Aquatic Mammals 1999, **25.2**, 91–103

Bottlenose dolphins of San Luis Pass, Texas: Occurrence patterns, site-fidelity, and habitat use

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Abstract

Bottlenose dolphins (*Tursiops truncatus*) in the Galveston Bay Estuary, Texas, have been studied continuously since 1990. Most of this research has taken place in the 'Galveston Bay' area at the northeastern end of Galveston Island. In September 1995 we began a project to examine bottlenose dolphin occurrence patterns, habitat use, site fidelity, and movements in the San Luis Pass area, a relatively undisturbed area at the southwestern end of Galveston Bay Estuary; and to compare findings to previous work in Galveston Bay, approximately 48 km away. Eighty-three boat-based photo-identification surveys were conducted during 12 months in 1995–1996, totaling 349.4 h of effort, of which 94.3 h were spent in direct observation of 102 dolphin groups. Seventy-one individuals were identified, including 37 'residents' (Bay) and 34 'transients' (Gulf). These individuals were compared with 63 individuals identified in the study area in 1990. Fourteen of 71 (19.7%) animals identified in 1995–1996 were present in 1990, suggesting that some dolphins exhibit long-term site fidelity to the area. Dolphins identified in San Luis Pass were compared to photographs taken during 1995 surveys of Galveston Bay. Three animals were sighted in both study areas, indicating coastal movements between sites do occur. The study area was divided into four sections based upon habitat characteristics. Season and study area section were not independent with regard to group sightings. During summer, animals were most frequently sighted in a shallow bay furthest inland, whereas during winter, they were most frequently sighted in the Gulf of Mexico. This study suggested that the San Luis Pass area, devoid of deep man-made channels and structures, is inadequate to support dolphins during winter. This is in contrast to Galveston Bay, where groups have been sighted regularly in bays and channels year-round. We suggest that food resources in Galveston Bay are present year-round due to deeper water provided by the Houston and Galveston Ship Channels, and that this habitat may therefore be more attractive to dolphins than before human restructuring of the underwater environment.

Introduction

Recent and on-going studies have undertaken the task of describing the behavioral ecology of bottlenose dolphins (*Tursiops truncatus*) inhabiting Texas coastal waters (i.e. Shane, 1980; Henningsen & Würsig, 1991*a,b*; Bräger *et al*., 1994; Fertl 1994*b*; Maze & Würsig, 1997, 1998; Weller, 1998). However, a comprehensive understanding of this species' abundance, site-fidelity characteristics, ranging patterns, distribution, and social structure across Texas study sites has not yet emerged. This study investigated some of these, as well as other parameters, for bottlenose dolphins using the San Luis Pass area of Galveston Bay Estuary; and compared findings with those for Galveston Bay, other Texas bays, and other well-studied populations outside of Texas.

Bottlenose dolphins within the Galveston Bay Estuary have been studied by researchers at Texas A&M University since 1990. Most of this research has taken place in the 'Galveston Bay' area at the northeastern (NE) end of Galveston Island. Jetties and dredged channels associated with the Ports of Houston and Galveston, local petrochemical industries, commercial and recreational fishing, and the surrounding Houston–Galveston area have heavily impacted Galveston Bay. Research has shown a large number of bottlenose dolphins using this area of high human impact (Henningsen & Würsig, 1991*a,b*; Bräger *et al*., 1994; Fertl 1994*b*). To date, over 1000 bottlenose dolphins have been identified in Galveston Bay, adjacent bays, and adjacent waters of the Gulf of Mexico. Group composition was fluid, and a trend of greater site fidelity inland

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than in nearshore Gulf waters was apparent (Henningsen & Würsig, 1991*a,b*; Bräger *et al*., 1994; Fertl, 1994*a*). In addition, a high level of feeding was shown to be in association with the shrimp fishery in Galveston Bay (Fertl, 1994*a*). It has been suggested by Henningsen & Würsig (1991*a*) that animals tolerate disturbance and noise pollution from various vessels and industrial activities for the advantage of an easy food supply provided by the shrimp fishery, jetties, and channels.

No research has been conducted solely on bottlenose dolphins inhabiting waters at the southwestern (SW) end of Galveston Island, a relatively undisturbed area referred to as the San Luis Pass area. However, during April–October 1990, Henningsen (1991) made 20 trips to the SW end of Galveston Island or completely around the island, which included 16 group sightings of bottlenose dolphins in the SW portion of West Bay (San Luis Pass area, Fig. 1), including adjacent Gulf waters. No sightings were made in the central or NE portions of West Bay. Based on Henningsen's observations, Henningsen & Würsig (pers. comm.) hypothesized that animals at the SW end of Galveston Island generally do not travel to the NE end or regularly associate with animals from the NE end. This study was designed to test hypotheses developed from Henningsen's study.

In September 1995, a research project was begun with the following objectives: (1) investigate seasonality of occurrence in San Luis Pass; (2) begin a description of bottlenose dolphin habitat use in San Luis Pass; (3) compare habitat use in San Luis Pass and Galveston Bay (approximately 48 km apart); (4) examine possible long-term site fidelity to San Luis Pass; and (5) examine movement between San Luis Pass and Galveston Bay.

Methods

Study area

The Galveston Bay Estuary, the second largest estuary in Texas, consists of approximately 1600 km^2 of mostly brackish water averaging 2.1 m in depth (Fig. 1) (Armstrong, 1987; Wermund *et al*., 1988). It contains two study sites that are discussed here: San Luis Pass ($\sim$65 km^2) and Galveston Bay ($\sim$100 km^2) (Fig. 1).

