*Aquatic Mammals* 2006, *32*(2), 133-139, DOI 10.1578/AM.32.2.2006.133

# Abundance, Distribution, and Residence of Bottlenose Dolphins (*Tursiops truncatus*) in the Bahía San Jorge Area, Northern Gulf of California, México

Eric Mellink[1, 2] and Adriana Orozco-Meyer[1]

[1]*Centro de Investigación Científica y de Educación Superior de Ensenada, BC, Carretera Tijuana-Ensenada Km 107, Ensenada, BC, México*
[2]*CICESE, P.O. Box 434844, San Diego, CA 92143-4844, USA*

### Abstract

We studied bottlenose dolphins (*Tursiops truncatus*) in Bahía San Jorge, northern Gulf of California, México, between August 1999 and March 2000. From a fishing skiff, we photo-characterized dolphins and noted their location, and from a raised platform on shore, we counted dolphins entering and exiting the bay. During our study, the area of Bahía San Jorge seemed to be important for bottlenose dolphins' feeding, especially in the winter, and also apparently for parturition. Most dolphins were only temporarily present in the area. There were no effects of tidal conditions on the numbers or activity of the dolphins. We documented few interactions between artisanal fishermen and dolphins. Only during the shrimp-fishing season, when the dolphins benefited from fishing, were some losses to the fishermen caused through net rupture and catch shaken from the net.

**Key Words:** Bottlenose dolphin, *Tursiops truncatus*, Bahía San Jorge, Gulf of California, Mexico, habitat use

### Introduction

For a long time, the Gulf of California has been considered to be an area of high biological importance (Ezcurra, 2001). The northern Gulf is characterized by shallow seas and unique ecological features of the most common homeotherms. Brown Boobies (*Sula leucogaster*) have a longer breeding season than elsewhere in the Gulf (Mellink, 2000), and they apparently feed on benthic species when pelagic fishes are not present (Mellink et al., 2001); whereas California sea lions (*Zalophus californianus*) have a benthic diet, as opposed to a pelagic diet elsewhere in the Gulf (García-Rodríguez & Aurioles-Gamboa, 2004; Mellink & Romero-Saavedra, 2005). Also, this area has supported the largest known Least Tern (*Sterna antillarum*) colony in the Gulf of California (Palacios & Mellink, 1996). Finally, ENSO (El Niño Southern Oscillation) events cause different responses by the homeotherms in the northern Gulf (Mellink, 2003). In addition to its apparent uniqueness, artisanal fisheries and environmental degradation are at much lower levels here than elsewhere in the Gulf. This unique set of conditions can help to clarify the natural activity patterns of marine homeotherms.

The two most abundant marine mammals in the Bahía San Jorge area are the California sea lion, for which some basic data from the region have been generated, and the bottlenose dolphin (*Tursiops truncatus*) (Silber et al., 1994). Despite their apparent abundance, not much was known about the abundance and ecology of the bottlenose dolphin in the northern Gulf, and the closest study was from Bahía Kino in the central Gulf (Ballance, 1990, 1992), an area with different oceanographic features. The objective of our study was to determine the patterns of habitat use by bottlenose dolphins in the Bahía San Jorge area.

### Study Area

Bahía San Jorge (113º 05' N, 30º 59' W) is a wide, 126-km$^2$ bay in the northeasternmost part of the Gulf of California. It is separated from the sea by a 10-km long barrier beach on the southern end (Barra la Purinera) and a short barrier beach on the northern end. The end of Barra la Purinera and the outer beaches are sandy, while most of the inner margins of the bay are silty. The entire area is shallow, with water depths below 20 m, and the internal part of the bay is between 1.8 and 5.4 m.

The area has a dry desert climate and exhibits strong circadian and seasonal climatic variations. Summers are hot and winters cold, with corresponding water temperatures. Annual rainfall at nearby Puerto Peñasco is 61 mm. The northern Gulf has water salinities between 35.5 and 37.5‰

(Maluf, 1983; Lavín et al., 1995). Tides are semi-diurnal, with over 6 m of vertical amplitude (M. Lavin, pers. comm.), and during low tides, the waterfront can retract as much as 5 km (Álvarez-Borrego & Lara-Lara, 1991). During the winter, northwestern winds and ocean currents cause a local upwelling that promotes high levels of nutrients, bacteria, plankton, and juvenile crustaceans (Álvarez-Borrego & Lara-Lara, 1991).

