Diet of the South American sea lion *Otaria flavescens* during the summer season at Río Negro, Patagonia, Argentina

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ABSTRACT: The South American sea lion *Otaria flavescens* population from northern Patagonia was under intensive commercial harvesting pressure between 1930 and 1950 and is currently increasing at a rate of nearly 6% yr^{-1}. Food availability in the oceans is one of the most important factors influencing the survival and dynamics of marine mammal populations. The objective of the present study was to determine the summer diet of *O. flavescens* by faecal analysis, in order to assess its trophic behavior, determine whether there are interannual differences in diet composition, and evaluate the potential interaction between fisheries operating in the study area and the species. Present results show that *O. flavescens* preys mainly on fish species, with *Raneya brasiliensis* being the most frequent (frequency of occurrence, %FO = 65.7) and abundant (%N = 47.9) fish prey. Cephalopods were the second most important prey item in terms of %FO (42.6%), with the highest index of relative importance corresponding to the octopod *Octopus tehuelches*. Since these prey taxa are not targeted by the commercial fishing fleet that operates in the study area, the overlap in the use of resources by *O. flavescens* and fisheries may not be substantial. Given that the biomass of the prey species mentioned above is not directly affected by fishery activities during summer, a greater amount of food may be available for sea lions, with this factor possibly contributing to the population recovery in the area.

KEY WORDS: *Otaria flavescens* · Summer diet · Scats · Patagonia · Argentina

INTRODUCTION

Food availability is one of the most important factors influencing the survival and reproduction of marine mammal populations (Trillmich & Dellinger 1991, Roux 1997). Many studies have focused on the interactions between pinnipeds and fisheries, which are classified as either direct (operational) or indirect (ecological). The former involves abandonment of a foraging area because of disturbance by a fishery or the disruption of foraging patterns by fishing activi-

ties, while the latter involves the direct competition of fishermen and pinnipeds for a particular prey (e.g. Wickens 1995, Crespo et al. 1997). A potential cause of the decline in pinniped populations is the depletion of their most important prey species, which results from ecological interactions (Trites & Larkin 1992, Merrick et al. 2009).

The South American sea lion *Otaria flavescens* is distributed from southern Brazil to southern Argentina (southwestern Atlantic Ocean) and along the Chilean and Peruvian coasts (southeastern Pacific

Ocean) (King 1983, Bastida et al. 2007). The population inhabiting the Argentine coast dramatically declined between the 1930s and 1950s due to commercial hunting, but since 1990 it has been increasing at a rate of nearly 6% yr^{-1} (Dans et al. 2004, Grandi et al. 2010).

The fisheries that operate in the San Matías Gulf, Río Negro province, target demersal and pelagic-demersal species, with the Argentine hake *Merluccius hubbsi* being the main species caught throughout the year (Irusta et al. 2003). A trend exists towards major diversification in landings and increased fishing activity (Romero et al. 2011). The fact that the stock of Argentine hake in the region was reported to have collapsed in the 1990s due to overfishing (Aubone 2000), combined with the extreme reduction of the sea lion population, led to a reorganization of the ecosystem (Koen Alonso & Yodzis 2005). This is now characterized by larger populations of the Magellanic penguin *Spheniscus magellanicus*, Argentine short-fin squid *Illex argentinus* and Argentine anchovy *Engraulis anchoita* (Koen Alonso & Yodzis 2005). Furthermore, predation on hake decreased, while predation on alternative prey, such as *Squalus acanthias*, increased (Koen Alonso et al. 2000).

All foraging trips of the South American sea lions from Patagonia are on the continental shelf of up to 400 km in width, with males moving further from the coast than females (Campagna et al. 2001). In the austral summer, adult females give birth to 1 pup, copulate about 1 wk later and then alternate foraging trips with offspring provisioning (Campagna & Le Boeuf 1988). South American sea lions seem to be generalist and opportunistic predators, with fish being the main prey group, followed by cephalopods and crustaceans (Thompson et al. 1998, Koen Alonso et al. 2000, Bustos et al. 2012). However, studies on the diet of *Otaria flavescens* populations distributed along the Argentine coast are scarce, and most of them reported only preliminary results (Koen Alonso et al. 2000, Suárez et al. 2005, Romero et al. 2011, Bustos et al. 2012). These studies were based on stable isotope techniques and the analysis of stomach contents and scats.