San Luis Pass was divided on the basis of habitat characteristics into four sections: Chocolate Bay (CB), West Bay (WB), Channel area (CH), and Gulf of Mexico (GOM) (see Fig. 1). CB varies in depth and bottom sediment, having numerous shallow areas, oyster reefs, and ship channels running through it. It is bordered on the SW by the Intracoastal Waterway, and an additional shipping channel runs northwest (NW) through the center of the bay. WB is uniformly about 1.8–2.1 m deep, having shallow areas only along its periphery. The bottom sediment consists of mud and silt. CH extends from WB to the Gulf of Mexico, and is an area of swift currents in places and continual hydrographic and topographic change. Shallow channels and sandbars predominate, with the area being submerged only at high tide. The GOM section extends from the Gulf shore of Galveston Island outwards 1.5 km into the Gulf and 4.7 km alongshore in a NE to SW direction. Near San Luis Pass, swift currents, continual hydrographic and topographic changes, channels, and sandbars characterize the area. Shrimp trawling and crab trapping occur in CB and WB. The CH area will not accommodate any shrimping activity, crab trapping, or large vessel traffic. Recreational fishing occurs in all four areas, and is the only one of the activities that occurs in the GOM section.

Data collection

After a pilot study from June to August 1995, primary data were collected for 12 months, from 1 September 1995 to 31 August 1996. A 5.1-m Boston whaler equipped with a 70-hp outboard motor was used to survey the study area. For all surveys, an attempt was made to systematically cover the study area. Surveys were only conducted in Beaufort sea states of 3 or less. A Garmin GPS 45 Personal Navigator was used to navigate, to maintain a speed of approximately 10 knots while surveying, and to record locations of dolphin groups. The survey vessel was stopped when a group of dolphins was sighted, and an attempt was made to photograph all individuals in the group. Photographs were taken with either a Nikon 2000 or a Nikon 6006 35-mm camera equipped with a 100–300 mm or a 70–210 mm zoom lens, a motordrive, and a databack for imprinting date and time on each frame. Film type used was Kodak T-max 400 black and white negative film.

Dolphin groups were defined as dolphins with relatively close-knit spatial cohesion, with each member within 10 m of any other member (10 m 'chain' rule) (Smolker *et al*., 1992). Group size estimates included the total number of adults, calves, and neonates. Calves were defined according to Shane (1987, 1990) and Fertl (1994*b*) as individuals two-thirds or less the length of an adult (judged by eye), swimming beside or slightly behind an adult. Neonates were distinguished by visible fetal folds, charcoal color, and uncoordinated surfacings.

Seasons were defined as: fall (September–November), winter (December–February), spring (March–May), and summer (June–August) (e.g. Gruber, 1981; Shane, 1990; Fertl, 1994*b*; Weller, 1998).

