchoita* | 50 | 8.8 – 17.3 | 14.2 ± 2.4 | 14 - 19 |
| *Raneya fluminensis* | 11 | 10.3 – 16.4 | 13.3 ± 2.3 | No commercial |
| *Micropogonias furnieri* | 50 | 4.1 – 7.8 | 6.1 ± 0.9 | 30 - 50 |
| Cephalopods | | | | |
| *Loligo sanpaulensis* | 1402 | 4.7 – 17.9 | 11.7 ± 1.8 | < 15 |
| Crustaceans | | | | |
| *Artemesia longinaris* | 5 | 4.6 – 11.8 | 7.2 ± 2.8 | 6 - 13.5 |
| *Pleoticus muelleri* | 2 | 9.4 – 10.6 | 10 ± 0.9 | |

n= Number of specimens measured. Total length (TL) was estimated for fish and crustaceans and mantle length (ML) for cephalopods

The number and composition of prey species varied along the distribution of franciscana dolphin (Ott *et al.* 1995, Di Beneditto & Ramos 2001, Rodriguez *et al.* 2002, Bassoi 2005, Cremer *et al.* 2012) and could be related to changes in prey availability and accessibility (Danilevicz *et al.* 2002). In the study area, the main prey of this dolphin are the most abundant species (Milessi 2008), characterizing an opportunistic behavior (Begon *et al.* 1996), also observed in other areas of the distribution of this species (Ott *et al.* 1995, Bassoi 2005, Cremer *et al.* 2012). Seasonal fluctuations in the franciscana's diet components coincide with the pattern variation observed in the abundance of the prey species off southern Brazil in different seasons of the year, indicating that the species may feed opportunistically upon those preys most frequent in the area (Bassoi 2005). Another evidence of predation on abundant prey was presented by Bassoi & Secchi (1999) with the reduction on occurrence of *Micropogonias furnieri* and *Macrodon ancylodon* in the diet of franciscana from southern Brazil, through a period of 15 years, as a consequence of stock depletion for those species (Haimovici 1998). Then, an opportunistic behavior could lead the species to change its foraging patterns as a consequence of fish stock reduction (Danilevicz *et al.* 2002).

Most of prey species present in the diet of franciscana from southern Buenos Aires province are of commercial interest (Table 3). The squid *L. sanpaulensis*, a main prey in the diet of franciscana dolphin, is an important resource for the small scale coastal fisheries developed along most of its distribution, from southern Brazil to the San Jorge Gulf in Argentina (Vigliano 1985, Ré & Beron 1999, Barón & Ré 2002), although it represented only a small percentage of the total squids landings of Argentina (FAO 2005). The same occurs with the red shrimp, *Pleoticus muelleri*, which represents one of the most important fisheries in the country because of its high commercial value (Bertuche *et al.* 2000, FAO 2005, De la Garza *et al.* 2009).

*Cynoscion guatucupa*, the main fish in the diet, together with *Micropogonias furnieri* are the most important fishing coastal resources of Argentina and Uruguay (Ruarte & Aubone 2008). In Bahía Blanca estuary, *C. guatucupa* supports important commercial fisheries although historical data show dramatic variability in its population over the last 10 years, probably due to the fishing pressure exerted on this species (Lopez-Cazorla 2000). Although a significant decrease was observed in *C. guatucupa* biomass between the periods 1981-1983 and 2004-2005, this species is still being abundant in the Buenos Aires coastal system (FAO 2005, Milessi 2008). Commercial sizes of *C. guatucupa* range between 35 and 45 cm of TL (Cousseu & Perrotta 2004), but the estimated mean size of this species consumed by franciscana was ~9 cm, reaching a maximum size of 28 cm. Although fisheries target larger individuals of *C. guatucupa* than those consumed by the franciscana, the use of different sizes does not necessarily imply less intensity of the interaction (Szteren *et al.* 2004). Consequently, there might be an overlap between franciscana and fisheries in the use of *C. guatucupa* as a resource. The others prey species, *Engraulis anchoita*, *Trachurus lathami*, *Loligo sanpaulensis* and *Artemesia longinaris* show sizes which overlaps with those of fisheries (Cosseau & Perrota 2004).

Franciscana dolphin has been classified as 'vulnerable' in its whole distribution, principally as a consequence of the incidental mortality in artisanal fisheries. In consequence, the detection of trophic overlapping with fisheries is important as a first step for marine mammal conservation in a dynamic ecosystem where fishery activity is growing continually and where the overlapping of target species and prey that are subject to overfishing could enhance the vulnerability of franciscana in southern Buenos Aires, Argentina.

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