The largest sea lion rookery in Patagonia is at Punta Bermeja, in the San Matías Gulf. The size of this permanent colony is maximum in winter and minimum in summer, and >80% of the sea lions from the colony are non-breeding individuals (Dans et al. 2004).

Based on the considerations mentioned above, the aims of the present study were to: (1) evaluate the diet of *Otaria flavescens* on the coasts of the Río Negro province by means of scat analysis; (2) determine whether interannual differences exist in diet composition, in order to better understand the trophodynamics of the species; and (3) investigate the potential interaction between *O. flavescens* and fisheries, which may be delaying the recovery of the sea lion population in Argentina.

MATERIALS AND METHODS

Fresh faecal samples were collected from the *Otaria flavescens* rookery at Punta Bermeja (41° 09′ S, 63° 05′ W), which is located within a Natural Protected Area managed by the Secretaría de Medio Ambiente of Río Negro province (Fig. 1). Samples were collected in the summers of 2007, 2008 and 2009 (n = 44, 48 and 45, respectively), between the last week of February and first week of March. During these collection periods, the mean number of sea lions ashore was 2650, with 70% of the colony being represented by juveniles and females, 27% by newborns and 3% by adult and subadult males.

A total of 137 samples of scat were collected and stored in plastic bags with 70% ethanol until further
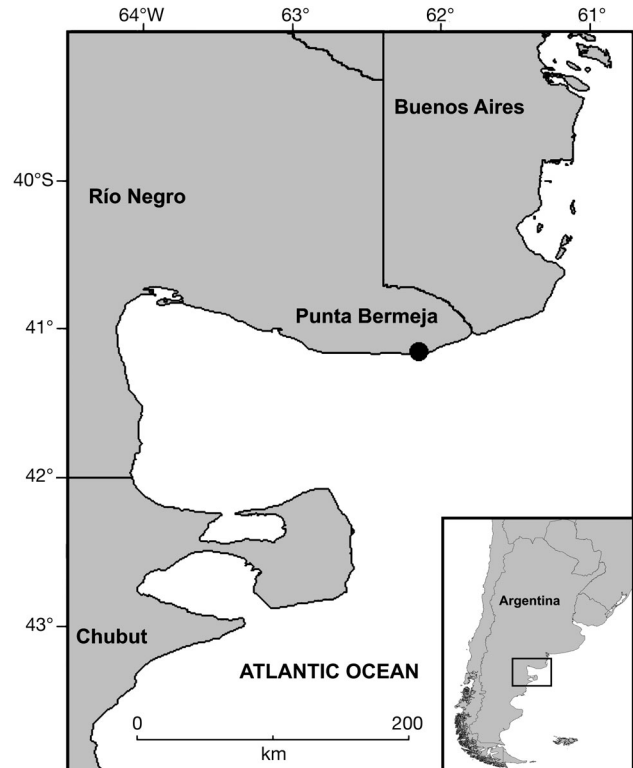

Fig. 1. Geographical location of the South American sea lion *Otaria flavescens* rookery at Punta Bermeja in Río Negro province, Argentina

analysis in the laboratory. Hard prey remains were extracted using sieves of different mesh sizes (range: 2.5 to 0.5 mm) and rinsing water, and they were classified into 3 categories: fish, cephalopods and crustaceans. Fish items were recognized from bones, otoliths, scales and eye lenses in the scat; cephalopod items from beaks, eye lenses and pens; and crustacean items from exoskeletal remains. When possible, prey items were identified to the lowest taxonomic level. Fish and cephalopod species were identified by comparing otoliths and beaks with available catalogs (Volpedo & Echeverría 2000, Xavier & Cherel 2009) and reference material.

The frequency of occurrence (%FO) and numerical abundance (%N) were calculated for both fish and cephalopod items. Only scats containing identifiable prey remains were used to calculate %FO. The minimum number of individuals in those remains was determined based on the most commonly found fish otolith (left or right) and the number of cephalopod lower beaks.