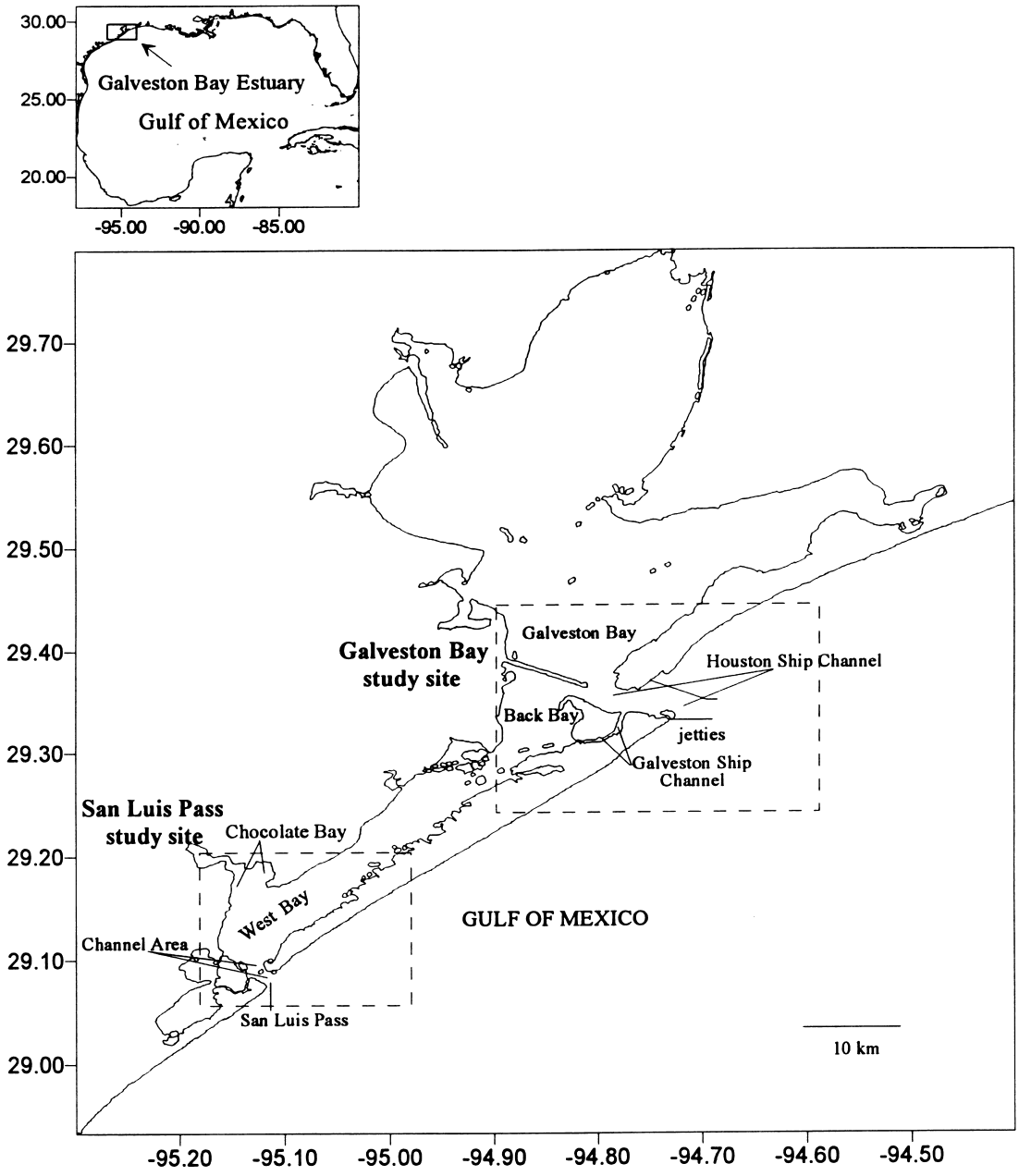

Figure 1. Galveston Bay Estuary, including the San Luis Pass and Galveston Bay study sites.

Photo-identification techniques

The use of natural marks, usually on the trailing edge of dolphin dorsal fins, is well-established (Würsig & Würsig, 1977; Würsig & Jefferson, 1990). Photo-identification techniques were similar to those of Defran *et al.* (1990), except the addition of a 'leading edge notch' category for cataloging purposes, and inclusion of sightings of well-known animals ($n=10$) for which there was no photographic record for a particular group, but for which a visual identification was made in the field and recorded on the data sheet.

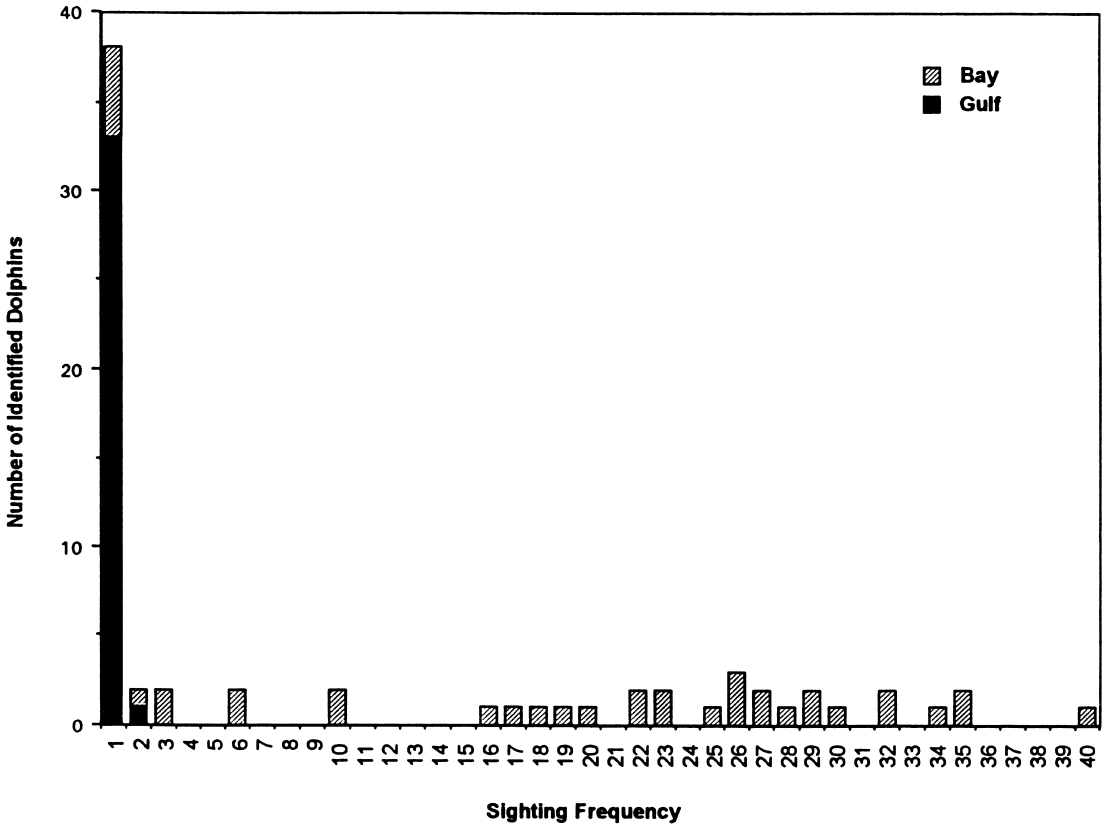

Figure 2. Sighting frequencies for dolphins identified in the San Luis Pass area ($n=71$). Individuals are partitioned into Bay and Gulf animals.

Datasets

Three datasets were incorporated. The primary dataset, referred to throughout this paper unless otherwise stated, is the San Luis Pass data collected September 1995–August 1996. The second dataset was from Galveston Bay; 42 surveys were conducted January–December 1995. These data are part of on-going research begun in 1990 by Texas A&M University. Data from 1990 to 1994 were not used because they are currently being analyzed and combined with data collected by Henningsen (1991), Bräger (1992), and Fertl (1994*a,b*). Data collection procedures for Galveston Bay were similar to those previously described for San Luis Pass. The resulting catalogs from San Luis Pass and Galveston Bay were compared to test for movements between sites. The third dataset is Henningsen's data from 1990 (Henningsen, 1991), which includes 20 surveys to the SW end of Galveston Island that overlapped with the San Luis Pass study area. Henningsen's photographs were also compared to the 1995–1996 San Luis Pass catalog to test for possible long-term site fidelity.

Results

Survey effort and encounter rates

Eighty-three surveys were conducted during the 12-month study. Of these, 21 (25.3%) covered the entire study area and 62 (74.7%) covered less. There was rarely an incomplete survey in CB or CH; however, there were many incomplete surveys in GOM and WB due to poor survey conditions. Survey effort totaled 349.4 h, with 20.4% in fall, 16.8% in winter, 24.2% in spring, and 38.6% in summer. The effort included 94.3 h spent in direct observation and photography of 102 dolphin groups.

