THE BOTTLENOSE DOLPHIN
(*TURSIOPS TRUNCATUS*)

Taxonomy and Systematics

The bottlenose dolphin (*Tursiops truncatus*) belongs to the Order Cetacea, Family Dephinidae, and Genus *Tursiops*. The genus *Tursiops* is polymorphic and at least 20 species have been described (Mead and Potter 1990). Because systematic studies have been conducted on relatively small sample sizes and restricted geographic areas, however, there is no general consensus on the validity of these species (Mead and Potter 1990, Ross and Cockcroft 1990, Rice 1998). A recent phylogenetic analysis of the mtDNA indicated that bottlenose dolphins of the tropical Indian Ocean are genetically closer to several species of *Stenella* than to *T. truncatus* (Curry et al. 1995, Curry 1997, Curry and Smith 1998). Consequently, for the interim it is treated as a separate species (*T. aduncus*; Rice 1998).

Distribution and Movements

The bottlenose dolphin is a cosmopolitan species and found in almost all oceans except at very high latitudes. This species is found in coastal waters of all continents, around most oceanic islands and atolls, and over shallow offshore banks and shoals (Rice 1998). In the Pacific, the species ranges along the both sides of the ocean from northern Japan and central California southward to Australia and Chile (Leatherwood and Reeves

1983, Wells et al 1990). In the Atlantic, bottlenose dolphins range from Nova Scotia and Norway southward to Patagonia and the tip of South Africa (Leatherwood and Reeves 1983). Bottlenose dolphins also are common in the Mediterranean Sea and the Indian Ocean (Leatherwood and Reeves 1983). Although the species is most common in the nearshore waters, pelagic populations have been reported for the Gulf Stream of the northwestern Atlantic and in the tropical eastern Pacific (Rice 1998).

Throughout the range of the species, researchers have found two morphological types among adult bottlenose dolphins, which often are referred to as ecotypes (Perrin 1984, Van Waerebeek et al. 1990). Bottlenose dolphins often exhibit offshore-inshore separation. Inshore, or coastal, bottlenose dolphins usually are found shoreward of the 18-m contour and often enter harbors, inlets, bays, lagoons, estuaries, and rivers (Leatherwood and Reeves 1983). Several studies have indicated that these coastal bottlenose dolphins have limited home ranges (Connor and Smolker 1985, Scott et al. 1990, Hammond and Thompson 1991, Caldwell et al. 2001,Gubbins 2002b, Zolman 2002). The offshore ecotype, however, is less restricted in its range and movements (Leatherwood and Reeves 1983, Leatherwood et al. 1988, Scott and Chivers 1990).

Kenney (1990) reported a distinct pattern in the distribution of bottlenose dolphins off the coast of the northeastern United States. Inshore sightings were located in the coastal waters (< 20 m) from Cape Lookout to Delaware Bay, whereas the offshore sightings were distributed between the 200 and 2000 m bottom contours, from Cape Hatteras to the eastern end of Georges Bank (Kenney 1990). The mean depth of the inshore sightings was 10.3 m, whereas that of the offshore sightings was 845.6 m

(Kenney 1990). The inshore-offshore distribution pattern, however, was less distinct south of Cape Hatteras (Scott et al. 1988) and no distinctive offshore groups of bottlenose dolphins have been described south of Cape Hatteras.

The offshore ecotype of bottlenose dolphins in the western Atlantic mainly exists in the oceanic waters (Duffield et al. 1983, Hersh and Duffield 1990, Mead and Potter 1995, Curry and Smith 1997). There are hematological, morphological, and genetic differences between these two ecotypes (Duffield et al. 1983, Hersh and Duffield 1990, P. Rosel, pers. comm.). The exact spatial distributions of these ecotypes, however, are unknown. These two ecotypes cannot be distinguished with certainty during visual observations from airplanes and large ships (Waring et al. 2001).

Some coastal bottlenose dolphins, north and south of Cape Hatteras, exhibit north-south seasonal migration. Researchers have hypothesized that coastal bottlenose dolphins migrate latitudinally in response to the seasonal change in the ocean temperature (Mead and Potter 1990). Because water temperature offshore is not influenced by the incursion of the Labrador Current during winter, offshore bottlenose dolphins may not migrate seasonally (Mead and Potter 1990). During summer, coastal bottlenose dolphins are distributed as far north as Long Island, New York. The main concentration of coastal bottlenose dolphins during summer, however, is along the coast of North Carolina to New Jersey (Scott et al. 1988).

