Satellite tracking of Franciscana Dolphins *Pontoporia blainvillei* in Argentina: preliminary information on ranging, diving and social patterns.

Bordino, Pablo[1], Wells, Randall. S.[2], Stamper, M. Andrew[3]

[1] AquaMarina CECIM, Artemisa 260, Pinamar, Buenos Aires, 7167, Argentina
[2] Chicago Zoological Society c/o Mote Marine Laboratory, 1600 Ken Thompson Parkway, Sarasota, FL 34236, USA
[3] Disney's Animal Programs, P.O. Box 10000, Lake Buena Vista, FL 32830 USA

ABSTRACT

The Franciscana dolphin is one of the most threatened small cetaceans in the Southwestern Atlantic. It is estimated that about 650 dolphins are by-caught in gillnets each year, representing over 2% of the estimated abundance for the coastline of Argentina. Currently, all Franciscanas in Argentina are considered to belong to a single stock. However, knowledge about movement patterns has been scarce; such data are critical for evaluating impacts and establishing effective protection measures. With the objective of providing information about their ranging patterns and building upon the results of tagging with VHF transmitters during 2005, small satellite-linked transmitters (Wildlife Computers SPOT or Splash tags) were attached to the dorsal fins of Franciscana dolphins captured and released in Bahia Samborombon in March 2006 (n=4) and in Bahia San Blas in March 2007 and 2008 (n=4 each year). These two Argentine bays are protected areas separated by about 700 km. Individuals were tracked via CLS/Argos for up to 261 days in Bahia Samborombon (two females and two males) and up to 189 days in Bahia San Blas (three females and one male in 2007, 2 females and 2 males in 2008). Home ranges from 2006 and 2007 were calculated using Kernel methods. Contrary to previously accepted descriptions of a single stock moving along the entire coast of Argentina, all tagged individuals exhibited localized movements, with an average home range of 150 km^2 in Bahia Samborombon (53% of locations within the protected area), and 345 km^2 in Bahia San Blas (100% of locations within the protected area). In addition to providing location information, three of the satellite-linked transmitters deployed in March 2008 in Bahia San Blas were equipped with time-depth recorders (Wildlife Computers Splash tags). Even though the dive data are still very preliminary as this is ongoing research, the consistency of patterns across the three dolphins over the initial period appears striking. Typically, the dolphins are swimming at a depth of less than 15m, and a typical dive lasts less than 1.5min. The dolphins have been recorded to dive to 30 to 35m, which would approximate the deepest points in the range they have used to date. Each dolphin has demonstrated an ability to make occasional dives lasting in excess of 4-5min. In 2008, all 4 dolphins were programmed with the same duty cycle in order to be able to examine social patterns. Findings over the first 77 days of tracking indicate strong associations initially for each pair caught together, with the recent separation of one pair. . Findings from tracking and recent genetic studies suggest that the current designation of a single population ranging over the entire Argentine coastline is incorrect. The suggestion of small ranges in bay areas of heavy artisanal fishing pressure increases the urgency with which more effective protective measures need to be implemented for the species, and may allow different approaches from those applied to widely-ranging populations.

INTRODUCTION

The Franciscana dolphin (*Pontoporia blainvillei*) is an endemic species to the coastal waters of Brazil, Uruguay and Argentina. The species' distribution in Argentine waters is mainly restricted to coastal Buenos Aires Province. It is currently the most threatened cetacean species in the Southwestern Atlantic. The primary threat throughout most of its range is incidental mortality in gillnetting. Bycatch of Franciscana dolphins has been largely reported associated with this fishing activity in coastal Buenos Aires Province (Albareda and Albornoz 1994, Corcuera 1994, Bordino et al. 2002). In the last 15 years, the fishing effort along the Buenos Aires coast has increased, suggesting the incidental take rate of Franciscana dolphin is also likely on the rise (Crespo et al. 1994). The abundance of the species in argentine waters was estimated from aerial and boat surveys in about 35,000 individuals (Bordino et al 2004, Crespo et al 2004). It is estimated that a minimum of 650 dolphins are by-caught each year off Argentina (Bordino and Albareda 2004), representing over 2% of the estimated abundance for Argentina.

Current data suggest that the Franciscana dolphin can not sustain the current level of incidental mortality throughout its entire range. The Franciscana is one of the smallest dolphins; adult males range between 121-158cm in length, and adult females between 134-177cm. The species matures sexually between 2 and 4 years, and like other cetaceans it has a low reproductive potential (Brownell 1989). Life span is about 20 years, however only a few individuals are likely to reach this age (Pinedo and Hohn 2000). As a consequence, the species has a low potential rate of population growth.