The size and weight of the main prey species consumed by *Otaria flavescens* were estimated using regression equations that relate fish otolith length to total length (TL, mm) and fish TL to wet mass (Pineda et al. 1996, Koen Alonso et al. 2000, Volpedo & Echeverría 2000). Since the regression equations corresponding to *Coelorinchus fasciatus* were not available, the size and weight of this species were determined using the equations corresponding to a morphologically and phylogenetically related species, *Macrourus holotrachys*.

The otoliths were compared with undigested otoliths of identified fish specimens from 2 reference collections (Mammalogy Division of the Museum of Natural Sciences Benardino Rivadavia and Vertebrate Laboratory [COLV], FCEN, Universidad de Buenos Aires) and assigned to 1 of the 3 following categories according to the degree of erosion: (1) good: little or no erosion, with intact margins and medial relief; (2) fair: some signs of smoothing of margins and medial relief; and (3) poor: heavily eroded, with no medial relief and margins generally rounded. A correction factor was applied to compensate for the erosion (10 % for Group 1 and 20 % for Group 2). The otoliths included in the third category were not taken into account for the estimation of fish size and biomass (Reid & Arnould 1996, Daneri et al. 2008, Bustos et al. 2012).

Previously reported allometric equations relating the lower rostral length (LRL, mm) to dorsal mantle length (DML, mm) and wet mass (W, g) were used for squids (Pineda et al. 1996, Koen Alonso et al. 2000,

Xavier & Cherel 2009), while those relating the lower hood length (LHL, mm) to mantle length (mm) and W were used for octopods (Pineda et al. 1996).

In addition, the index of relative importance (IRI) was estimated with an equation modified from Pinkas et al. (1971) to include percentage wet weight instead of volume (Reid 1995). This index was calculated for prey species with a %FO >5 %, and it was expressed as a percentage (%IRI) to facilitate its interpretation (Cortés 1997).

A cumulative prey curve was constructed to determine whether the number of scats analyzed gave an accurate description of summer diet composition. The curve was constructed using randomization procedures (EstimateS v. 8) based on the occurrence of primary prey. Sample-based curves were plotted by calculating the mean number of prey items identified, followed by repeated re-sampling of scats without replacement and 1000 randomizations of scat order. Sampling adequacy was evaluated by visual inspection of curve stabilization.

A nested ANOVA was used to detect interannual differences in the size of prey items consumed by sea lions, with scats (random factor) nested in years. This analysis allowed testing of the null hypothesis of no differences between years and estimation of the variance component associated with scats. In addition, a chi-squared test was performed to assess the temporal variation in the FO of the main prey species of *Otaria flavescens*.

RESULTS

Prey remains were found in 89 % of the scats collected. Fish was the most frequent prey item, which occurred in 91.6 to 100 % of scats throughout the sampling period (mean: 96.7 %), followed by cephalopods, which occurred in 36 to 48.8 % of scats throughout the sampling period (mean: 42.6 %). Crustacean items were found in 36 % of the scats with hard remains (Fig. 2). A total of 19 different prey species were identified (16 species of teleosts and 3 species of cephalopods). According to the constructed cumulative prey curve, the following percentages of prey were found with respect to the total percentage expected after the analysis of 40 scats: 88.2 % of in 2007, 85 % in 2008 and 87 % in 2009 (Fig. 3). This sample size was considered adequate to describe the relative contribution of prey species to the diet of *Otaria flavescens*.