Survey effort was partitioned by Beaufort 0–2 and Beaufort 3 sea states to look for differences in dolphin encounter rates as a function of sea state conditions. No difference was found when monthly or seasonal encounter rates (groups encountered/hour survey) were compared between Beaufort 0–2 and Beaufort 3 conditions ($P=0.53$ (monthly), $P=0.14$ (seasonal), Wilcoxon signed rank test), indicating that all survey effort could be pooled.

Spring and summer were the seasons of greatest survey effort, and overall, more effort took place under Beaufort 3 conditions than calmer Beaufort 0–2 conditions.

Dolphins were encountered during 54 (65.1%) of 83 surveys. Twenty-nine surveys (34.9%) encountered zero groups, 22 (26.5%) one group, 19 (22.9%) two groups, 10 (12.0%) three groups, and 3 (3.6%) four groups.

Identified individuals and resightings

Seventy-one bottlenose dolphins were identified from natural dorsal fin markings. Of these, 26 had been identified previously during the pilot study; however, pilot study data are excluded from results unless stated otherwise. Number of sightings for the 71 identified dolphins ranged from 1 to 40 (Fig. 2). Thirty-three dolphins (46.5%) were sighted more than once. For many analyses, dolphins were partitioned into two groups: (1) dolphins sighted only in the GOM section of the study area (referred to as Gulf animals), and (2) dolphins sighted in bay sections (CB, WB, or CH) or both in bay and Gulf of Mexico sections (referred to as Bay animals). This partitioning was done to look for patterns of residence to the San Luis Pass area and transience through the area. Of the 71 identified individuals, 34 were Gulf and 37 Bay animals. Only one Gulf animal was resighted, but 32 (86.5%) of the 37 Bay animals were resighted (Fig. 2).

Rates of discovery and occurrence patterns

Rate of discovery curves were created for both Bay and Gulf animals (Fig. 3). The gentle slope of the curve for Bay animals indicated a slow rate of discovering new individuals, and suggested a small, relatively closed population using this area. The curve for Gulf animals indicated that occasional pulses of new individuals were identified throughout the study.

The trend shown by occurrence patterns of Bay animals matched that of the rate of discovery curve, demonstrating either no increase or a slight increase in individuals identified with time. The data also suggested year-round presence in the study area for many individuals (Fig. 4). The occurrence pattern for all identified Gulf individuals was strikingly different. The Gulf trend matched that of the rate of discovery curve, showing four pulses of newly-identified individuals. Seven group sightings on five different days in December, March, April, and June produced sightings of new individuals that were never resighted.

Group sightings

A G-squared test was performed to discern whether season and study area section were independent with regard to group sightings ($G^2=23.001$, $P=0.0062$). Post hoc cell contributions indicated that during summer, animals were most frequently sighted in Chocolate Bay, a shallow bay furthest inland, whereas during winter, they were most frequently sighted in the Gulf of Mexico (Fig. 5).

Long-term site fidelity

The San Luis Pass catalog was compared to photographs taken by Henningsen in 1990 (Henningsen, 1991). Twenty surveys passed through part or all of the present study area, encountering 16 groups and producing usable photographs of 13. These 13 group sightings occurred on 13 different days between 1 May 1990 and 2 October 1990. Sixty-three different individuals were identified, with resightings of many animals. Of the 63 individuals, 14 (22.2%) were found in the San Luis Pass catalog: 12 Bay and 2 Gulf animals. Henningsen's records were also checked to see if any of these 14 animals were found outside the San Luis Pass area in 1990. Only one animal, SLP071 (a Gulf animal), which was sighted in GOM in July 1990 and June 1996, was sighted approximately 35 km NE of San Luis Pass in May 1990. The remaining 13 animals were only sighted in the San Luis Pass study area.

Movements between San Luis Pass and Galveston Bay

To test for movements between San Luis Pass and Galveston Bay, photographic catalogs from 1995–1996 San Luis Pass surveys and 1995 Galveston Bay surveys were compared. Three San Luis Pass animals (one Bay and two Gulf) were identified from five group sightings on four different days in Galveston Bay between June and August 1995. Three of the five sightings occurred in the Gulf of Mexico, one in the Galveston Ship Channel, and one in the Houston Ship Channel. SLP074, a Gulf animal, was sighted once in GOM during June 1996. The previous summer it had been sighted during a Galveston Bay survey approximately 32 km to the NE in the Gulf of Mexico. SLP053, another Gulf animal, was also sighted once in GOM during March 1996. This animal had previously been sighted in the Gulf, 35 km and 45 km to the NE during June 1995. SLP038, a Bay animal, was sighted twice in the Galveston Bay study area during summer of 1995, once in the Houston Ship Channel at the tip of the jetties (approximately 44 km away), and once in the Galveston Ship Channel. This animal did not appear in the San Luis Pass catalog until December 1995, after which it was sighted in the area 19 times during the remaining nine months of the study.