Despite some recent progress in abundance estimation, knowledge of population structure and movement patterns is still scarce, information that is critical for evaluating impacts and establishing effective protection measures. The existence of four management stocks of Franciscana dolphins through the species range was proposed based in a combination of morphological, ecological, and genetic information: two inhabiting coastal central Brazil, one in southern Brazil and Uruguay, and one in Argentina (Secchi et al 2003). These initial stock definitions were based largely on the distribution of dead specimens caught in fishing nets or found on the beach, as little work has been done on the behavioral ecology of the species (Bordino et al. 1999, Bordino 2002, Di Beneditto et al. 2001).

Defining population units is crucial for appropriate, effective management. Such definition can come from repeated observations of distinctive individuals, or from tracking individuals. With the objective of providing information on their ranging patterns and building upon previous results of tagging with VHF transmitters (Bordino and Wells 2005), small satellite-linked transmitters were attached to the dorsal fins of Franciscana dolphins in Bahia Samborombon (March 2006) and Bahia San Blas (March 2007 and March 2008).

MATERIALS AND METHODS

Study areas

The field sites are located in northern and southern coastal Buenos Aires Province (Figure 1). The northern study area was in the southern portion of Bahia Samborombon, a large bay along the western coast of the Rio de la Plata estuary which encompasses over 3,000km^2 with an average depth of 5m . The area contains a variety of habitats ranging from intertidal mudflats and creeks, tidal salt marshes, permanent and seasonally-flooded freshwater lagoons, and slow and fast flowing streams, creating a complex hydrological system with a diversity of wetland types. The estuarine turbidity front, an area of plankton concentration, creates a highly productive area and acts as one of the most important nursery areas for some commercial fish. It is in fact, the main local fishing ground supporting traditional artisanal fishing and an inshore industrial fleet from Argentina and Uruguay. Approximately thirty-five coastal fishermen operate with gillnets throughout the year in this area, targeting mainly white croaker *(Micropogonias furnieri)* and striped weakfish *(Cynoscion guatucupa).*

The southern area is located in Bahia Anegada, which extends over 1,800km^2. It is a coastal marsh zone which includes a group of five islands and sand embankments. However, the coast drops off steeply in some places with depths of up to 5m at distances of only 10m from the coastline. This area includes Bahia San Blas, the only developed zone in the region, where at least 20 vessels operate in a shark sport fishery. Also, about four artisanal fishery vessels operate in the area from September to November, targeting mainly Patagonian smoothhound *(Mustelus schmitti).* The semidiurnal tide regime in Bahia Samborombon and Bahia San Blas presents mean tide amplitude of about 0.75m and 2.5m respectively. These areas are important habitats for amphibiotic and sea fish, as well as an important concentration area for shorebirds. These two Argentine bays are provincial protected areas separated by about 700km. Franciscana dolphins frequent the relatively sheltered waters in these areas (Bordino et al. 1999, Bordino 2002, Bordino et al. 2004).

Capture-tagging-release

The operation required the coordination of about 40 people on six to eight small outboard boats looking for dolphins during calm conditions (Beaufort < 3). When dolphins were sighted, the group size as well as the presence of calves within the group were recorded. The water depth was measured to ensure safe capture conditions. Once the depth was determined to be less than 3m, the net was deployed. . Dolphins were captured by encircling individuals with a 500m x 4.5m seine net, based on capture technique used successfully for more than 35 years with bottlenose dolphins in Florida (Wells and Scott 1990, Wells 2003). A team of dolphin handlers and observers were placed in all boats around the net circle to assist dolphins in case of entanglement The fisherman deploying the net and many personnel had received prior training with bottlenose dolphins in Sarasota Bay, Florida. Observers monitored the net corral for the presence of the encircled dolphins to ensure that they did not become entangled, and were ready to intervene if that happened. Franciscana dolphins remained calm swimming inside the circle. When the circle was slowly contracted to a small diameter, the dolphins swam into the net and received immediate assistance from handlers. The dolphins were removed from the net and transferred to the foam-padded deck of an inflatable boat for processing. Each captured dolphin was kept wet with sponged seawater, and was continuously monitored by a veterinarian to ensure that it was responding well

to procedures. Tagging typically required about 5min or less, and with measurements and blood sampling the animals were onboard the boat for about 10min.

Two kinds of satellite-linked transmitters were used. The tags were nearly identical in terms of size, shape, and weight. SPOT5 tags (Figure 2a, Wildlife Computers, Redmond, WA, USA), which provide location information only, were applied to four dolphins in Bahia Samborombon in 2006, four in Bahia San Blas in 2007, and one in Bahia San Blas in 2008. Splash tags (Figure 2b, Wildlife Computers, Redmond, WA, USA), which provide both location and dive information, were attached to three dolphins in Bahia San Blas in 2008. Each tag consisted of a satellite-linked transmitter, controller board, and battery cast in epoxy and designed for water depths of up to 1,000m (8.0cm L x 4.5cm H x 2.2cm W, 64g; 20cm semi-rigid antenna). The tags were powered by a single AA battery, generating 0.5 W of radiated power, with estimated battery life of 25,000-30,000 transmissions. The Splash tag also included a pressure transducer.

