Residence patterns and site fidelity in bottlenose dolphins, *Tursiops truncatus* (Montagu) (Cetacea, Delphinidae) off Southern Brazil

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ABSTRACT. Residence patterns, habitat use, range, and some population estimate of the coastal bottlenose dolphin, *Tursiops truncatus* (Montagu, 1821), were documented in two coastal sites in southern Brazil: Laguna (Santa Catarina) (28°30'S; 48°55'W), and Imbé/Tramandaí (Rio Grande do Sul) (29°58'S; 50°07'W). Regular observations were carried out at the Laguna system for 27 months (August 1989 to December 1991). The dolphins were photo-identified using natural permanent marks. Over 4,500 photograps were taken from shore grounds 6 to 14 meters away. Up to 51 dolphins have used the estuaries of Laguna's canal and Imaruí-Santo Antonio's lagoon system in 1991. A stable group of nine animals has inhabited the Imbé/Tramandaí area for over 13 years. Both sites were considered distinctive geographical communities, with 5.7% interchange within their individuals. In Laguna 88.5% of the individuals were resident and the rest were nonresident. Four cases of movement along the coastline were followed and females were more resident than males.
KEY WORDS. *Tursiops truncatus*, bottlenose dolphin, residence patterns, site fidelity, Southern Brazil

The first attempts to monitor movements and site fidelity patterns in bottlenose dolphins, *Tursiops truncatus* (Montagu, 1821), were made by CALDWELL (1955) and ESSAPIAN (1962). Subsequently, several other authors have improved upon the technique and systematically used photo-identification to recognize naturally-marked dolphins in the wild (*e.g.* WÜRSIG & WÜRSIG 1977; SHANE 1980; BALLANCE 1990, 1992; WÜRSIG & HARRIS 1990; BEARZI *et al.* 1997). Some kinds of marks are present for long periods of time and are therefore usefull in long-term studies. So Bottlenose dolphins occuring along the southwestern South Atlantic Ocean are little know, specially in aspects of their population dynamics. In this paper, residence patterns, habitat use, range and preliminary population estimates of *T. truncatus* in two localities in southern Brazil are presented.

MATERIALS AND METHODS

Bottlenose dolphins using the inshore waters of the Laguna system, Santa Catarina State, and Imbé/Tramandaí, Rio Grande do Sul State, southern Brazil, were monitored and photo-identified from shore based locations (see figure 1 from SIMÕES-LOPES *et al.* 1998). Regular observations were carried out at the Laguna

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system for 27 months (August 1989 to December 1991). Sporadical or non-regular surveys were carried out in Imbé/Tramandaí for 13 years (1982 to 1995), covering all seasons. From April 1991 to March 1992, boat transects were carried out in order to detect areas of greater usage within the habitat. Routine observations were made during 12 hours day periods (from 6:00 a.m. to 6:00 p.m.), 36 hours per month and totaling 1,024 hours.

Due to the time-frame of this study, only natural permanent marks with frequent significant loss of body tissue were considered (categories 3 and 4 of LOCKYER & MORRIS 1990). Over 4,500 photographs were taken from shore grounds 6 to 14 meters away. Boats trials proved inefficient because dolphins avoided boats throughout the Laguna canal. Black and white *Kodak* Plus-X, *Kodak* T-Max and *Ilford* 400 ASA films pushed to 800 ASA, were used. Color films and slides were also used. High speeds (1/500 and 1/1000 sec) and small openings (f22 and f11) provided for a large depth of field. The confirmation of new individuals in the catalog was obtained by examining the negatives and print frames sheets of photographic paper using an 16x optical lupes. In order to avoid the false positives errors (from GUNNLAUGSSON & SIGURJÖNSSON 1990), the dorsal ratio was calculated for fins with two or more notches (DEFRAN *et al.* 1990).

For the purpose of censusing Laguna's system dolphins it is used the mark-recapture Jolly-Seber method, considering the number of recognizable dolphins per group. In order to decrease biases caused by easily recognizable individuals, which remained for long time close to shore stations, groups with four or more animals leaving or entering the canal were considered. Long-term residency was indicated from routine resightings of a number of individuals. "Nonresident" dolphins were considered those sighted only one time and the "residents" were sighted more than once (*sensu* BALLANCE 1990).