During winter, only a few bottlenose dolphins are found in the coastal water north of Cape Hatteras (Kenney 1990, Blaylock and Hoggard 1994, Wiley et al. 1994). The coastal ecotype is found along the coast of North Carolina to Florida. The winter

destinations of bottlenose dolphins that are found north of Cape Hatteras during summer are unknown. It is suspected that they inhabit along the coast of North Carolina during winter.

Seasonal movements, extent of offshore distributions, and inshore-offshore movements of the offshore ecotype have not been determined because sampling has been limited to areas within 200 km of shore and no studies have been conducted to determine the movements (Wang et al. 1994).

The coastal bottlenose dolphins also are found throughout the year in some estuaries, inlets, and rivers south of Cape Hatteras (North Carolina to Florida; Scott et al. 1988, Hohn 1997, Caldwell et al. 2001, Gubbins 2002a, Zolman 2002, A. Hohn and L. Hansen, pers. comm.). Results of photographic identification studies indicate that there is a difference in the extent of residency among dolphins: residents throughout the year, seasonal residents (returning to the same area during one season every year but not present during other seasons), migrants or transients, and possible groups with large home ranges (Hohn 1997, Caldwell et al. 2001). Resident bottlenose dolphins have been reported from North Carolina to Florida (Sayigh et al. 1997, Hohn 1997, Caldwell et al. 2001, Gubbins 2002a, Zolman 2002). Researchers have reported sympatric occurrences of residents, seasonal residents, and transients at various locations (Odell and Asper 1990, Hohn 1997, Caldwell et al. 2001).

Movements and home ranges of bottlenose dolphins have been studied using radio telemetry, tagging, satellite telemetry, and photographic identification of natural marks. Extensive studies on home ranges of bottlenose dolphins come from the Sarasota

Bay area, Florida, in which some marked bottlenose dolphins have maintained fidelity to the area for over 17 years (Scott et al. 1990). In the Sarasota Bay area, home ranges of males are larger than females. Adult females create several relatively discrete spatial groups, with each group occupying different and relatively limited core areas that broadly overlap, and adult males travel from one female group to another (Scott et al. 1990).

Odell and Asper (1990) caught and freeze-branded 133 bottlenose dolphins in Indian River, Florida, between March 1977 and October 1981. Marked dolphins were searched for actively and opportunistically after branding from September 1979 through March 1982. Eight branded individuals were never identified following their release. Of 81 freeze-branded individuals with sighting records, 60 were sighted exclusively within Indian River (mean linear range = 32.8 km, SD = 18.0 km) whereas the others were seen in both Indian and Banana rivers (mean linear range = 55.6 km, SD = 20.5 km).

Gubbins (2002a) studied home ranges of 20 resident bottlenose dolphins in a South Carolina estuary using the photographic identification technique. The computed home ranges were 14.7 to 98.9 km^2, depending on the method of computations. She found that the resident bottlenose dolphins exclusively used the estuary. Caldwell et al. (2001) studied home ranges of bottlenose dolphins for Jacksonville, FL. They found three behaviorally and genetically distinct groups in their study area, two of which were year-round residents. One resident group was found in the coastal waters and the other in the Intracoastal Waterway (ICW). The third group was found only during summer in the St. John's River. The mean home range for the year-round residents in the ICW was 22.3 (SD = 7.5) km^2, whereas that for the summer residents in the St. John's River was 8.2

(SD = 4.2) km^2. They reported that the home range of the coastal dolphins was larger than the study area.

Continuous movements of bottlenose dolphins have been estimated using satellite telemetry. Mate et al. (1995) deployed a satellite transmitter on a bottlenose dolphin in Tampa Bay, Florida, and found that the dolphin traveled at least 581 km during 25 days, and the longest distance traveled in a day was 50.2 km. Similar results have been reported for resident bottlenose dolphins in Sarasota Bay, Florida (< 30 km/day; Irvine et al. 1981), and a satellite-tagged bottlenose dolphin off Japan (604 km/18 days; Tanaka 1987). Two rehabilitated adult bottlenose dolphins, both of which were believed to be the offshore ecotype, were tagged and tracked via satellite-linked transmitters (Wells et al. 1999). One was released in the Gulf of Mexico but moved around Florida peninsula and northward to off Cape Hatteras, NC, covering 2,050 km in 43 days. The other was released off Cape Canaveral, FL, and moved offshore covering 4,200 km in 47 days.

Morphology, Hematology, and Growth

Male bottlenose dolphins are larger than females. Tolley et al. (1995) reported the sexual dimorphism in bottlenose dolphins in waters near Sarasota Bay, Florida. Males were larger than females in 20 out of 29 measurements. For seven skull measurements, however, only one (rostral girth) indicated a sexual dimorphism, in which males had greater girths than females. Males also were proportionally more robust and

possessed larger appendages than females. Sexual dimorphism of offshore dolphins in the Atlantic has not been investigated.