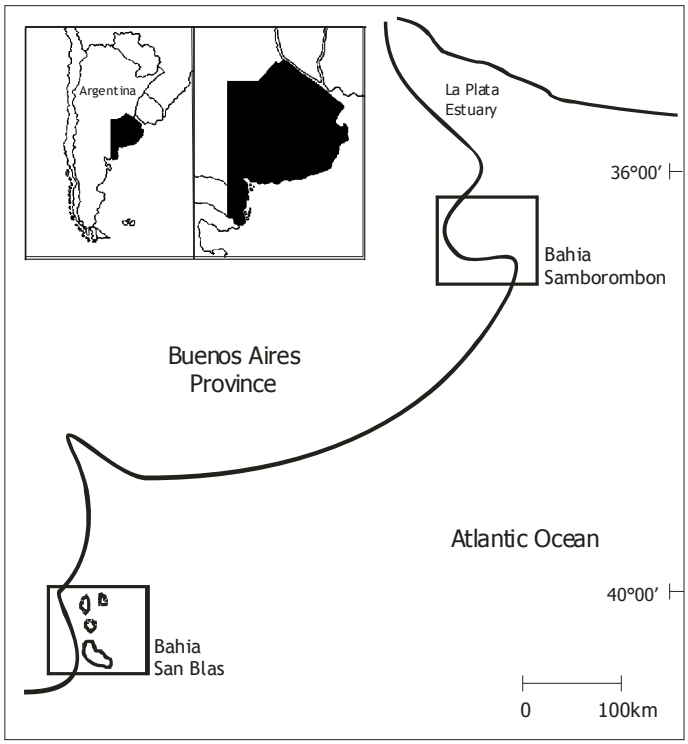

Figure 1. Location of the study areas, Bahia Samborombon and Bahia San Blas in northern and southern Buenos Aires Province, Argentina.

Dive information included the number of dives performed within established depth categories, the number of dives within established duration categories, time spent at specified depths, and time spent in specified water temperatures. These data were collected throughout the day, stored in 6-hr blocks, and were transmitted during daily transmission windows designed to maximize the life of the battery while still providing sufficient transmissions to define movement patterns. The tags were programmed to transmit for eight hours each day. During 2006 and 2007, duty cycles were staggered to provide information on possible diurnal patterns of movement. In 2008, all four tags were set on the same duty cycle in order to provide information on patterns of social association. The tags were programmed for 250 (SPOT5) or 500 (Splash) transmissions each day.

Each satellite-linked transmitter was attached to the dorsal fin by three delrin pins (0.64 or 0.48cm diameter), threaded on each end and secured with corrosible lock nuts designed to jettison after the end of the tag's battery life. Tags were mounted on the left side of the fin with closed cell foam backing material as padding, and were secured to padded washers on the right side of the fin. Holes for the pins were cored with a sterilized punch. Skin from the cores was preserved for genetic analyses.

Data were processed and preliminary data made available daily via the internet. Final processed data were provided monthly on a cd-rom. Plausible locations were identified by filtering with Argos_Filter V7.02 (Douglas 2006, Klatsky *et al.* 2007).

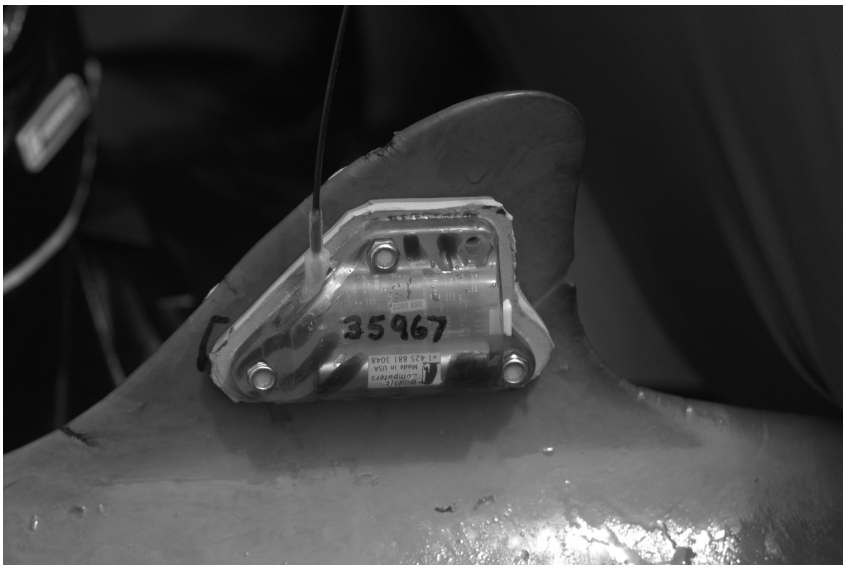

Figure 2a. SPOT5 transmitter on adult female Franciscana dolphin, Bahia San Blas, March 2008.