The term "community" was used in after WELLS *et al.* (1987), emphasizing the geographic and social relationships of the individuals, and not as a closed reproductive unit. Almost all dolphins were sexed by the direct observation and photographs of the genital area, and some females (#L7, #L33 and #L35) were identified by swimming side by side with very young calves during several days.

RESULTS

Population estimate

Twenty-six dolphins were photo-identified at Laguna canal and Imaruí-Santo Antonio lagoon (Santa Catarina). During 1991 it is identified an average of 50.75% of dolphins per group, considering their natural permanent marks ($n = 52$ monitored groups; $s^2 = 0.0183$; s.d. = 0.1354). Therefore, the regional population using the inshore waters of Laguna in 1991 was estimated at about 51 individuals. This number may be very close to reality as the counting was done in a passageway, where each animal had the same probability to be registered.

Boat route sampled the average of dolphins sighted at the site simultaneously (Fig. 1). The highest rates were obtained from May to August 1991, although seasonal differences occurred on habitat use. Thus, during fall and winter (April to September) the dolphins were concentrated in the mouth of the canal, while during summer they moved to shallower areas into the lagoon (Fig. 2).

Nine adult dolphins were identified at Imbé/Tramandaí, and this is the total number of animals at this site. These numbers were based over 13 years of monthly observations, as well as on other researchers' photographs and anedoctal information provided by local fishermen.

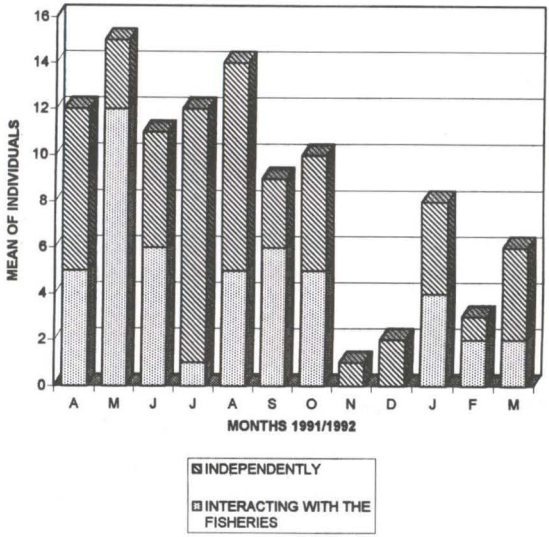

Fig. 1. Average of individuals of *Tursiops truncatus* registered simultaneously during boat transections at Laguna canal and Santo Antonio lagoon (Santa Catarina, 28°30'S) between April 1991 and March 1992. Dolphins could be interacting with the mullets artisanal fisheries or feeding independently.

Residence Patterns

Of 26 identified dolphins during 27 months of studies in Laguna, as few as 3 (11.5 %) were sighted only once and considered nonresidents (# L_5, # L_{23} and # L_{27}). The other 88.5% were present twice or more, with different degrees of residency (Tab. I). The number of months in which an individual was registered, and the time length between the first and the last sighting, allowed to estimate the site association degree. The presence and absence of resident individuals is shown in figure 3. Only three dolphins (# L_{22}, # L_{16}, # I_5L_{34}) stayed less than 10% of the time in Laguna area (2 out of 27 months). Nevertheless, they have shown seasonality, being sighted during fall, winter, or spring (Fig. 3). Seasonal movements were also disclosed by other dolphins, suggesting the importance of their seasonal presence in relation to an abundance of food resources.

Dolphins # L_2, # L_{14} and # L_8 had the highest degree of residency, being resighted in 23, 22 and 21 months, respectively. The first and the second ones stayed 10 and 12 consecutive months in the study area, respectively. The three dolphins were absent in December 1990 and December 1991, when food resources were scarce. Dolphins # L_9 and # L_6 also reached residency rates over 50%, totaling eight consecutive months.