The %FO of the main prey taxa (i.e. fish, cephalopods and crustaceans) was similar among years
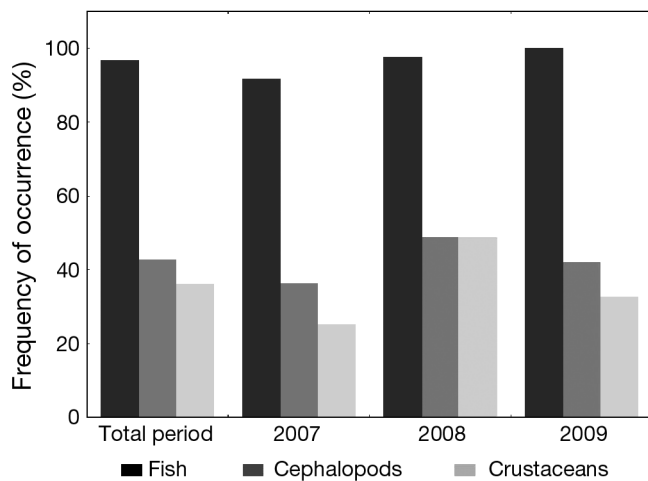
Fig. 2. *Otaria flavescens*. Frequency of occurrence of the major prey taxa contributing to the diet of the South American sea lion from the San Matías Gulf
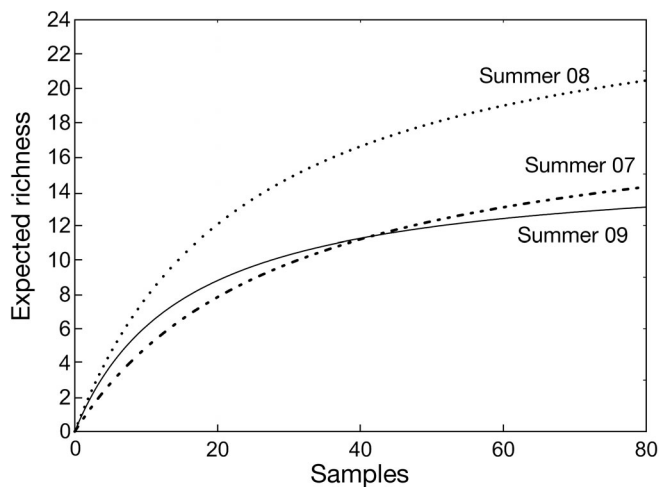

Fig. 3. *Otaria flavescens*. Cumulative curves of the mean number of individual prey consumed by the South American sea lion from the San Matías Gulf versus the number of samples. The curves were computed by repeated re-sampling of scats without replacement and 1000 randomizations of scat order

($\chi^2_{10} = 2.1$; p = 0.7). A combination of items from these 3 prey groups was found in 16% (n = 19) of the samples, while fish items alone were found in 45.4% (n = 54) of the samples. Fish and cephalopod items were found in all the scats containing crustacean items, except for 1 fecal sample.

A total of 366 otoliths were recovered from scats containing fish remains: 79 otoliths of 10 species (2.3 otoliths scat^{-1}; n = 33), 152 otoliths of 14 species (3.6 otoliths scat^{-1}; n = 27) and 135 otoliths of 10 species

(3.1 otoliths scat^{-1}), corresponding to the summers of 2007, 2008 and 2009, respectively. *Raneya brasiliensis* was the most frequent and abundant prey species (%FO = 65.7, %N = 47.9), followed in terms of FO by *Coelorinchus fasciatus*, *Cynoscion guatucupa*, *Porichthys porosissimus* and *Trachurus lathami* (%FO = 23.9, 19.4, 7.1 and 9, respectively). All these species accounted for 90% of the total amount of fish preyed upon by sea lions during the entire sampling period (Table 1). The highest IRI corresponded to *R. brasiliensis*, followed by *C. guatucupa* (75.4 and 11.8%, respectively).

A total of 314 beaks (163 upper and 151 lower beaks) were recovered from 42 of the 52 fecal samples containing cephalopod remains: 27 beaks from 8 samples (2.1 beaks scat^{-1}), 153 beaks from 16 samples (7.3 beaks scat^{-1}) and 113 beaks from 18 scats (6.3 beaks scat^{-1}) collected in 2007, 2008 and 2009, respectively. Three prey species were identified: *Loligo gahi*, *Illex argentinus* and *Octopus tehuelchus* (Table 1). Octopods predominated over teuthoids in the diet and accounted for 90% of the cephalopods preyed upon by sea lions.

Significant interannual differences were found in the mean size of *Raneya brasiliensis* prey (mean ± SE, 182.8 ± 8.8, 203.9 ± 4.3 and 192.3 ± 5.3 mm in 2007, 2008 and 2009, respectively; p = 0.005, F = 5.55) and in the mean mantle length of *Octopus tehuelchus* prey (58.4 ± 4.6, 51.6 ± 2.2 and 61.4 ± 2.3 mm in 2007, 2008 and 2009, respectively; p = 0.001, F = 6.86) (Fig. 4).