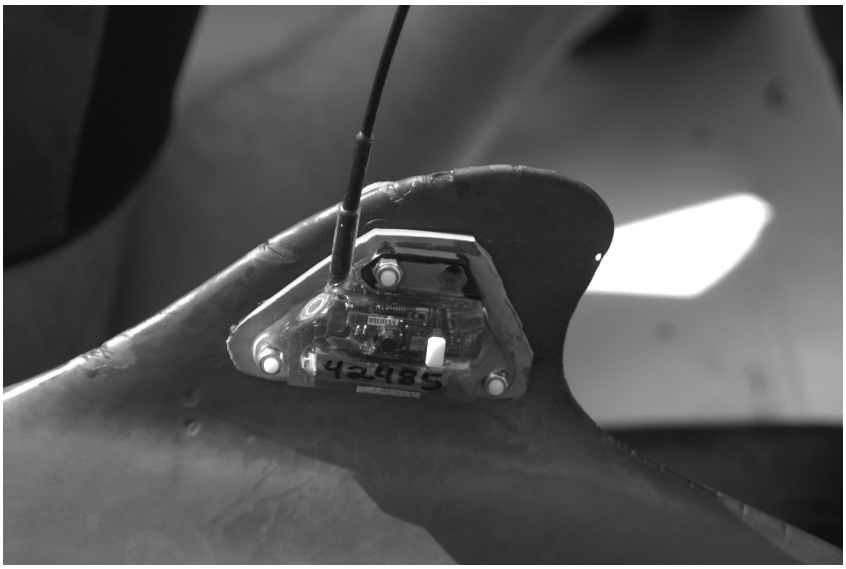

Figure 2b. Splash transmitter on adult female Franciscana dolphin, Bahia San Blas, March 2008.
Transmissions from the dolphins were received via satellite by CLS America (ARGOS).

Overlap with fishery activities

Annual fishing effort from local gillneters operating in Bahia Samborombon was calculated from data provided through an established observer program from 2004 to 2007, and plotted in a 10km by 10km grid. Reliable estimations of fishing effort in Bahia San Blas were not available for analysis.

RESULTS

Twelve dolphins were tagged with satellite-linked tags and tracked via CLS/Argos during 2006-2008 (Table 1). The four tags deployed in March 2008 were still transmitting as of the time of this writing (May 2008), so analyses presented below are mostly for the 2006 and 2007 dolphins for which tracking has been completed and final processed data are available.

Date	Study area	Time	Tag type	Tag ID	Dolphin ID	Sex	Length (cm)	Tracking days	# filtered locations
2006									
March 08	BS	10:28	SPOT 5	65626	CPb0106 / Pampa	F	147	7	33
March 08	BS	10:28	SPOT 5	65625	CPb0206 / Bruce	M	115	173	520
March 10	BS	14:40	SPOT 5	65624	CPb0306 / Chica	F	147	258	679
March 10	BS	14:40	SPOT 5	65628	CPb0406 / Tango	M	130	109	376
2007									
March 10	BSB	17:24	SPOT 5	35961	CPb0107 / Yaana	F	154	189	822
March 11	BSB	16:05	SPOT 5	35962	CPB0207 / Martha	F	135	12	52
March 13	BSB	15:39	SPOT 5	35963	CPb0307 / Roberto	M	140	55	260
March 13	BSB	15:39	SPOT 5	35965	CPb0407 / Lea	F	142	53	269
2008									
March 04	BSB	11:45	SPLASH	42483	CPb0108 / Tunken	M	128	> 77	NA
March 04	BSB	12:13	SPLASH	42485	CPb0208 / Kure	F	147	> 77	NA
March 07	BSB	13:50	SPLASH	53625	CPB0308 / Nahuel	M	132	> 74	NA
March 07	BSB	14:10	SPOT 5	35967	CPB0408 / Kona	F	147	> 74	NA

Table 1. Summary of tagged Franciscana dolphins in Bahia Samborombon (BS) and Bahia San Blas BSB).