Human activities in the area include a large culture of Japanese oysters (*Crassostrea gigas*) grown in boxes and limited artisanal fishing using small fiberglass skiffs powered by outboard motors (48 to 75 hp). Cortez swimming crabs (*Callinectes bellicosus*) are captured with wire traps throughout most of the year. During the spring, shovelnose sharks (*Rhinobatos productus*), some species of stingray, and dogfish (*Mustelus* spp.) are fished with gillnets, and in late August of some years, and for a few weeks only, shrimp are fished with gillnets inside the bay or immediately outside it. Such a fishery developed during our study and included 73 skiffs at its peak. Outside the bay, large trawlers fish for shrimp seasonally.

## Materials and Methods

We studied bottlenose dolphins during four sampling periods in which we made observations from a 7-m long fishing skiff powered by a 55- or a 75-hp outboard motor, and from an observation platform 5 m above the ground at Punta la Purinera (the end of Barra la Purinera) during spring and nip tides. Due to time constraints and navigation complications, effort varied among periods. The second and third period were divided into two subperiods, each including a spring and a nip tide. Sampling dates were 26 August to 20 September 1999 (10 skiff days; 3 platform days during spring tide and 3 during nip tide), 23 October to 18 November 1999 (6 skiff days; 6 platform days during spring tide and 5 during nip tide), 20 January to 16 February 2000 (9 skiff days; 6 platform days during spring tide and 5 during nip tide), and 16 to 30 March 2000 (5 skiff days; no platform days).

Surveys aboard the skiff began at Punta la Purinera and encompassed the entire bay and, when dolphins were detected outside of the bay, the immediate vicinity of the bay in open sea. We had planned to follow a fixed itinerary, but during the first surveys, it was evident that such a plan would not give us a good picture of the dolphin numbers and distribution because it did not allow for close inspection of most individuals. We, therefore, changed the procedure to actively searching the entire area for dolphins. All bottlenose dolphins found were photographed and, when possible, drawings were made of their dorsal fins. Negatives (X Pan Plus, 125 ISO) were examined under a stereoscopic microscope. Of the 1,124 photographs obtained, 622 were adequate to describe clearly the dorsal fin and dorsal markings of 338 individuals.

On each platform day, we scanned the surface of the sea from the platform constantly with the aid of 10 × 50 binoculars to record dolphins entering and exiting the bay. The sighting distance was about 2 km. Additionally, we swept the entire area surrounding the end of the barrier beach every 10 min. We added these sweeps into 1-h units. Observations were carried out from sunrise to sunset throughout each day of sampling, for 13 h during the first two visits, and 11 h during the last two when the days were shorter. For the statistical analysis, only the first 11 h of observation were used (no individuals were recorded during the last 2 h on the first two sampling periods).

Statistical analyses were performed only on data obtained from the platform. We compared the total number of bottlenose dolphins during sampling periods, and the number of dolphins that entered and exited the bay during spring versus nip tides, with the numbers expected under a hypothesis of uniformity through chi-square tests. Likewise, we compared the numbers of groups. Through nonparametric random block ANOVA (Friedman's test; Zar, 1974), we compared the total number of dolphins recorded during spring tides with those recorded during nip tides; those that entered during a certain type of tide (spring or nip) with those that exited during the same type of tide; and those that entered or exited during spring tides with those that did so during nip tides. Numbers of dolphin groups were analyzed in a similar way.

Using chi-squared tests, we compared the number of dolphins at each hour with the numbers expected if they had been uniform throughout the day. For this, we averaged the observations throughout the study for each of the following cases: number of individuals entering in spring tides, those entering in nip tides, those exiting the bay in both cases, and the number of groups in the same cases.

We compared the number of individuals and of groups entering or exiting the bay during spring tides with those doing so during nip tides with Friedman's tests. We compared individuals and groups entering or exiting during incoming tides with those doing so on the outgoing tide of the same day, in both tidal conditions, through Friedman's tests.