Sightings of SLP074 and SLP053 in Galveston Bay were made in areas not typically surveyed during 1995. All three Galveston sightings of these two animals occurred in the Gulf of Mexico at a

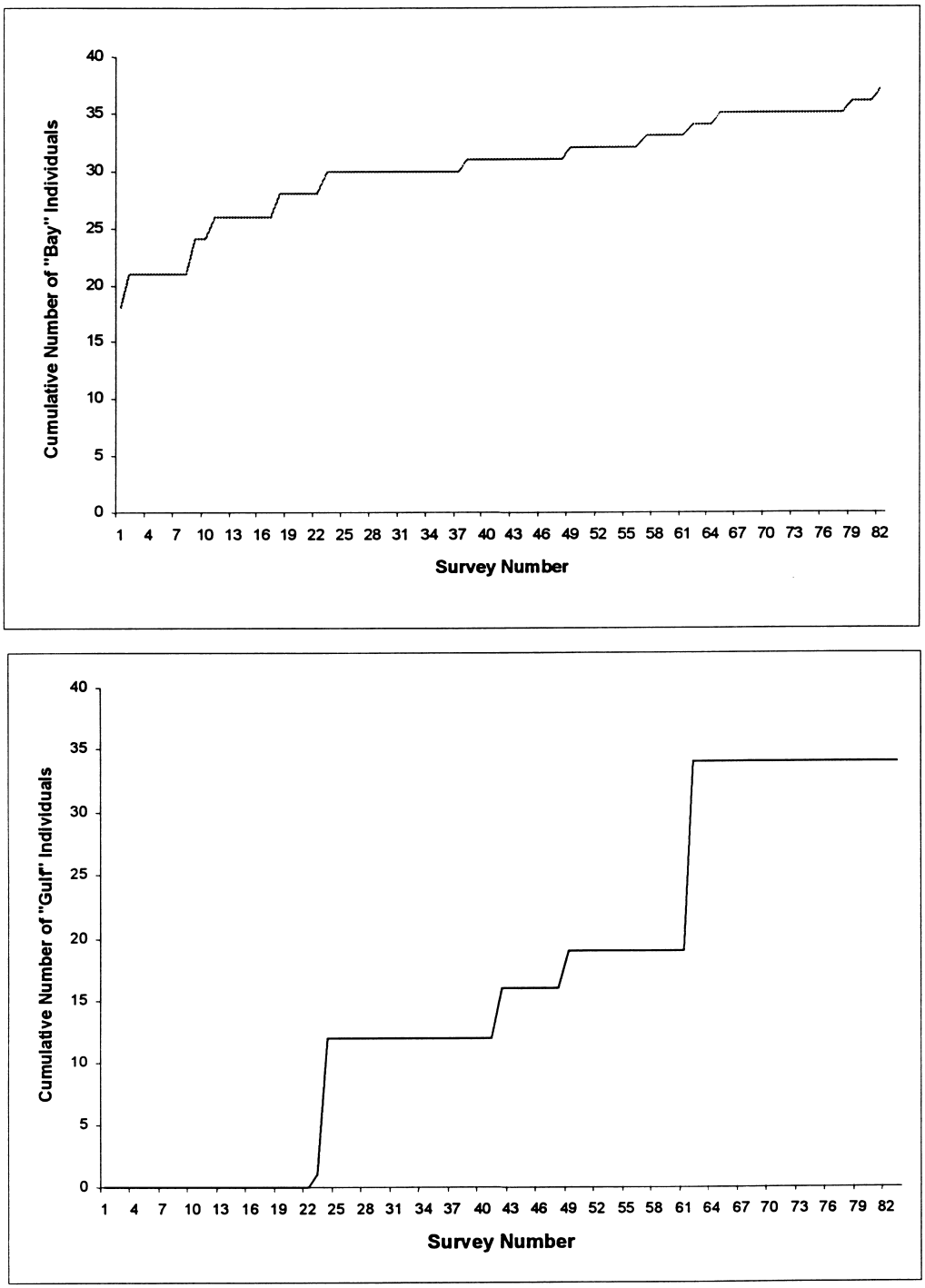

Figure 3. Cumulative rate of discovery of new individuals by survey number for Bay and Gulf animals.