Analyses revealed fairly localized movements by the dolphins, which were mainly recorded in the same area where they were caught. The 95% and 50% kernel home ranges calculated for each tagged dolphin at both study areas in 2006 asnd 2007 are shown in Figures 3 and 4. The average home range sizes recorded were 150km^2 and 345km^2 at Bahia Samborombon and Bahia San Blas, respectively. Overall, 53% and 100% of total filtered locations at Bahia Samborombon and Bahia San Blas, respectively, were within the protected area boundaries. Preliminary analyses of dolphins tagged in 2008 in Bahia San Blas show movements limited to the extent of Bahia Anegada, although some of the movements have extended farther to the north of Bahia San Blas than was seen during 2007. In each case to date, dolphins have moved northward along the sandbanks off the mouth of the bay, and returned within a few days to Bahia San Blas.

The individual locations recorded suggest a movement pattern associated with tidal flow, with dolphins coming into the bays during rising and high tide and going out to the mouths of the bays during falling and low tide (Figure 5). In 7 of the 8 cases (for all but the case of the briefest tracking in Bahia Samborombon), the east-west movements of the dolphins were significantly different depending on tidal state, with the pattern being most clear in Bahia San Blas, where the daily tidal excursion is greatest.

The preliminary dive data analyses, incorporating thousands of dive records, show that typically, the dolphins are swimming at a depth of less than 15m. The dolphins have been recorded to dive to 30 to 35m, which would approximate the deepest points in the range they have used to date. Each dolphin has demonstrated an ability to make occasional dives lasting in excess of 4-5min. and a typical dive lasts less than 1.5 min.

Both dolphin pairs released together with satellite-linked tags with the same duty cycle in 2008 remained tightly together, but mostly separate from the other pair for the first month of tracking. Subsequently, one pair has separated, reunited briefly and then separated again. The males in each pair could not be clearly distinguished as adult vs. subadult based on body length. Whether these pairs consisted of females with potential mates or mothers with large male calves may be determined through genetic testing over the next few months.

The annual fishing effort calculated for Bahia Samborombon during 2004 through 2007 is shown in Figure 6. The area of highest fishing effort overlaps with the core areas of each of the tagged dolphins as shown in Figure 3.

DISCUSSION

The tracking data suggest site fidelity at both study areas. While none of the dolphins have been tracked for more than 8.5 months, one dolphin in Bahia San Blas was was first photographed in March 2007 and recognized in March 2008 from natural markings in the same area, suggesting the possibility of repeated or multi-year residency at this site.

Dolphins were frequently located near shallow sandbanks. These sandbanks, in particular at Bahia Samborombon, are the most important feeding areas for migratory shorebirds (Mauco, *pers. comm.*), and these shorebirds mainly feed on prey of the same species and size as do Franciscana dolphins. If prey is abundant on