## Results

*Number and Distribution*

The 338 cases of individual identification included 217 different dolphins (Table 1). Of these, 7 individuals (3%) were present in all surveys, 15 (7%) in three, 50 (23%) in two, and 145 (67%) in only one. Of the 55 individuals identified in March 2000, 10 had been identified in the August to September 1999 survey. During the winter, there were many more individuals in the area than at any other season (Table 1). Indeed, 50 individuals were present only at that time. Mean group size varied greatly between surveys, but so did the variance, and no significant differences were detected (we considered a group as a series of individuals that were near each other and obviously interacting, and were separated from other such associations).

Habitat use by bottlenose dolphins is regulated, in general, by the distribution of their prey (Leatherwood, 1975; Hanson & Defran, 1993; Acevedo-Gutiérrez & Parker, 2000); and in other areas, seasonal use by bottlenose dolphins has been linked to the distribution of food (Shane, 1980; Wells et al., 1980; Irvine et al., 1981; Shane et al., 1986; Ballance, 1990). Bottlenose dolphins move with the concentrations of their food, entering bays and estuaries in pursuit of their prey, and taking advantage of high tides to enter shallow areas. Tidal rhythms affect them directly, both by changing the water depth in different areas and by causing their food to move (Shane et al., 1986). In addition, habitat use by bottlenose dolphins is affected by depth and surface temperature of water (Shane et al., 1986; Ballance, 1990, 1992).

In the Bahía San Jorge area, bottlenose dolphins used different areas throughout the study (Figure 1). The concentration inside the bay during the summer and autumn coincided with shrimp fishing, of which the dolphins took advantage, either by taking fish from the nets or eating those discarded by the fishermen (see "Interactions of Bottlenose Dolphins with Fisheries"). At this time, the dolphins did not feed in groups, and groups were observed only while the dolphins traveled to enter or exit the bay. This might suggest that food was plentiful and well distributed, not only in association with the fishing nets, but perhaps also over the whole area.

During the winter and spring, the dolphins stayed outside the bay feeding (Figure 1). During the winter, the number of dolphins in the area more than doubled, suggesting that the area was richer than other regions available to the dolphins for feeding. This is concordant with satellite images that show this region as having ocean upwellings during this time of the year (Álvarez-Borrego & Lara-Lara, 1991).

*Number of Bottlenose Dolphins Entering and Exiting the Bay*

From the observation platform, we recorded 206 bottlenose dolphins (Table 2). Of these, 76.5% were of grouped individuals, and the remainder were of solitary dolphins. Numbers of dolphins entering the bay matched the seasonal distribution of the dolphins (Figure 1). During the winter, even those dolphins that entered the bay remained near the mouth and did not travel further inside the bay.

The number of individuals and of groups entering and exiting the bay, both in spring and nip tides, was not statistically uniform throughout the day (Figure 2). Overall, the greatest numbers of dolphins entered the bay during the second and third hours of observation (0700-0859 h in summer and fall, and 0800-0959 h in winter). The lowest numbers of individuals were during the 9th hour (1400-1459 h in summer and fall; 1500-1559 h in winter). Groups entered the bay mostly in the 2nd, 3rd, and 4th hours (0700-0959 h in summer and fall, and 0800-1059 h in winter), but the number of groups exiting the bay did not differ throughout the day.

**Table 1.** Number of bottlenose dolphins identified and recorded subsequently, through photo-characterization, by mean group size (± standard deviation) and number of calves observed from a skiff in Bahía San Jorge, Sonora, 1999 to 2000

| | 25 Aug.- 20 Sept. 1999 | 23 Oct.- 19 Nov. 1999 | 20 Jan.- 16 Feb. 2000 | 16-30 March 2000 | Grand total |
|---|---|---|---|---|---|
| Total individuals identified | 63 | 48 | 149 | 57 | 317 |
| New individuals | 63 | 20 | 84 | 11 | 217 |
| Individuals re-sighted from period 1 | | 28 | 35 | 11 | |
| Individuals re-sighted from period 2 | | | 30 | 9 | |
| Individuals re-sighted from period 3 | | | | 26 | |
| Mean group size | 2.63 ± 2.63 | 3.74 ± 2.68 | 8.15 ± 7.21 | 13.00 ± 10.84 | |
| Numer of calves | 8 | 16 | 35 | 5 | 64 |