DISCUSSION

Scat analysis is a powerful tool for studying mammalian diets and has been widely used for several pinniped species (Reid & Arnould 1996, Daneri et al. 1999, Daneri et al. 2005, Páez-Rosas & Aurioles-Gamboa 2010, Bustos et al. 2012). One of the advantages of this method is that, in most cases, feces are easily collected in large numbers, with minor short-term disturbance to the seal colonies (Kucey & Trites 2006). It also provides a wealth of information with less effort than that required by other methods (Reid 1995, North 1996). Nevertheless, scat analyses suffer from some biases, largely as a result of total or partial remains after digestion (e.g. Tollit et al. 1997, Bowen 2000). Dellinger & Trillmich (1988) stated that the length of fishes calculated from otoliths found in the feces of captive seals was possibly underestimated by 15%. They also suggested that gut passage times may be shorter in wild, freely moving animals, which

Table 1. *Otaria flavescens*. Taxonomic composition of the diet of the South American sea lion from the San Matías Gulf in the summers of 2007, 2008 and 2009. %FO: frequency of occurrence; %N: numerical abundance; %W: percentage of total mass; %IRI: index of relative importance; n: number of samples

Prey taxon	Total (n = 137)				2007 (n = 44)				2008 (n = 48)				2009 (n = 45)			
	%FO	%N	%W	%IRI	%FO	%N	%W	%IRI	%FO	%N	%W	%IRI	%FO	%N	%W	%IRI
Fishes																
Raneya brasiliensis, Ophidiidae	65.7	47.9	38.5	75.4	61.1	53.8	30.9	68.4	66.7	41	46.6	76.6	68.2	52.3	34.5	74.5
Genypterus blacodes, Ophidiidae	1.5	0.4	–	–	5.6	1.9	–	–	–	–	–	–	–	–	–	–
Coelorinchus fasciatus, Macrouridae	23.9	19.7	8.5	9.0	11.1	13.5	3.4	2.5	25.9	20	11.2	10.6	31.8	23.3	8.5	12.7
Cynoscion guatucupa, Sciaenidae	19.4	8.8	36.9	11.8	27.8	11.5	59.0	25.9	14.8	10	30.5	7.9	18.2	5.8	32.0	8.7
Porichthys porosissimus, Batrachoididae	16.4	7.1	5.0	2.6	16.7	7.7	6.0	3.0	14.8	6	7.2	2.6	18.2	8.1	2.4	2.4
Trachurus lathami, Carangidae	9.0	6.7	1.9	1.0	5.6	3.8	–	–	11.1	12	4.6	2.4	9.1	2.3	0.4	0.3
Eleginops maclovinus, Eleginopidae	4.5	1.3	–	–	5.6	1.9	0.7	0.2	7.4	2	–	–	–	–	–	–
Paralichthys patagonicus, Paralichthyidae	4.5	1.3	–	–	5.6	1.9	–	–	7.4	2	–	–	–	–	–	–
Conger orbignianus, Congridae	4.5	1.3	–	–	5.6	1.9	–	–	3.7	1	–	–	4.5	1.2	–	–
Merluccius hubbsi, Merlucciidae	3.0	0.8	–	–	5.6	1.9	–	–	3.7	1	–	–	–	–	–	–
Sebastes oculatus, Sebastidae	3.0	1.3	–	–	–	–	–	–	3.7	1	–	–	4.5	2.3	–	–
Pseudopercis semifasciata, Pinguipedidae	1.5	0.4	–	–	–	–	–	–	3.7	1	–	–	–	–	–	–
Percophis brasiliensis, Percophidae	1.5	0.4	–	–	–	–	–	–	3.7	1	–	–	–	–	–	–
Prionotus nudigula, Triglidae	1.5	0.4	–	–	–	–	–	–	3.7	1	–	–	–	–	–	–
Acanthistius brasilianus, Serranidae	1.5	0.8	–	–	–	–	–	–	–	–	–	–	4.5	2.3	–	–
Stromateus brasiliensis, Stromateidae	1.5	0.4	–	–	–	–	–	–	–	–	–	–	4.5	1.2	22.1	1.3
Helicolenus lahillei, Sebastidae	1.5	0.4	–	–	–	–	–	–	–	–	–	–	4.5	1.2	–	–
Unidentified	29.9	0.4	–	–	22.2	–	–	–	25.9	–	–	–	40.9	–	–	–
Cephalopods																
Octopus tehuelchus, Octopodidae	78.8	90.7	96	99.1	46.2	100	100	100	81.0	82.4	92	98.2	100	98.2	98.9	99.8
Loligo gahi, Loliginidae	15.4	2.6	1	0.38	7.7	–	–	–	19.0	4.1	1.44	0.7	16.7	1.8	1.1	0.2
Illex argentinus, Ommastrephidae	9.6	4.6	2.6	0.47	7.7	–	–	–	9.5	9.5	6.78	1.1	–	–	–	–
Unidentified	9.6	2	–	–	23.1	–	–	–	4.8	–	–	–	5.6	–	–	–