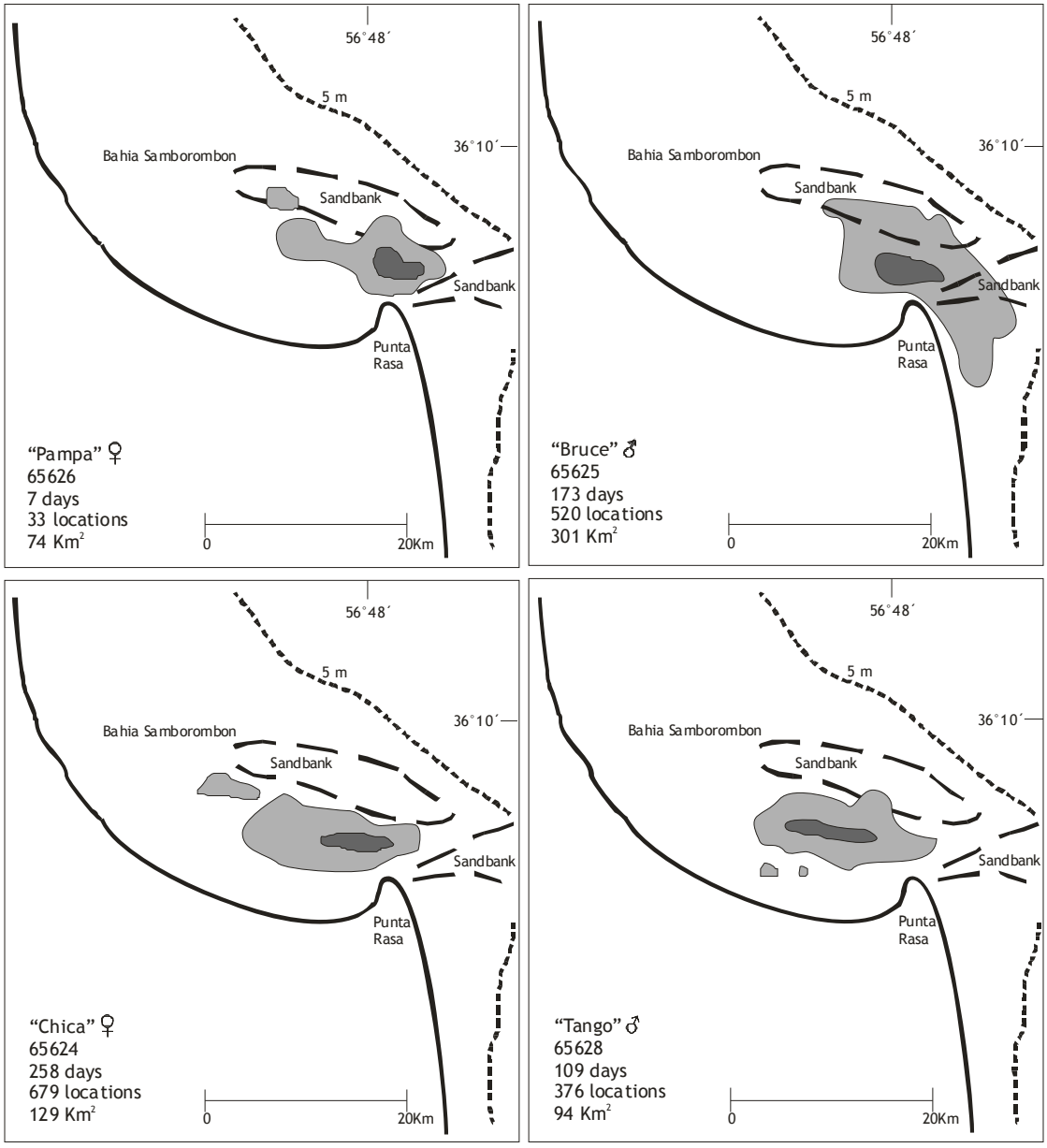

Figure 3. Home ranges (Light grey: 95% UD, Dark grey: 50% UD), recorded for Franciscana dolphins in Bahia Samborombon (2006). The 50% UD represents the core area.

the sandbanks, then it would not be necessary for the dolphins to travel long distances. In addition, estuarine waters with muddy bottoms such as those of Bahia Samborombon offer rich feeding because of the abundance of invertebrates and larval stages or juvenile forms of fish and crustaceans (Lasta, 1994).

The consistency of findings across all of the tagged animals, limiting their movements over periods of weeks to months to specific bay systems, suggests that the current designation of a single management stock in Argentina is incorrect. This is also supported by genetic studies indicating the existence of at least one isolated population unit at Bahia Samborombon (Mendez et al. 2007). More work is needed to try to define movement patterns outside of the bays, along open coasts.

From the analysis, the tagged Franciscana dolphins were mainly moving into the bays during ebb and high tides at both study areas. The tagged dolphins followed the similar movement pattern in relation to tidal state previously observed in non-tagged individuals (Bordino 2002). Correlations with tidal state may be associated with prey species abundance and distribution. The effects of the tide appear to be a decisive factor affecting short-term movement in many coastal dolphins, and for Franciscana dolphins tidal state seems more important than diurnal factors.