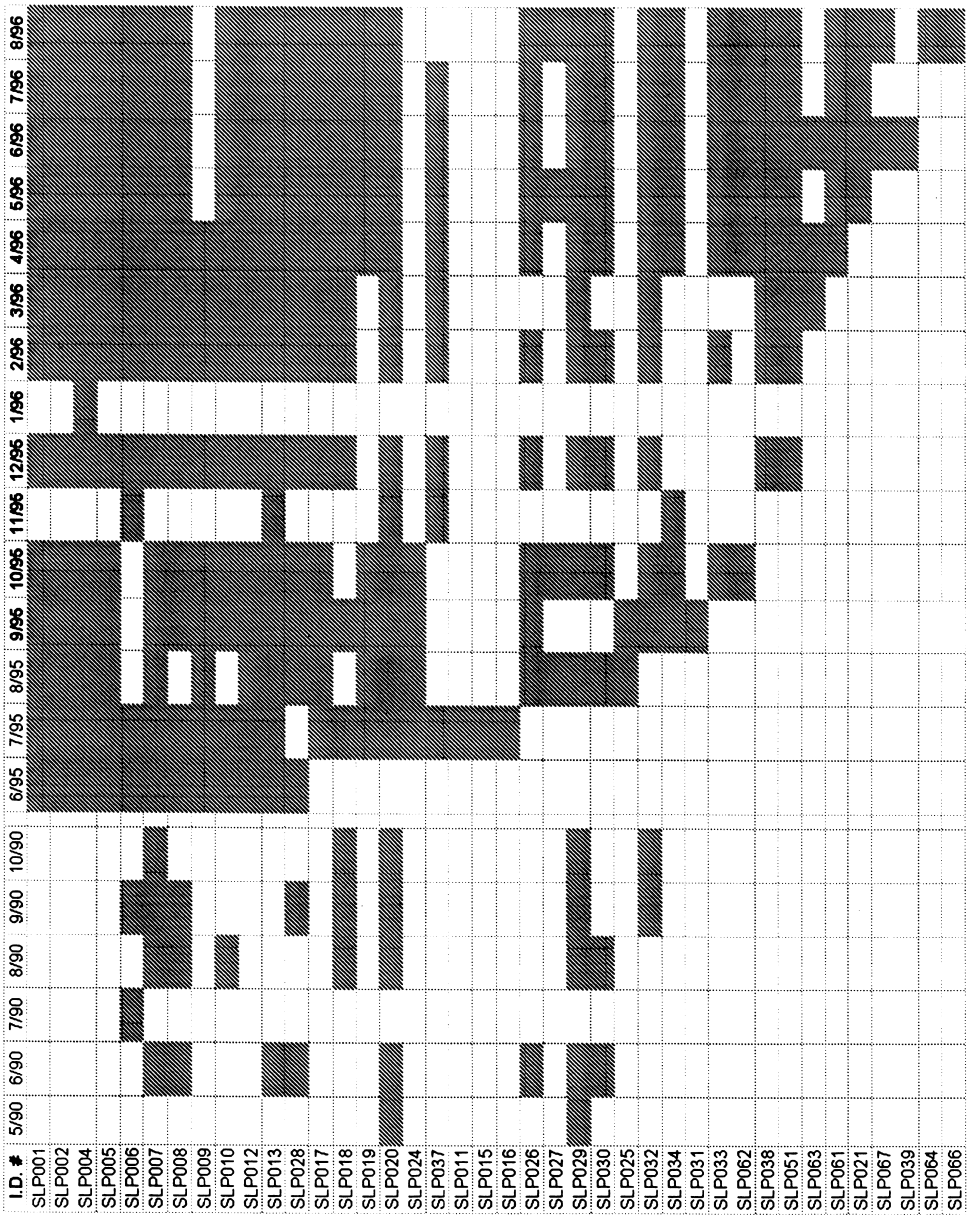

Figure 4. Occurrence patterns for Bay animals. Shaded boxes represent identification of an individual in the study area during the designated month. Data from Henningsen's 1990 surveys and 1995 pilot-study surveys are included.

distance ≥ 2 km from the Houston Ship Channel jetties. Only 21 (50.0%) of 42 Galveston 1995 surveys covered the Gulf of Mexico; of these, only 11 (26.2%) of the total surveys ventured ≥ 2 km from the Houston Ship Channel jetties. Of these 11 surveys, 4 (36.4%) encountered individuals that were identified in San Luis Pass in 1995–1996.

Discussion

Study site and Bay/Gulf comparisons

The most interesting findings relate to differences and similarities between the San Luis Pass and Galveston Bay study sites and to striking differences between Bay and Gulf dolphins. The San Luis

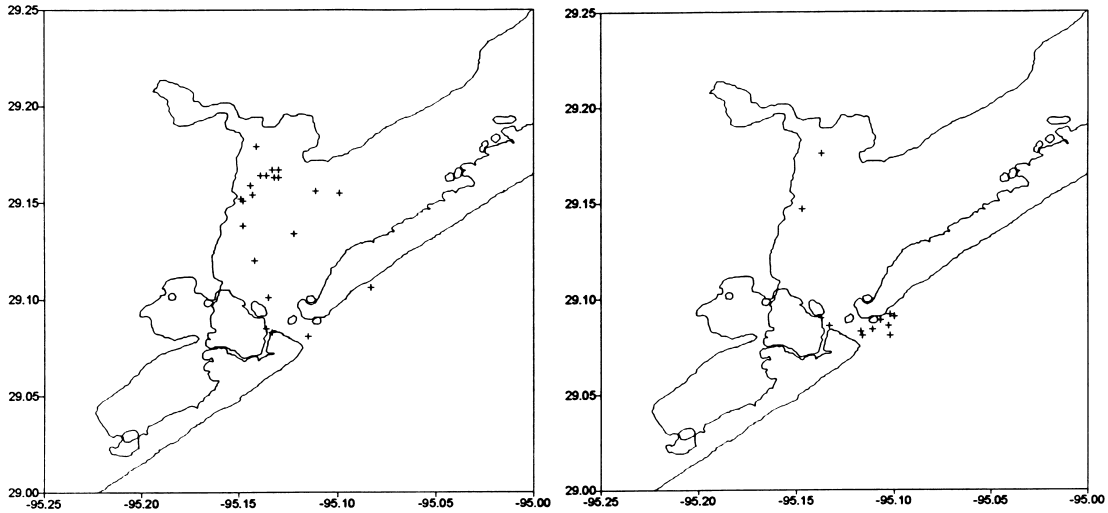

Figure 5a. Fall 1995

Figure 5b. Winter 1995-96

Figure 5c. Spring 1996

Figure 5d. Summer 1996

Figure 5. Seasonal group sightings during 1995–1996 in San Luis Pass. Each '+' represents one group.

Pass population consisted of a core group of year-round residents, as well as transient animals. This trend may parallel findings reported for Galveston Bay. Differences in study area sizes and durations of previous studies hinder comparisons between the two sites, but a representative description of Galveston Bay may come from Bräger's (1992; Bräger *et al.*, 1994) eight-month study of an area ($\sim$100 km^2) encompassing both bay and Gulf waters. The resident/transient situation reported was similar to that of San Luis Pass and suggests that similarities exist between the two sites.

In contrast to Galveston Bay findings, transient animals in the San Luis Pass area were sighted almost exclusively in the Gulf of Mexico. In the Galveston Bay study area it has been common for animals only seen one time to be sighted in either bay or Gulf waters. Perhaps the bay/Gulf comparison is not appropriate or does not apply to Galveston Bay due to drastic modification by the Houston Ship Channel and jetties. There are no longer clear bay/Gulf distinctions as there are for San Luis Pass. Many transient animals have been sighted in the Houston Ship Channel. Henningsen

& Würsig (1991*a,b*) hypothesized that dolphins are attracted by a good food supply provided by shrimp trawling nets that disturb fishes and crustaceans, and by jetties and dredged channels where fishes often concentrate.