may reduce the exposition of otoliths to digestive fluids. In the present study, the underestimation of fish size was minimized, since the otoliths were classified according to the degree of erosion, with those heavily eroded being excluded from the analysis. The above-mentioned authors also concluded that the ratios of numbers of otoliths of different species found in faeces corresponded with the ratios of those species fed to the seals although the variance was relatively high.

Present results show that *Otaria flavescens* consume a wide variety of prey items with only a few species predominating in the diet. This has also been observed in other sea lion species, such as *Zalophus californianus* and *Z. wollebaeki* (Porras-Peters et al. 2008, Páez-Rosas & Aurioles-Gamboa 2010), which are defined as plastic specialists (Porras-Peters et al. 2008, Páez-Rosas & Aurioles-Gamboa 2010). Fish species were the most frequent prey items throughout the sampling period, and the proportion of scats containing only fish remains was quite high (45.4%), which suggests that *O. flavescens* is mainly an ichthyophagous species (Fig. 2). This is in line with previous dietary studies that also reported fish to be the dominant prey items consumed by this otariid (Thompson et al. 1998, Koen Alonso et al. 2000, Suárez et al. 2005, Romero et al. 2011, Bustos et al. 2012).

In the present study, *Raneya brasiliensis* was clearly the dominant prey species throughout the sampling period, since it was the most frequent and abundant fish item and contributed 75% to the IRI (Table 1). Interestingly, *R. brasiliensis* has been reported to be a food item frequently consumed by South American sea lions from different localities in northern Patagonia (Koen Alonso et al. 2000, Romero et al. 2011) and as the most frequent and abundant fish prey consumed by the population from Punta Bermeja in the spring and win-
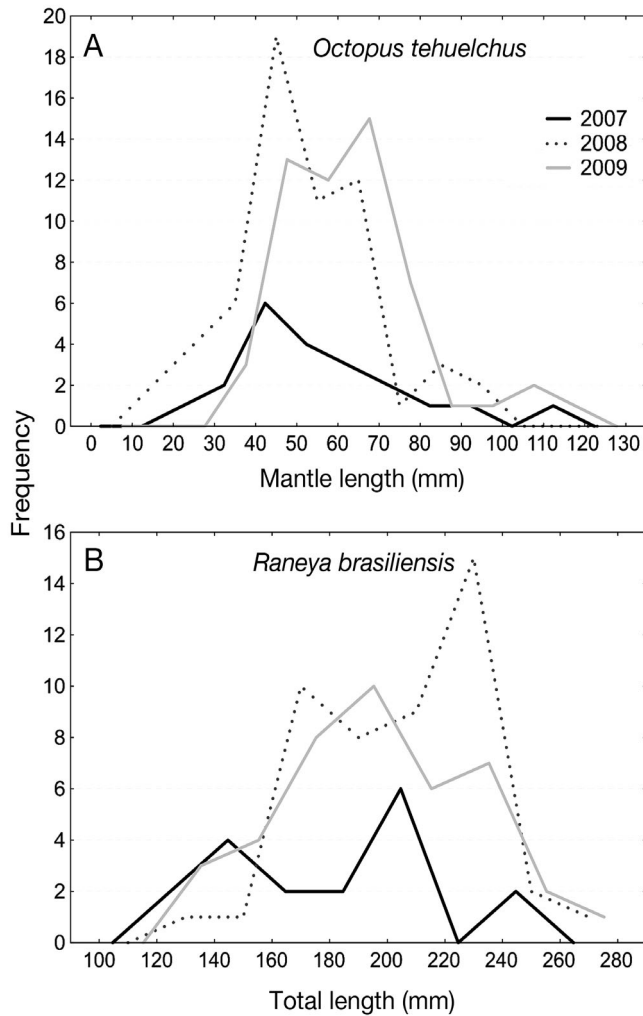
Fig. 4. *Otaria flavescens*. Frequency distribution (no. of cases) of the estimated (A) mantle length of *Octopus tehuelches* prey items and (B) total length of *Raneya brasiliensis* prey items consumed by the South American sea lion from the San Matías Gulf, during the summers of 2007, 2008 and 2009