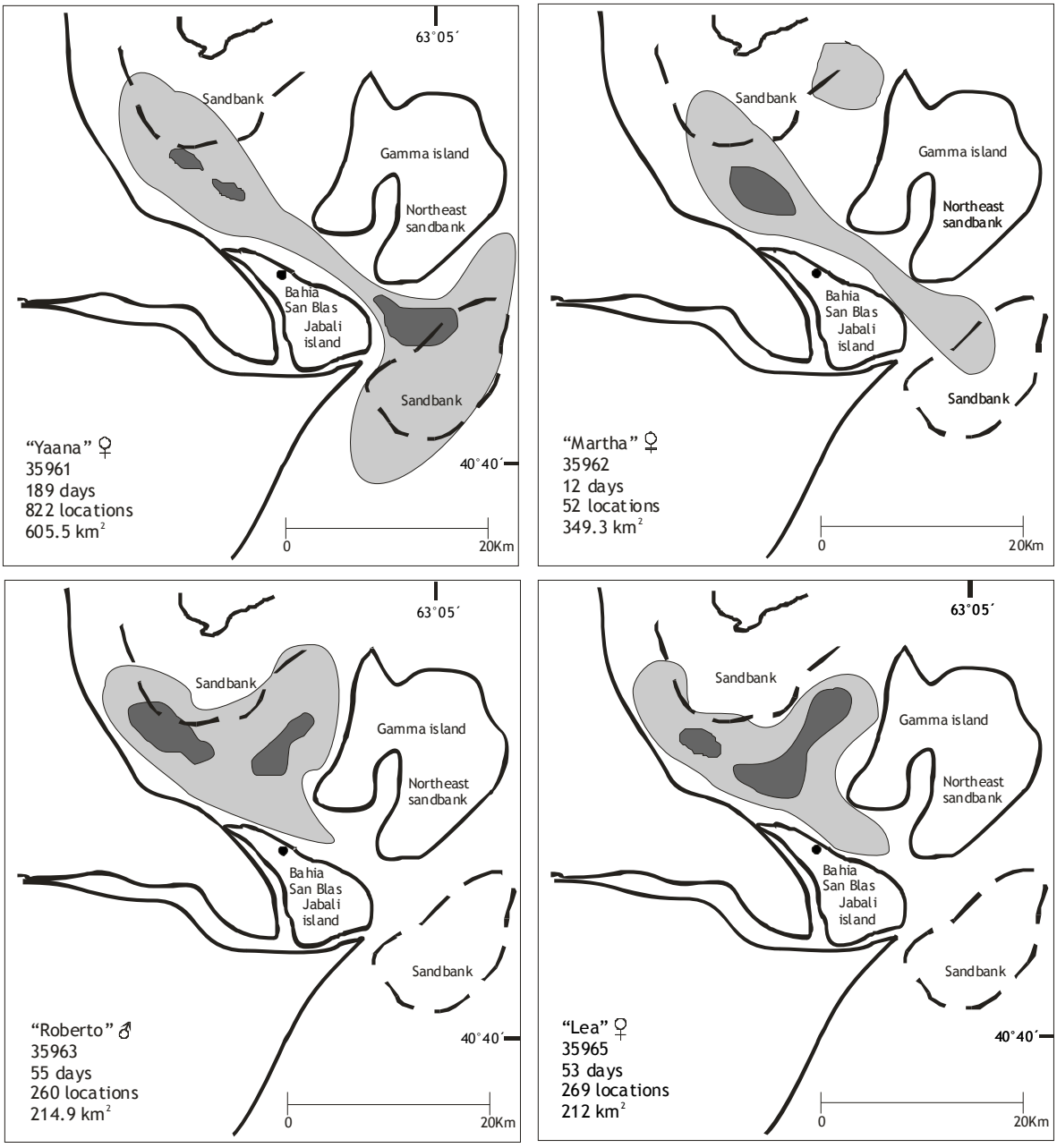

Figure 4. Home ranges (Light grey: 95% UD, Dark grey: 50% UD), recorded for Franciscana dolphins in Bahia San Blas (2007). The 50% UD represents the core area.

Even though the dive data are still very preliminary as this is ongoing research, the consistency of patterns across the three dolphins provided with TDRs appears striking. Information on average dive durations should help to develop correction factors and address potential biases that have been identified in abundance estimates for the species obtained to date from boat and aerial surveys in Brazil and Argentina.

Currently-deployed tags are providing some of the first information on the stability of social relationships and group dynamics for Franciscana dolphins. Over the next few months, as genetic analyses are completed and length distributions relative to age/maturity are developed, it should be possible to place these data into perspective and provide preliminary descriptions of aspects of the social system for this species.

The primary threat to the species throughout most of its range is incidental mortality in fishing nets. For Bahia Samborombon, the dolphin home ranges overlap with areas of high and medium fishing effort. The suggestion of small ranges in areas of heavy artisanal fishing pressure increases the urgency within which protective measures need to be implemented for this species, and may allow different approaches from those applied to widely-ranging populations. More refined studies employing TDRs in areas of heavy fishing may be able to examine the use of the water column by the dolphins relative to where fishermen are setting their nets. This study represents the first time that tagging and satellite tracking has been accomplished with Franciscana dolphins.