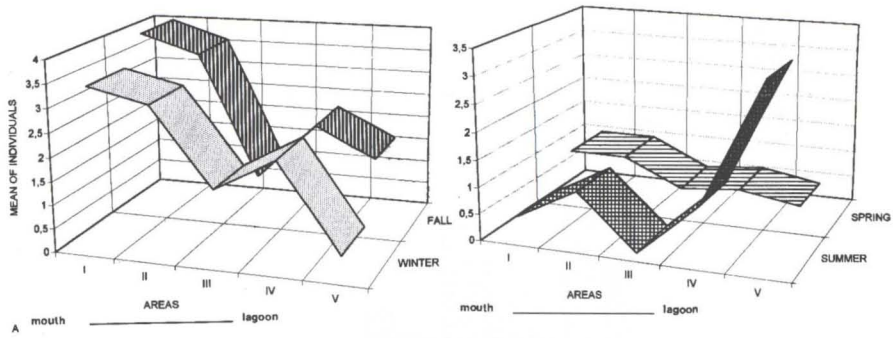

Fig. 2. Seasonal patterns of habitat use at Laguna canal and Santo Antonio lagoon (Santa Catarina, 28°30'S) between April 1991 and March 1992. The mean of individuals is related to the average of all months in each season: (A) fall-winter; (B) spring-summer. Areas: (I) mouth to Pasto V, (II) Tesoura to Toca-da-Bruxa, (II) Balsa to Capim do Meio, (IV) Tubarão River to Ponta das Pedras, (V) Portinho to Arrebentão.

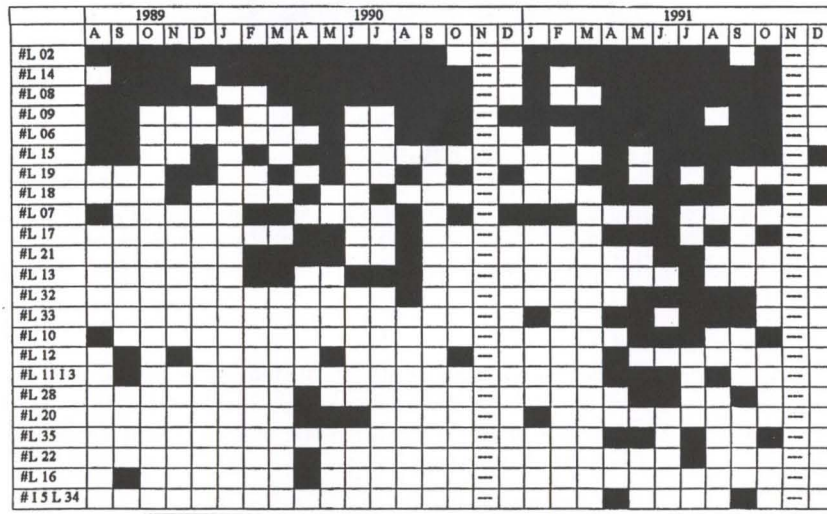

Fig. 3. Month-to-month table (shade fields) of 23 resident individuals of *Tursiops truncatus* at Laguna (Santa Catarina), between August 1989 to December 1991.

Females showed a higher degree of residency, although part of these individuals could not be sexed (Tab. I). Males were the animals with the lowest degree of residency. The one that reached the highest residency rate in Laguna was there only 22.2 % of the time.

The dolphins group of Imbé/Tramandaí remained steady throughout the study period. Despite the non-systematic follow up, more than 13 years of occasional observations allowed for long-term features. Female # I_1 was the animal with highest degree of residency, being sighted in all seasons. Entire month absences rarely

occurred. One such time was in the summer of 1994, when intensive nautical sports are generally practiced. Along with female # I_8, male # $L_{11}I_3$ and adult # I_2 (sex unknown) were sighted at the area for more than 13 consecutive years. This number included only photographic evidences.

Table I. Site fidelity of resident individuals of the bottlenose dolphin, *Tursiops truncatus*, at Laguna (Santa Catarina, 28°30'S; 48°55'W), between August 1989 and December 1991.

Catalog number	Sex	TM	TL	RR%
#L_2	Female	22	26	81.4
#L_{14}	–	22	25	81.4
#L_8	Female	21	26	77.7
#L_9	Female	18	26	66.6
#L_6	Female	15	26	55.5
#L_{15}	–	13	27	48.1
#L_{19}	–	11	21	40.7
#L_{18}	–	10	25	37.0
#L_7	Female	9	22	33.3
#L_{17}	–	8	18	29.6
#L_{21}	Female	7	17	25.9
#L_{13}	Male	6	17	22.2
#L_{32}	–	6	13	22.2
#L_{33}	Female	6	9	22.2
#L_{10}	–	5	26	18.5
#L_{12}	Male	5	18	18.5
#$L_{11}I_3$	Male	5	23	18.5
#L_{28}	–	4	17	14.8
#L_{20}	–	4	9	14.8
#L_{35}	Female	4	7	14.8
#L_{22}	–	2	15	7.4
#L_{16}	Male	2	8	7.4
#I_5L_{34}	Male	2	6	7.4

(TM) total number of months in which an individual was registered; (TL) time length between the first and the last sighting; (RR%) percentage residency rate (RR% = TM/27 months).