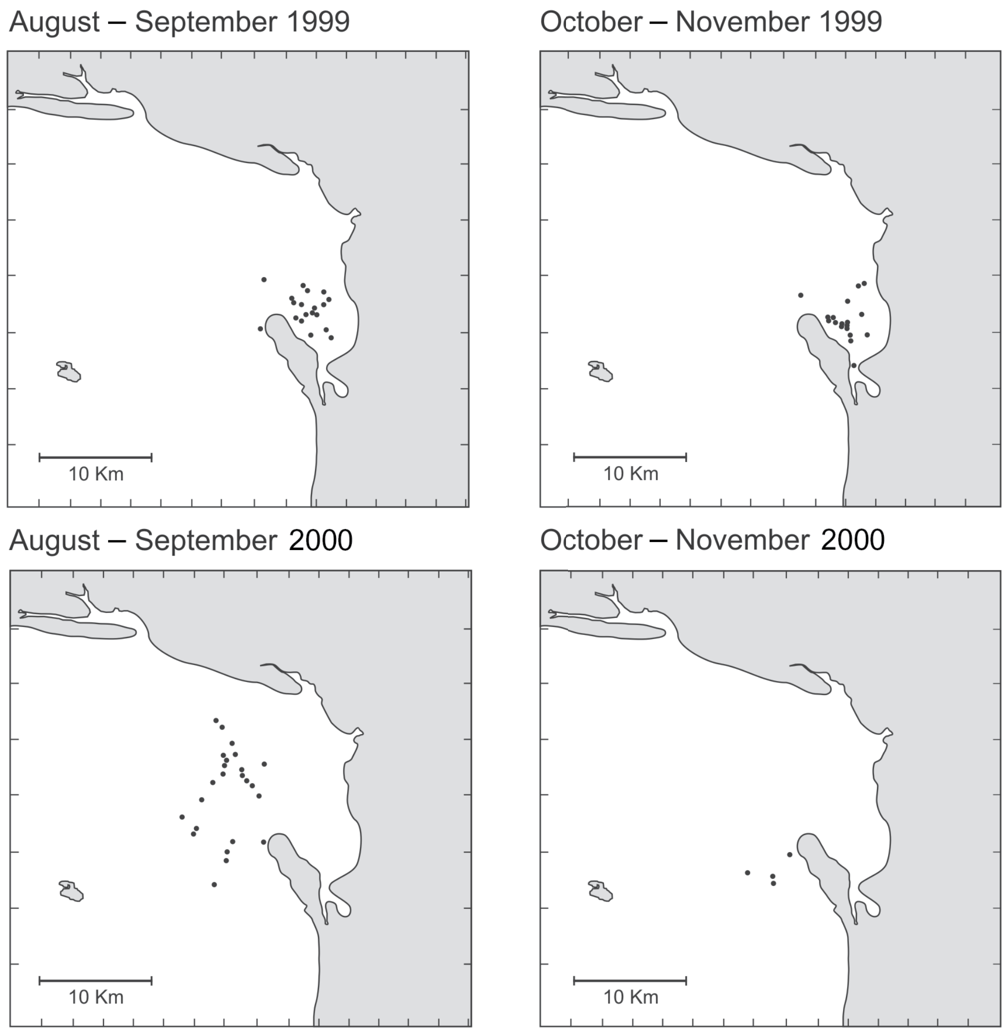


**Figure 1.** Distribution of bottlenose dolphins in the Bahía San Jorge area, northern Gulf of California, Mexico, 1999-2000

**Table 2.** Number of bottlenose dolphins and bottlenose dolphin groups (within parenthesis) that entered and exited Bahía San Jorge, Sonora, in two tidal conditions on five sampling periods, 1999-2000; * indicates data adjusted from two days of sampling (within a tidal stage) by multiplying it × 1.5.