ter of 2005 (Bustos et al. 2012). Suárez et al. (2005) also reported *R. brasiliensis* as the dominant fish item in all seasons when studying the seasonal variation in the diet of *Otaria flavescens* from Quequen, Buenos Aires province, Argentina, by fecal analysis. In particular, they found that the 2 dominant prey species in summer were *Cynoscion guatacupa* and *R. brasiliensis*, although their contribution to the IRI (51.1 and 42.6%, respectively) was remarkably different to the one observed in the present study. These results, together with the fact that *R. brasiliensis* is a common prey item of other marine mammals, marine birds and fishes (Gosztonyi et al. 2007), possibly make it a key species in the food webs of the Patagonian marine ecosystem and, consequently, one of the most important factors influencing the recovery of the *O. flavescens* population in the area. In addition, the interannual differences in the estimated size of *R. brasiliensis* prey items consumed by sea lions may indicate that *O. flavescens* fed on fish of different age classes during the sampling period.

On the other hand, some authors have suggested that hake *Merluccius hubbsi* make an important contribution to the diet of the South American sea lions from Patagonia, after analysis of the stomach contents of individuals found dead on the beach or recovered from incidental catches (Koen Alonso et al. 2000, Romero et al. 2011). However, in other studies based on scat analysis, including the present one, hake was shown to be absent or poorly represented in the diet of *Otaria flavescens* (Table 2) (Suárez et al. 2005, Bustos et al. 2012). These apparently contrasting findings may be a consequence of the different sample sources (scats versus stomach contents) and the low number of stomach samples obtained over a prolonged period of time, with no reference to the season in which data were collected. Moreover, the

Table 2. *Otaria flavescens*. Comparative summary of studies on the contribution of *Merluccius hubbsi* and *Raneya brasiliensis* to the diet of the South American sea lion from different localities along the Argentine coast. %FO: frequency of occurrence; %N: numerical abundance; F: females; M: males; n: number of samples with prey remains; stomach dead stranded: stomachs from stranded, dead individulals

Study	Source	n	Collection years	Seasons	*Merluccius hubbsi* %FO	%N	*Raneya brasiliensis* %FO	%N
Koen Alonso et al. (2000)	Stomach dead stranded and by-catch	48	1982–1987, 1990–1998	Not specified	34.6 F/ 72.7 M	14.2 F/ 38.8 M	19.2 F/ 40.9 M	21.2 F/ 9.1 M
Romero et al. (2011)	Stomach dead stranded and by-catch	26	2006–2009	Not specified	44.4	39.7	29.6	26.7
Suárez et al. (2005)	Scat	207	2001	Summer–Autumn, Winter–Spring	8.21	1.22	49.3	30.4
Bustos et al. (2012)	Scat	73	2005	Winter–Spring	Absent	Absent	58.6	49.7
Present study	Scat	122	2007–2009	Summer	3	0.8	65.7	47.9

stomach samples were obtained mainly from subadult/adult males (Crespo et al. 1997, Goetz et al. 2008), while in the present study scats were obtained mainly from females and juveniles, which are the dominant sex and age classes, respectively, in the rookery at Punta Bermeja. Furthermore, hake otoliths may be underrepresented in scats and overrepresented in stomachs of sea lions as a result of their higher digestion rates in comparison with otoliths of other fish species. However, the fact that hake otoliths were remarkably well preserved in scats sampled in the present study suggests that the low occurrence of this species as evidenced in scats is due to its low contribution to the diet of sea lions. On this basis, it can be assumed that the interaction between *O. flavescens* and the commercial fisheries operating in the San Matías Gulf, whose main target species is the Argentine hake, is much smaller than previously thought (Sardella & Timi 2004). In any case, a greater amount of stomach samples from dead and incidentally caught individuals may be necessary to make an accurate comparison between diet compositions derived from scats and those from stomach contents.