Long-distance movements of four residents at Imbé/Tramandaí community were documented. Two males covered a distance of about 219 km and a female, 82 km, moving north all. The fourth individual # I2 (sex unknown) was photo-identified 314 km south (April 1993) and 82 km north (May 1995).

Imbé/Tramandaí individuals were confirmed as far south as Mostardas lighthouse latitude (32°07'S). The first evidence about this community's reaching area showed a 210 km of coastline between Torres (29°19'S; 49°43'W) and Mostardas (32°07'S; 52°05'W), respectively. To the Laguna community, it is known that some individuals were sighted at Araranguá River mouth, 65 km south to the probable home range center.

DISCUSSION

Residency and movement patterns vary from one region to another. The use of estuarine areas for feeding activities may represent a trend in habitat use by many coastal populations of *T. truncatus,* mainly because of the high abundance of prey

(BALLANCE 1992). It is observed a seasonal change in the number of individuals utilizing different sections of the coast, suggesting movements between these areas. WELLS *et al.* (1980), IRVINE *et al.* (1981) and SHANE *et al.* (1986), believed such movements and abundance variations were related to changes in the distribution of food resources. Some authors cite latitudinal migrations (TRUE 1890; CALDWELL & CALDWELL 1972; MEAD 1975; SHANE 1980), but the term migration should be used cautiously here, due to the fact that many individuals remain at the site year-round, and virtually nothing is know about movements and home ranges of individual dolphins.

Contrary to what was observed by BALLANCE (1990) for Kino Bay at California Gulf, most of the identified animals were resident and only a few were nonresident. In Imbé/Tramandaí female # I_1 was observed and photographed for 13 years, but though anecdotal information from locals suggest longer periods of residency. Dolphins # I_8, # $L_{11}I_3$ and # I_2 are at the site for 13 years too, but with less frequency. High rates of site fidelity were reported at San José Bay in Argentina (WÜRSIG 1978; WÜRSIG & HARRIS 1990) and in Sarasota in the West coast of Florida (WELLS *et al.* 1987). CONNOR & SMOLKER (1985) mentioned a recognizable group of individuals for more than 20 years in Shark Bay, Australia, but such information comes from local people and visitors.

Movements of 314 km were confirmed for the small groups of Imbé/Tramandaí. WÜRSIG & WÜRSIG (1979) cite movements of about 300 km, WOLF *et al.* (1987) cite 483 km, and WELLS *et al.* (1990), round-trip 1340 km. In southern Brazil these movements follow the seasonal variations of prey abundance, mainly mullet migration [*Mugil* spp., Mugilidae, *e.g.* SADOWSKI & ALMEIDA-DIAS (1986) and VIEIRA & SCALABRIN (1991)].

It was considered that Laguna, and Imbé/Tramandaí dolphins belonged to distinctive communities or subsets of a metapopulation, although there is little interchange between them (5.7 %; n=2). MÖLLER *et al.* (1994) argued that this small interchange is associated with food or genetic exchanges. Those communities' degree of overlap and their members' home range are unknown. Home range overlaps were proposed by IRVINE *et al.* (1981) and BALLANCE (1992) suggested individual ranges of a minimum of 65 km of coastline. In agreement with long-term studies in Florida by WELLS *et al.* (1987), it was observed that females showed higher site fidelity and underwent shorter movements than the males. Males have shown a disposition to explore farther sites, and may be responsable by genetic exchanges.

ACKNOWLEDGMENTS. We are grateful to Miriam Marmontel and Fernando W. Rosas who gave away the first pictures taken at Imbé, Rio Grande do Sul. I am grateful to Edward J. Heske, Nélio B. Barros and two anonymous reviewers for critical reviews of the manuscript. The Barddal Foundation support and FAPERGS grant were greatly appreciated.

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Recebido em 04.VI.1998; aceito em 24.IX.1999.