| | Spring tide | | Nip tide | | |
|---|---|---|---|---|---|
| Period | Entering | Exiting | Entering | Exiting | Total observations |
| 25 August - 20 September 1999 | 34(19) | 12(3) | 4(2) | 7(2) | 57.0 |
| 23 October - 6 November 1999 | 23(11) | 2(2) | 17(14) | 9(4) | 51.0 |
| 7-19 November 1999 | 14(3) | 9(4) | 19.5*(6*) | 15*(4.5*) | 57.5 |
| 20 January - 2 February 2000 | 0 | 0 | 3(3) | 7(3) | 10.0 |
| 3-16 February 2000 | 0 | 8(1) | 9*(7.5*) | 13.5*(4.5*) | 30.5 |

During the summer and autumn, bottlenose dolphins entered Bahía San Jorge early in the morning, mostly in groups, and, once inside the bay, they dispersed to feed, usually individually. They exited the bay through the mouth in a more dispersed manner than that in which they entered. Commonly, the number of dolphins exiting the bay was lower than entering it. Those that exited close to our platform assembled in groups immediately outside the bay and traveled southward along the coast.

There were no significant differences in the following comparisons:

- *Between spring and nip tides* – In total number of individuals (both entering and exiting the bay), number of individuals entering, number of individuals exiting, total number of groups, number of groups entering, and number of groups exiting
- *Between entrances and exits* – In number of individuals in spring tides, number of individuals in nip tides, number of groups in spring tides, and number of groups in nip tides
- *Between incoming and outgoing tides* – In number of individuals and of groups entering and exiting the bay, in both tide conditions

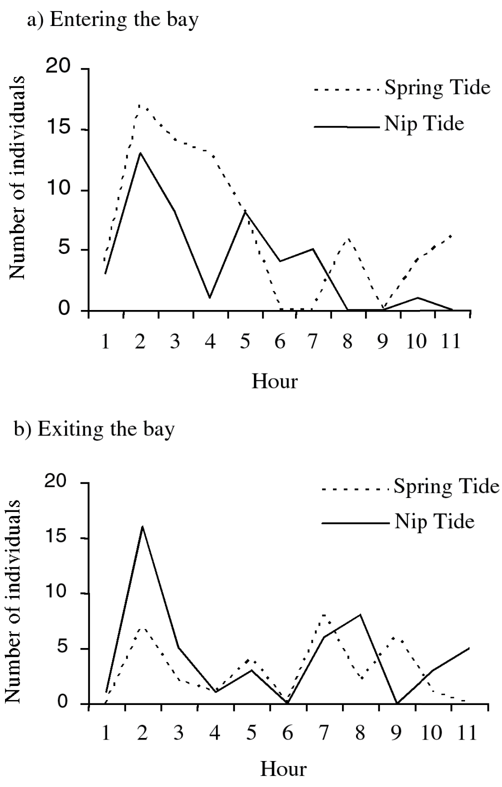


**Figure 2.** Number of bottlenose dolphins that entered and exited Bahía San Jorge during two tidal conditions over an 11-h period and five periods of sampling

*Calves*

We saw bottlenose dolphin calves in all surveys, but there was a higher proportion of them in autumn (Table 1). On 23 October 1999, we saw a clearly distinguishable dolphin swimming slowly into the bay, about 1 m from shore. On 10 November 1999, we saw the same individual with a 1-m long calf alongside. This estimated size corresponds to a newborn bottlenose dolphin calf (Leatherwood et al., 1988), and it seems likely the dolphin could have delivered her calf in Bahía San Jorge.

*Interactions of Bottlenose Dolphins with Seabirds and Sea Lions*

Often, like elsewhere, bottlenose dolphins foraged in aggregations with other marine homeotherms. Winter feeding aggregations included, in addition to the dolphins, Brown Boobies, double-crested cormorants (*Phalacrocorax auritus*), brown pelicans (*Pelecanus occidentalis*), different species of gull (including *Larus livens*, *L. heermanni*, and *L. delawarensis*), and California sea lions. These are common species in feeding aggregations elsewhere in the Gulf (Ballance, 1992; E. Mellink, unpub. obs., 15-19 April 2000). There were no clear patterns of association in those aggregations. On seven occasions inside the bay, we saw California sea lions following dolphins, and we presumed that dolphins' feeding facilitated that of the sea lions. During the shrimp fishing season, we saw feeding aggregations associated with fishing nets. On one occasion, a Brown Booby collided with a dolphin while diving.