Although bottlenose dolphins are the most studied cetacean species, few studies have been conducted to estimate the growth and reproduction of the species. The majority of the information comes from dolphins in the Gulf of Mexico and around Florida, especially near Sarasota. For bottlenose dolphins in Sarasota Bay and its vicinity, virtually all individuals in the community have been examined at least once since 1970 (Scott et al. 1990). Read et al. (1993) used the longitudinal data set from around Sarasota Bay to estimate growth of bottlenose dolphins (47 males and 49 females) in the community. Ages of captured bottlenose dolphins were either known from field observations or estimated by the method described by Hohn (1980, 1990). Male dolphins showed greater asymptotic values in length (266.4 ± 2.86 SE vs. 249.2 ± 1.30 SE (cm)), girth (154.0 ± 5.67 SE vs. 141.7 ± 1.36 SE (cm)), and mass (259.0 ± 14.6 SE vs. 194.4 ± 4.72 SE (kg)) than females (Read et al. 1993). During the first six years of life, however, most females were larger in length and mass than males of the same age (Read et al. 1993). Males grow continuously for several years, especially in mass and girth, after the age at which females reach their asymptotic body size (Read et al. 1993).

Fernandez and Hohn (1998) aged 195 stranded carcasses of bottlenose dolphins (78 males, 81 females, and 36 unknown sex) along the Texas coastline. The asymptotic lengths for these bottlenose dolphins using the Gompertz model were 263.5 cm for males and 244.7 cm for females, indicating no significant differences from the estimates for bottlenose dolphins near Sarasota, Florida (Read et al. 1993, Fernandez and Hohn 1998).

Data from the Cape Hatteras area, however, indicated no sexual dimorphism and the asymptotic length of 240 cm (44 females and 38 males; Mead and Potter 1990). Stolen et al. (2002) examined 199 stranded carcasses of bottlenose dolphins from the Indian River Lagoon system in Florida. They found an asymptotic length for males was 255 cm, whereas that for females was 246 cm.

In Florida, female bottlenose dolphins reach sexual maturity at 5 to 12 years of age and a length of 220 to 235 cm, whereas males mature at 10 to 13 years and 245 to 260 cm (Odell 1975). Mean length at birth for a sample of both sexes was estimated to be 109.4 cm (SD = 8.5, n = 42; Fernandez and Hohn 1998), which was comparable to another estimate from the Cape Hatteras area ($\bar{x}$ = 114.3, SD = 7.8, n = 26; Mead and Potter 1990). Predicted birth lengths for bottlenose dolphins from the Indian River Lagoon system for males was 124 cm, whereas that for females was 114 cm (Stolen et al. 2002).

The number of stranded neonates has been used as an indicator of calving in the region. In the Cape Hatteras area, 20 out of 32 stranded neonates were found during March and April, indicating a prolonged calving season with a peak during the spring (Mead 1975, Mead and Potter 1990). In waters around Florida and Texas coast lines, however, calving appeared to occur almost throughout the year and varied among locations (Urian 1996, Fernandez and Hohn 1998). No information is available for the growth, calving seasons, and the sexual dimorphism of the offshore ecotype.

Morphological and hematological differences exist between the coastal and offshore ecotypes (Leatherwood and Reeves 1983, Duffield et al. 1983, Hersh and

Duffield 1990). Duffield et al. (1983) compared hematological variables of 70 Atlantic and 35 Pacific bottlenose dolphins, which were maintained at Sea World facilities in San Diego and Florida. Although no offshore ecotype bottlenose dolphins from the Atlantic were included in the sample, distinctive differences were found in hemoglobin concentration, packed cell volume, and red blood cell counts between coastal and offshore types from the Pacific (Duffield et al. 1983). Hersh and Duffield (1990) compared hemoglobin profiles and morphometrics among fresh carcasses of stranded bottlenose dolphins along the east coast of Florida and found distinctive differences. Four carcasses that were found in the area close to the deep water exhibited electrophoretically different hemoglobins from the carcasses found in areas with no immediate deep water access. They also found significant differences in skull measurements between the two groups. In general, offshore bottlenose dolphins had longer body lengths with a proportionately shorter snout and proportionately smaller flippers and wider skulls and rostrums than coastal bottlenose dolphins (Hersh and Duffield 1990).