A very low number of animals ($n=71$) were identified in San Luis Pass compared to previous studies in Galveston Bay. For example, during 1995 Galveston Bay surveys, approximately 650 animals were identified. The San Luis Pass study area is slightly smaller than Galveston Bay (~ 65 km^2 compared to ~ 100 km^2), but size alone is not enough to account for this drastic difference. Perhaps this difference also relates to the large number of transient animals using the Houston Ship Channel area.

Rates of discovery and occurrence patterns

For Bay animals, the two months of apparent low occurrence, November and January, were the two months of lowest survey effort. Since most Bay animals were sighted during December, and some sightings did occur during November and January, it is likely that the lows represented biased data collection, and that these animals used the study area year-round. It was difficult to interpret the results for occurrence of Gulf animals. Because the GOM section was completely surveyed only about one-third of the time, transient groups undoubtedly were missed on many occasions. Whether increased survey effort in the Gulf would have produced sightings during additional months or resightings is not known.

During the study, some new animals may have immigrated into the area and begun to use it regularly. SLP038 was sighted twice in Galveston Bay during the three months prior to the start of the San Luis Pass study. This individual was first sighted in San Luis Pass in December 1995, and sighted 19 times during the remainder of the study in all months except January. This may represent either permanent or temporary immigration from one study site to the other. As has been noted by other studies (e.g. Wells *et al.*, 1996*a,b*), additional factors may have contributed new sightings as the study period progressed, such as calves acquiring new markings that would make them recognizable whereas they had previously been unrecognizable, and animals being photographed that had previously been missed.

Many studies, including several Texas studies, have reported peaks in abundance during certain seasons or months. Fertl (1994*b*) reported spring and late summer to fall peaks for the Galveston Ship Channel. Henningsen & Würsig (1991*a*) found a tendency for increasing numbers of dolphins in Galveston Bay from May to October. Bräger (1992) surveyed between May and December 1991, and reported that a preference to use the study area during summer may exist. Peaks in dolphin abundance during winter were reported for Aransas Pass and the Pass Cavallo area of Matagorda Bay (Shane, 1980; Gruber, 1981), which may parallel findings of increased sightings around San Luis Pass (the actual pass itself, not the entire study area) and in adjacent Gulf waters during winter. However, no evidence of peaks in occurrence during any particular season or month was found for the San Luis Pass study area.

Habitat use

The seasonal shift in habitat use was probably indirectly related to environmental parameters and directly related to prey movements. Sea surface temperatures and surface salinities ranged lower for CB and WB during winter than measurements taken during any group sightings. Colder temperatures during winter cause many fish species to move from bays to Gulf waters (Monaco *et al.*, 1989; Pattillo *et al.*, 1997). In addition, many species make inshore-offshore movements during fall and winter in order to spawn in offshore Gulf waters, returning to bays in spring and summer. Of the fish and invertebrate species that are common to highly abundant in the Galveston Bay Estuary, nearly every species moves to Gulf waters during fall and winter; and 10 of the 14 fish species and two of the three invertebrate species have been identified as bottlenose dolphin prey in the literature (Gunter, 1942; Monaco *et al.*, 1989; Mead & Potter, 1990; Barros & Odell, 1990; Cockcroft & Ross, 1990; Barros & Odell, 1995; Pattillo *et al.*, 1997; Barros & Wells, 1998). Seasonal distributional shifts from bay to Gulf waters of most common and abundant fish species may result in associated changes in dolphin distribution.

Similar seasonal shifts in dolphin distribution have been reported for Sarasota Bay, describing abundance to be highest in passes, channels, and shallow Gulf waters during winter, and highest in shallow bays during summer (Irvine *et al.*, 1981; Wells *et al.*, 1987; Scott *et al.*, 1990; Barros & Wells, 1998). Waples *et al.* (1995) found a significant difference in seasonal habitat use when 12 Sarasota residents were followed during 1992–1994. This difference was attributed largely to a seasonal change in habitats where the dolphins fed. During winter, feeding occurred more frequently in coastal Gulf waters and deep-water passes; whereas during summer, dolphins fed primarily in shallow seagrass habitat.

The overall and potential home ranges of Bay dolphins were not studied, but their ranges included at least the study area and waters farther offshore in the Gulf. No dolphins were seen in CB for nearly four months during fall and winter. It is unknown whether Bay dolphins abandoned this area for these

months or just used it at low frequency and were therefore undetected. It is also unknown whether their ranges in the Gulf expanded during the fall and winter, when they were using this area more intensely.

This study indicates that the San Luis Pass area, devoid of deep man-made channels and structures, appears to be inadequate to support dolphins during winter. This is in contrast to Galveston Bay, where groups have been sighted regularly in bays and channels year-round (Bräger, 1993; Fertl, 1994*b*; unpub. data). We suggest that food resources in Galveston Bay are present year-round due to deeper water in the Houston and Galveston Ship Channels. The Galveston Bay Estuary is very shallow (on average 2.1 m), causing many estuarine-dependent fish species to move to warmer, slightly deeper waters during winter (Pattillo *et al*., 1997). Areas with 13.7 m deep (30.5 m wide) man-made channels probably remain warm enough for fish to overwinter. The dolphins' use of channels may be broadly comparable to other human-impacted areas where particularly adaptive species, such as gulls (Jones & DeGange, 1988) or polar bears (Stirling, 1988), take advantage of newly-formed habitat.