*Interactions of Bottlenose Dolphins with Fisheries*

During the artisanal shrimp fishing season, bottlenose dolphins seemed to be attracted to the fishing skiffs, apparently by the noise of the motors, the noise produced while setting the nets, or by the noise of the lead at the bottom of the nets when it hit the rind of the skiff. The dolphins took fish from the nets, if there were any. The fish most often taken seemed to be mullets (*Mugil cephalus*), corvinas (*Cynoscion parvipinnis*), and sierra (*Scombromorus sierra* and *S. concolor*). When the fishermen picked up their nets, the dolphins stayed to feed on the discards as usually only the shrimp and a few prime fish were kept by the fishermen.

Sometimes, when dolphins pulled a fish from the net, they caused ruptures in the net or caused the shrimp to dislodge and fall out. Despite this, we did not detect any aggressive actions by the fishermen towards the dolphins. On 8 September

1999, there was a dead dolphin in a gillnet set by an artisanal fisherman. Given that this was the only such event during the 1999-2000 shrimp fishing season in Bahía San Jorge, and since the nets have a mesh small enough to be easily detected by the dolphins (6.25 cm) and were checked about half an hour after being set, it seems unlikely that it caused the death of the dolphin. Rather, it seems more likely that the tidal current had pushed the dead dolphin into the net. We did not record any dolphins feeding in association with gillnets set to capture sharks and rays, nor with crab traps. Shrimp trawlers have been argued to cause bottlenose dolphin mortality in the Gulf of California, but our study did not cover this interaction.

## Discussion

From our observations, it appears that the area of Bahía San Jorge was apparently important to bottlenose dolphins during our study for feeding, especially in the winter, and that it could be used for parturition. Most of the dolphins detected were only temporarily present in the area, with very few individuals detected during the entire study. We did not detect any effect of tidal conditions on the numbers or activity of the dolphins. During our study, there were few interactions between artisanal fishermen and dolphins, and what interaction there was was limited to the shrimp fishing season when the dolphins benefited from fishing, but occasionally caused some damage to the fishermen.

## Acknowledgments

The Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE), Consejo Nacional de Ciencia y Tecnología (CONACYT), Sociedad Cooperativa de Producción Pesquera Ejidal Bahía San Jorge, Horacio de la Cueva, Rubén Astorga, Carmelo Gil, and Arturo Dena provided logistical support. Sergio Ramos provided GIS assistance, and Silvia Avilés helped with fish identification. Francisco Ponce redrew Figure 1. J. A. Thomas and an anonymous referee assisted with editorial comments. Our appreciation goes to all of them.

## Literature Cited

Acevedo-Gutiérrez, A., & Parker, N. (2000). Surface behavior of bottlenose dolphins is related to spatial arrangement of prey. *Marine Mammal Science*, *16*, 287-298.

Álvarez-Borrego, S., & Lara-Lara, R. (1991). The physical environment and primary productivity of the Gulf of California. In J. P. Dauphin & B. Simoneit (Eds.), *The Gulf and Peninsular Province of the Californias* (American Association of Petroleum Geologists Memoir No. 47) (pp. 555-567). Tulsa: American Association of Geologists. 834 pp.

Ballance, L. T. (1990). Residence patterns, group organization and surfacing associations of bottlenose dolphin in Kino Bay, Gulf of California, México. In S. Leatherwood & R. R. Reeves (Eds.), *The bottlenose dolphin* (pp. 267-284). New York: Academic Press. 653 pp.

Ballance, L. T. (1992). Habitat use patterns and ranges of the bottlenose dolphin in the Gulf of California, México. *Marine Mammal Science*, *8*, 262-274.

Ezcurra, E. (2001). Desert and sea. In P. Robles-Gil, E. Ezcurra, & E. Mellink (Eds.), *The Gulf of California: A world apart* (pp. 37-61). District Federal, México: Agrupación Sierra Madre. 335 pp.