The second most important fish prey items consumed by South American sea lions in terms of their contribution to the IRI were *Coelorinchus fasciatus* in the summers of 2008 and 2009 and *Cynoscion guatacupa* in the summer of 2007. *C. fasciatus* is found in waters of the Malvinas Current flowing on the continental shelf and in slope waters and high-sea areas, at depths ranging from 70 to 1090 m (Cohen et al. 1990, Giussi et al. 2010). Campagna et al. (2001) reported that during the breeding season *Otaria flavescens* females dive to depths ranging from 2 to 30 m, and adult males travel nearly twice as far to the east and to deeper waters than lactating females, close to the edge of the Patagonian shelf (ca. 80 km). Therefore, since sea lion females and *C. fasciatus* occur in different areas and at different depths, the latter may make a relatively important contribution only to the diet of adult and subadult *O. flavescens* males. This is in agreement with previous studies, which suggested that females have more coastal predation habits and males are more pelagic, after analyzing the stomach contents of adult South American sea lions from northern and central Patagonia (Crespo et al. 1997, Koen Alonso et al. 2000).

Both *Coelorinchus fasciatus* and *Raneya brasiliensis*, which is a benthic-demersal species that inhabits coastal waters, are of no commercial value to fisheries operating in the study area. The latter represents <1% of the total discards (Romero et al. 2011). Therefore, *C. guatucupa* is the only fish species of

commercial interest with a relatively important contribution to the diet of South American sea lions, even though it is not targeted by the commercial fisheries operating in the study area. Previous studies on the diet of *Otaria flavescens* have shown that they generally consume fish prey of a smaller size than that of fish caught by fisheries (Koen Alonso et al. 2000, Szteren et al. 2004, Suárez et al. 2005, Romero et al. 2011). In particular, some authors demonstrated that sea lions feed mainly on juveniles up to 1 yr of age, which are smaller than fish from commercial landings (350 to 400 mm) (Cousseau & Perrota 2004). Nevertheless, the use of the same resource at different times or spatial locations and of different age classes does not necessarily imply that the interaction between sea lions and fisheries is less strong (Szteren et al. 2004). Still, considering that the main prey item (*R. brasiliensis*) of *O. flavescens* is not targeted by commercial fisheries and that it only represents a small percentage of the discards, the overlap in the use of resources by the former and the latter may not be substantial, at least during the summer season.

On the other hand, the present results show that *Octopus tehuelchus* was the most important cephalopod prey of South American sea lions in summer, which coincides with previous results reported by Bustos et al. (2012) for the spring of 2005. This octopod species is an important coastal resource for artisanal fishing in the San Matías Gulf, with this activity taking place during the spring and summer seasons (Storero et al. 2010). Hence, there may be a certain degree of overlap in the use of this resource by *Otaria flavescens* and artisanal fishermen. Sea lions consumed *O. tehuelchus* octopods of 2 different sizes in each of the 3 seasons studied (Fig. 4), which may be explained by the fact that 2 cohorts of *O. tehuelchus* coexist during the austral summer: one of them born in the previous winter (under-yearling) and the other born in the winter of the previous year (yearling) (Storero et al. 2010).

With respect to crustaceans, their mean %FO was 36 during the entire sampling period (range: 25 to 48). However, a low number of exoskeletal fragments and appendages were recovered from fecal samples. The fact that the most important prey taxa consumed by South American sea lions (fish and octopods) are, at least partially, carcinophagous may indicate that crustaceans are secondary prey items (prey of prey), as previously proposed by Bustos et al. (2012).

In summary, the present study suggests that *Otaria flavescens* feed mainly on demersal species and secondarily on benthic species associated with the continental shelf and the shelf break. Based on satellite

telemetry, it is assumed that, during summer, South American sea lions focus their foraging activity on the temperate waters of the Patagonian continental shelf (Campagna et al. 2001). No significant inter-annual differences were found in the composition of the summer diet of *O. flavescens*, which may indicate a uniform pattern of predation through time. Fish were the dominant prey items, followed by cephalopods. There may be a certain degree of overlap in the use of food resources (octopods) by sea lions and the local artisanal fishery.

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