Long-term site fidelity

Although there is no evidence that the 14 animals sighted in the San Luis Pass study area in 1990 and resighted during 1995–1996 were present during the intermediate years, it is likely that they were present at least part of that time. It is possible that more than 14 of the 63 animals identified in 1990 were present in 1995–1996 but were not recognized due to changes in dorsal fin markings. However, the 14 animals that were resighted had identical markings during both studies. Other researchers have also reported stability in markings over time (e.g. Wells, 1986; Würsig & Harris, 1990).

Long-term site fidelity has been demonstrated by other coastal populations as well. The same dolphins have frequented a coastal region on the east side of Peron Peninsula, Western Australia, for over 20 years (Connor & Smolker, 1985). The Sarasota, Florida dolphin community has been studied since 1970; long-term site fidelity has been demonstrated consistently for the area through capture and tagging studies and photo-identification surveys (Irvine *et al*., 1981; Wells *et al*., 1987; Scott *et al*., 1990). Würsig & Harris (1990) also reported site fidelity for dolphins frequenting the SE portion of Golfo San Jose, Chubut, Argentina, from resightings during 1984 and 1986 of animals originally identified during 1974–1976. Fertl (1994*b*) reported that 56 animals were resighted in the Galveston Ship Channel during each of three years from 1990–1992. Of the 56, at least 13 were photographed as early as 1986–1987. A small core of semi-residential dolphins was identified in the Aransas Pass region of Texas during 1991–1994 by Weller (1998). In addition, he sighted four dolphins that were first identified by Shane during 1976–1977, representing 18 years of potential use of the area by some animals.

Movements between San Luis Pass and Galveston Bay

Low survey effort in GOM and the Gulf outside the Houston Ship Channel jetties may be the reason for a small number of matches between study sites. Since movement between sites was detected despite low effort, coastal movements may be very common. Movement between San Luis Pass and Galveston Bay was also detected during Henningsen's (1991) study, with at least seven additional individuals identified at both sites during his seven-month study in 1990.

The case of SLP038, a Bay animal that was sighted twice during the summer of 1995 in the Galveston Bay area, and then 19 times in the San Luis Pass area between December 1995 and August 1996, is interesting. This animal may regularly or occasionally move back and forth between the two areas, or a temporary or permanent shift in its home range may have occurred. This animal did not merely move along the coastline while remaining in the Gulf of Mexico, because it was sighted in the inner bays of San Luis Pass and in the Galveston and Houston Ship Channels in Galveston Bay. Given the frequency with which it was sighted in San Luis Pass from December to August, either a temporary or permanent shift in its home range probably occurred.

Coastal movements of approximately 45 km are not surprising for this species, as much longer movements have been found for the Texas coast and other areas. Gruber (1981) sighted a Matagorda dolphin that had been sighted previously 95 km away in the Corpus Christi area by Shane (1977). During cruises at eight Texas inlets from 1988–1990, Jones (1991) identified 11 dolphins that had been documented at two or more inlets; two of the 11 were documented at three inlets. The greatest distances traveled were at least 622 and 517 km by two individuals, but the bulk of movements were between inlets less than 300 km apart. Lynn (1995) and Würsig & Lynn (1996) reported several long distance movements, including movement between Port O'Connor and the Corpus Christi jetties (100 km), between Matagorda Bay and South Padre (285 km) by two individuals, and between Matagorda Bay and Galveston Bay (200 km). In other areas, such as along the U.S. Atlantic coast (Kenney, 1990; Mead & Potter, 1990) and within the Southern California Bight (Defran

et al., 1999), animals are known to make regular long-distance movements. During the 1982–1983 El Niño warm-water incursion, bottlenose dolphins previously identified in Southern California were sighted in the Monterey Bay area, over 600 km to the N of their usual range (Wells *et al*., 1990).

Similar to findings from the central west coast of Florida (Wells *et al*., 1996*a,b*), research in Texas bays and coastal waters indicates that some animals are residents, whereas others are non-residents traveling the coastline. Whether the non-residents are migratory (seasonally or non-seasonally), nomadic, or a combination of both remains unknown. Systematic photo-identification surveys have been conducted in Galveston Bay, Corpus Christi Bay, and Laguna Madre since 1990, and in Matagorda Bay since 1992. Data synthesis from all sites is in progress (D. Weller, pers. comm.), and once completed, a better understanding of range characteristics and site fidelity of Texas bay and coastal bottlenose dolphins should emerge.

Concluding remarks

With recent die-offs and an increase in mortality for this species along the Texas coast (Worthy, in press), it is important to continue monitoring coastal populations. Year-round residency within the relatively small San Luis Pass area makes this population an ideal one to monitor as a general indicator of health of local populations and the marine environment. Furthermore, as potential long-term residents, these dolphins face increased risk from geographically-localized impacts.

In addition, the San Luis Pass study has raised questions of dolphin occurrence patterns being influenced by human development. In the Galveston Bay Estuary, the apparent attraction of both fish and dolphins to a highly industrialized area raises concerns and questions for future research.

Acknowledgements

Field and laboratory support for this project were provided by numerous members of the Marine Mammal Research Program of Texas A&M University at Galveston. We especially thank D. Weller, A. Acevedo, S. Lynn, J. Stern, A. Schiro, J. Ortega-Ortiz, E. Zuñ iga, B. Borchardt, V. Cozby, D. Dick, and K. Little for their assistance. We are indebted to K. Mullin, D. Fertl, and two anonymous reviewers for commenting on earlier drafts of this manuscript. D. Hanisko and M. McDuff generously assisted with the production of maps. Several organizations provided funding for this project: National Marine Fisheries Service, Southeast Fisheries Science Center; Marine Mammal Research Program, TAMUG; Texas Institute of Oceanography, TAMUG; and Department of Marine Biology, TAMUG. This represents contribution number 66 of the Marine Mammal Research Program, Texas A&M University at Galveston.

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