García-Rodríguez, F. J., & Aurioles-Gamboa, D. (2004). Spatial and temporal variation in the diet of the California sea lion (*Zalophus californianus*) in the Gulf of California, Mexico. *Fishery Bulletin*, *102*, 47-62.

Hansen, L. J. (1990). California coastal bottlenose dolphins. In S. Leatherwood & R. R. Reeves (Eds.), *The bottlenose dolphin* (pp. 403-420). New York: Academic Press. 653 pp.

Hanson, M. T., & Defran, R. H. (1993). The behaviour and feeding ecology of the Pacific coast bottlenose dolphin, *Tursiops truncatus*. *Aquatic Mammals*, *19*, 127-142.

Irvine, A. B., Scott, M. D., Wells, R., & Kaufmann, J. H. (1981). Movements and activities of the Atlantic bottlenose dolphin, *Tursiops truncatus*, near Sarasota, Florida. *Fishery Bulletin*, *79*, 671-688.

Lavín, M. F., Gaxiola-Castro, G., & Robles, J. M. (1995). Winter water masses and nutrients in the northern Gulf of California. *Journal of Geophysical Research*, *100*, 8587-8605.

Leatherwood, S. (1975). Some observations of feeding behavior of bottlenose dolphins (*Tursiops truncatus*) in the northern Gulf of México and (*Tursiops* cf. *T. gilli*) off southern California, Baja California and Nayarit, México. *Marine Fisheries Review*, *37*, 10-16.

Leatherwood, S., Reeves, R. R., Perrin, W. F., & Evans, W. E. (1988). *Whales, dolphins and porpoises of the eastern north Pacific and adjacent waters.* New York: Dover. 256 pp.

Maluf, L. (1983). The physical oceanography. In T. J. Case & M. L. Cody (Eds.), *Island biogeography in the Sea of Cortéz* (pp. 24-45). Los Angeles: University of California Press. 508 pp.

Mellink, E. (2000). Breeding of brown boobies in the Gulf of California: Seasonality and apparent effects of El Niño. *Waterbirds*, *23*, 89-99.

Mellink, E. (2003). Effect of the 1997-1998 El Niño and 1998-1999 La Niña events on breeding waterbirds and sea lions in the Upper Gulf of California, México. *Geofísica Internacional*, *42*, 539-546.

Mellink, E., & Romero-Saavedra, A. L. (2005). Dieta del lobo marino de California, *Zalophus californianus* (Lesson, 1828), en la Isla San Jorge, en el norte del Golfo de California, México, 1998-1999. *Ciencias Marinas*, *31*, 369-377.

Mellink, E., Domínguez, J., & Luévano, J. (2001). Diet of Eastern Pacific Brown Boobies *Sula leucogaster brewsteri* on Isla San Jorge, north-eastern Gulf of California, and an April comparison with diets in the Middle Gulf of California. *Marine Ornithology*, *29*, 39-44.

Palacios, E., & Mellink, E. (1996). Status of the Least Tern in the Gulf of California. *Journal of Field Ornithology*, *67*, 48-58.

Shane, S. H. (1980). Occurrence, movements, and distribution of bottlenose dolphin, *Tursiops truncatus*, in Southern Texas. *Fishery Bulletin*, *78*, 593-601.

Shane, S. H., Wells, R. S., & Würsig, B. (1986). Ecology, behavior and social organization of the bottlenose dolphin: A review. *Marine Mammal Science*, *2*, 34-63.

Silber, G. K., Newcomer, M. W., Silber, P. C., Perez-Cortez, M. H., & Ellis, G. M. (1994). Cetaceans of the northern Gulf of California: Distribution, occurrence, and relative abundance. *Marine Mammal Science*, *10*, 283-298.

Wells, R. S., Irvine, A. B., & Scott, M. D. (1980). The social ecology of inshore odontocetes. In L. M. Herman (Ed.), *Cetacean behavior: Mechanisms and functions* (pp. 263-317). New York: John Wiley and Sons. 463 pp.

Zar, J. H. (1974). *Biostatistical analysis* (2nd. ed.). Englewood Cliffs, NJ: Prentice-Hall. 718 pp.