Diet

Because bottlenose dolphins are found nearshore and often interact with fishing activities, their diet has been described by several researchers. Bottlenose dolphins are often described as opportunistic foragers and they feed on a wide variety of fish and invertebrates. Stomach samples (n = 76) from stranded carcasses of bottlenose dolphins

in the southeastern United States indicated that the main prey items of bottlenose dolphins included silver perch (*Bairdiella chrysoura*), Atlantic croaker (*Micropogonias undulatus*), mullet (*Mugil* spp.), brief squid (*Lolliguncula brevis*), and spot (*Leiostomus xanthurus*), all occurring in 20% or more of the stomachs (Barros and Odell 1990). Although most prey were benthic species (e.g., drums, croakers, seatrouts, toadfishes, and midshipman), pelagic (e.g., jacks, bluefish, and cutlass fish) and surface (e.g., mullets and clupeids) fishes also were included in their diet. Main prey items of bottlenose dolphins differed among locations, reflecting the abundance of local fish species (Barros and Odell 1990). To compare prey items found in stranded carcasses of bottlenose dolphins and that of free ranging bottlenose dolphins, Mead and Potter (1990) compared the stomach samples of stranded carcasses and those of bottlenose dolphins that were incidentally killed in fishing operations. No differences in prey items were found between these two groups (Mead and Potter 1990).

Although few studies have been conducted to describe food habits of the offshore type bottlenose dolphins, Barros and Odell (1990) reported that ommastephid squids (*Illex* sp. and *Ornithoteuthis antillarum*) were the primary prey items in one offshore bottlenose dolphin. Another stomach sample of an offshore type bottlenose dolphin contained 150 beaks from the shortfin squid (*Illex illecebrosus*), three octopodid squids, and an unidentified fish otolith (Mercer 1973).

Anecdotal reports indicate that bottlenose dolphins steal several fish species from fishing lines of fishermen, including king mackerel (*Scomberomorus cavall*), Spanish mackerel (*S. maculatus*), kingfish (*S. regalis*), tarpon (*Megalops* (*Tarpon*) *atlanticus*),

sailfish (*Istiophorus americanus*), hammerhead shark (*Sphyrna zygaena*), speckled trout (*Cynoscion nebulosus*), roballo (*Centropomus undecimalis*), spotted eagle-ray (*Aetobatus* (*Stoasodon*) *narinari*), mullet (*Mugil* sp.), sea catfish (*Aris* (*Galeichthys*) *felis*), sheephead (*Archosargus probatocephalus*), and flounder (*Paralichthys* sp.; Gunter 1942, Odell 1975). Gunter (1942) also examined stomach samples collected from 34 bottlenose dolphins killed in a small-scale harpoon fishery in Aransas County, Texas, and found striped mullet (*Mugil cephalus*), gizzard shad (*Dorosoma cepedianum*), spot (*Leiostomus xanthurus*), croaker (*Micropogon undulatus*), sand trout (*Cynoscion arenarius*), puffer (*Sphoeroides marmoratus*), sheephead, needle gar (*Strongylura marina*), black drum (*Pogonias cromis*), spotted trout (*Cynoscion nebulosus*), and flounder (*Paralichthys lethostigmus*).

Abundance

To estimate the abundance of bottlenose dolphins along the Atlantic coast of the United States, aerial surveys have been conducted. In the areas north of Cape Hatteras, Kenney (1990) used data from the surveys conducted by the Cetacean and Turtle Assessment Program (CETAP) between 1978 and 1983. Data were collected from the shoreline to 5 nautical miles seaward of the 1,600 m isobath, using random line-transect procedures (Kenney 1990). This study defined the inshore as all bottlenose dolphins found in waters less than 32 m, whereas all bottlenose dolphins found in waters deeper than 32 m were considered the offshore form. No bottlenose dolphins were observed in

inshore waters during winter. The greatest number of bottlenose dolphins was found in the coastal water during summer, with estimates ranging from 400 to 700. In the offshore water, the number of bottlenose dolphins was least during winter (1,500 to 2,300) and greatest during summer (9,700 to 12,800; Kenney 1990).

From 1992 through 1994, several aerial surveys were conducted along the Atlantic coast of the United States between Cape Hatteras and southeast Florida (Blaylock and Haggard 1994, Blaylock 1995). The abundance of bottlenose dolphins during the winter of 1992 was estimated to be 12,435 (95% CI = 9,684 - 15,967) between Cape Hatteras and southeast Florida using the line-transect method (Blaylock and Haggard 1994). During the summer of 1994, two types of aerial surveys were conducted. One type was a direct count of bottlenose dolphins within approximately 1 km of shore, and the other was the simple-random line transect method (Blaylock 1995). Direct count surveys indicated the minimum of 2,482 dolphins along the shore. The estimated abundance of dolphins from the line-transect survey was 25,841 (95% CI = 13,010 - 51,329; Blaylock 1995). During these surveys, however, offshore-inshore types were not distinguished.