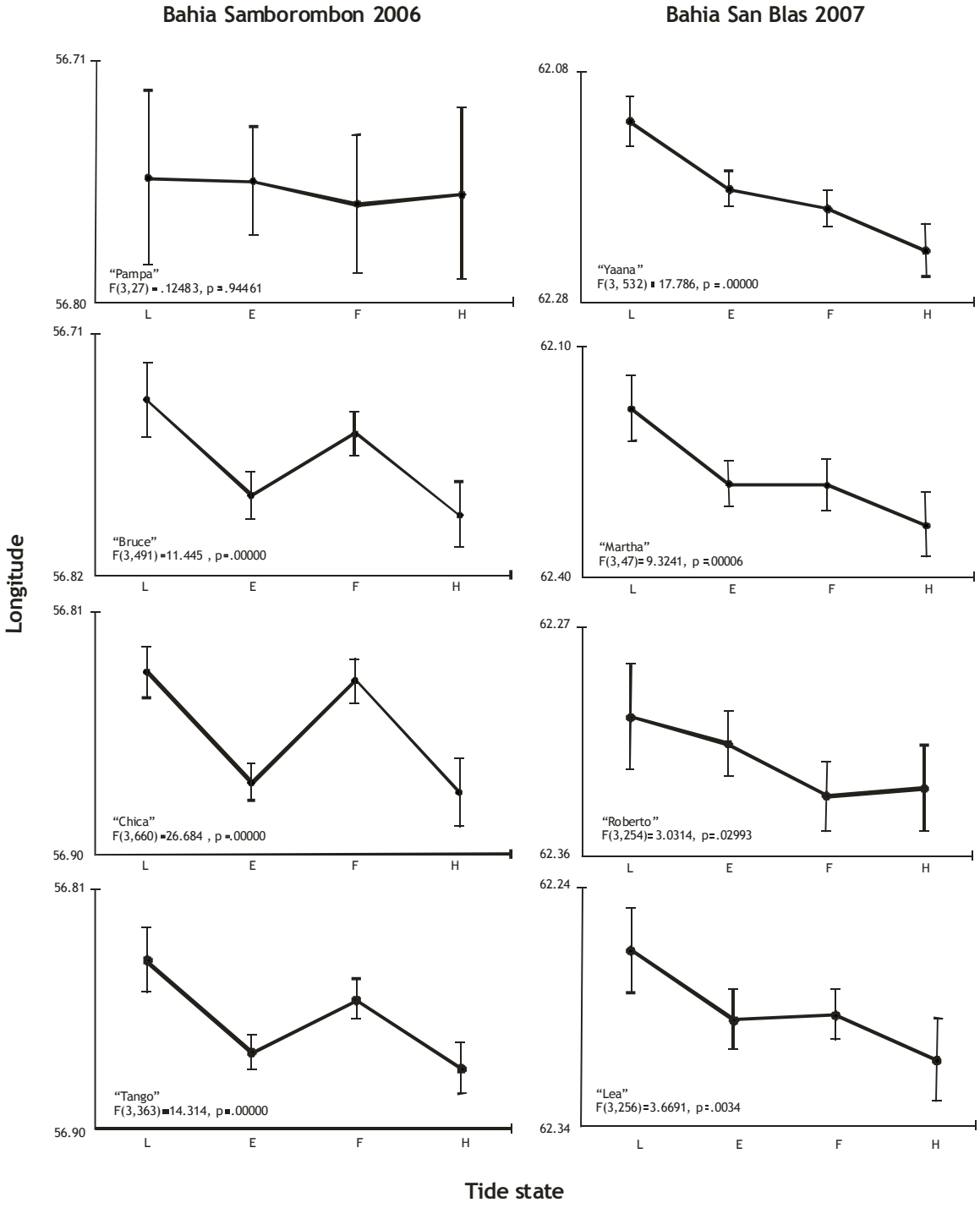

Figure 5. Locations of tagged Franciscana dolphins during 2006 and 2007 relative to tide state at both study areas. L: Low, E: Ebb, F: Flood, H: High. Vertical bars denote 0.95CI.

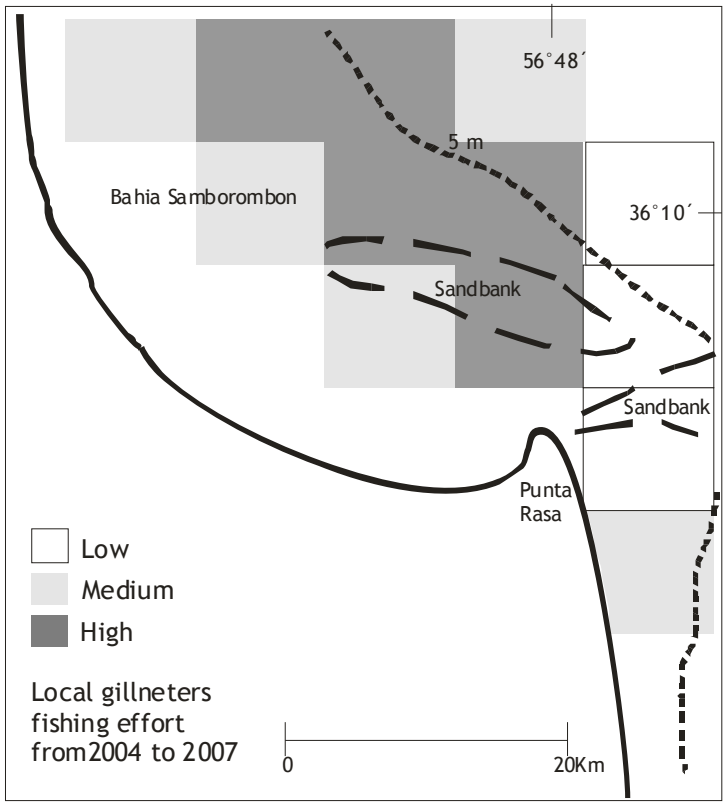

Figure 6. Average local gillneters annual fishing effort (m^2 x h) in Bahia Samborombon from 2004 to 2007. Low: < 900m^2 x h x day , Medium: > 900 and <3600 m^2 x h x day, High: > 3600 m^2 x h x day.

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