All aerial surveys targeted bottlenose dolphins in the oceanic waters. Until recently, no study had been conducted to estimate abundance of bottlenose dolphins in inshore waters, including bays, sounds, and estuaries. To estimate abundance of bottlenose dolphins in bays and sounds of North Carolina, Read et al. (2003) conducted a mark-recapture study during summer 2000. Using a closed model that allows variable

capture probabilities over time and among individuals, the abundance of bottlenose dolphins was estimated to be 1,154 (95% CI = 996 – 1,370).

From June 1987 to March 1988, an epizootic of morbilliviruses caused mass die-off of bottlenose dolphins along the Atlantic coast of the United States from New Jersey to Florida (Scott et al. 1988, Lipscomb et al. 1994, Duignan et al. 1996). Between June 1987 and April 1988, a total of 742 dolphins were found dead from New Jersey to Florida, which was 10 times greater than the previous 3-year historical level of carcass detection (mean = 73 dolphins; Wang et al. 1994). Although the exact number of deaths was unknown, Scott et al. (1988) estimated greater than 50% of the coastal migratory stock between New Jersey and Florida died during this epizootic. The method of the estimation, however, was not described in the report. Consequently, on 6 April 1996, the National Marine Fisheries Service (NMFS) listed the migratory stock of Atlantic coastal bottlenose dolphins as depleted under the Marine Mammal Protection Act (MMPA 1972, amended 1994; Wang et al. 1994).

Human Interactions

Increasing human activities in nearshore waters and fishing activities have added another source of mortality for bottlenose dolphins. From 1991 through 1995, an average of 81.8 (CV = 0.27) offshore type bottlenose dolphins were killed annually by commercial fisheries (Waring et al. 1997). Pelagic pair trawl fisheries killed the greatest number of bottlenose dolphins (44.8/yr, CV = 0.28) compared with other fisheries

(Pelagic drift gillnet (18.8/yr, CV = 0.06), bottom trawl (18.2/yr, CV = 0.97), and coastal sink gillnet; Waring et al. 1997). Because of the differences in the methods used to estimate the number of incidental kills among fisheries and among years, these numbers may not indicate the actual number of bottlenose dolphins killed during their operations.

Stranded bottlenose dolphins along the Atlantic coast of the United States often show signs of interactions with fishing activities: entanglement, net marks, and missing appendages. During 1993, 22% of stranded bottlenose dolphins in North Carolina indicated interactions with fisheries (Waring et al. 1997). During 1994, 192 bottlenose dolphins stranded along the coast between Florida and North Carolina, of which 24 (12%) indicated signs of human interaction and 14 (7%) had evidence of entanglement with fishing gear. During 1995, 23 (12%) out of 196 stranded dolphins indicated human interactions and 12 (6%) had evidence of entanglement with fishing gear. From 1988 to 1995, the annual average of 22 stranded bottlenose dolphins indicated signs of human interaction (Waring et al. 1997). Palka and Rossman (2001) reported that the highest incidental mortality of bottlenose dolphins in the coastal gillnet fisheries for the Atlantic coast of the U.S. was found along the coast of North Carolina and Virginia during winter. They estimated that an average of 181 (SD = 46.7) bottlenose dolphins were killed annually by the coastal gillnet fisheries off NC and VA from 1996 to 2000.

Other causes of human-induced mortality in bottlenose dolphins may include contamination of the environment, habitat degradation, boat strikes, and gunshots (Waring et al. 1997). Gorzelany (1998) reported deaths of two previously identified bottlenose dolphins in the Sarasota area by ingestion of fishing gear. McFee and

Hopkins-Murphy (2002) reported that 23.1% of all stranded bottlenose dolphins (n=153; 1992 to 1996) along the coast of South Carolina were killed by interactions with human activities.

An immediate management action is necessary for the bottlenose dolphin along the Atlantic coast of the U.S. Recent studies have indicated that there are many small genetically distinct subgroups of bottlenose dolphins may exist in inshore waters, which may require separate stock status. Without a sound management plan, the reported high anthropogenic mortality may extirpate one or more of these small stocks. To establish a management goal for a stock, abundance of the stock needs to be estimated. As Read et al. (2003) demonstrated, CMR methods are viable alternatives to distance-based methods for these waters.