

BOTTLENOSE DOLPHIN (*Tursiops truncatus*): Western North Atlantic Coastal Morphotype Stocks

STOCK DEFINITION AND GEOGRAPHIC RANGE

Geographic Range and Coastal Morphotype Habitat

The coastal morphotype of bottlenose dolphin is continuously distributed along the Atlantic coast south of Long Island, New York around the Florida peninsula and along the Gulf of Mexico coast. Based on differences in mitochondrial DNA haplotype frequencies, nearshore animals in the northern Gulf of Mexico and the western North Atlantic represent separate stocks (Curry 1997; Duffield and Wells 2002). On the Atlantic coast, Scott *et al.* (1988) hypothesized a single coastal migratory stock ranging seasonally from as far north as Long Island, to as far south as central Florida, citing stranding patterns during a high mortality event in 1987-88 and observed density patterns. More recent studies demonstrate that the single coastal migratory stock hypothesis is incorrect, and there is instead a complex mosaic of stocks (NMFS 2001; McLellan *et al.* 2003).

The coastal morphotype is morphologically and genetically distinct from the larger, more robust morphotype primarily occupying habitats further offshore (Hoelzel *et al.* 1998; Mead & Potter 1995). Aerial surveys conducted between 1978 and 1982 (CETAP 1982) north of Cape Hatteras, North Carolina identified two concentrations of bottlenose dolphins, one inshore of the 25 m isobath and the other offshore of the 50 m isobath. The lowest density of bottlenose dolphins was observed over the continental shelf, with higher densities along the coast and near the continental shelf edge. It was suggested, therefore, that north of Cape Hatteras, North Carolina the coastal morphotype is restricted to waters < 25 m deep (Kenney 1990). Similar patterns were observed during summer months in more recent aerial surveys (Garrison and Yeung 2001; Garrison *et al.* 2003). However, south of Cape Hatteras during both winter and summer months, there was no clear longitudinal discontinuity in bottlenose dolphin sightings (Garrison and Yeung 2001; Garrison *et al.* 2003).

A combined spatial and genetic analysis of tissue samples from large vessel surveys during the summers of 1998 and 1999 indicated that bottlenose dolphins within 7.5 km from shore were most likely of the coastal morphotype, and there was a region of overlap between the coastal and offshore morphotypes between 7.5 and 34 km from shore south of Cape Hatteras (Torres *et al.* 2003). However, relatively few samples were available from the region of overlap, and therefore the longitudinal boundaries based on these initial analyses were uncertain (Torres *et al.* 2003). Extensive systematic biopsy sampling efforts were conducted in the summers of 2001 and 2002 to supplement collections from large vessel surveys. During the winters of 2002 and 2003, additional biopsy collection efforts were conducted in nearshore continental shelf waters of North Carolina and Georgia. Additional biopsy samples were collected in deeper continental shelf waters south of Cape Hatteras during winter 2002. Genetic analyses using mitochondrial DNA sequences of these biopsies identified individual animals to the coastal or offshore morphotype. Using the genetic results from all surveys combined, a logistic regression was used to model the probability that a particular bottlenose dolphin group was of the coastal morphotype as a function of environmental variables including depth, sea surface temperature, and distance from shore. These models were used to partition the bottlenose dolphin groups observed during aerial surveys between the two morphotypes (Garrison *et al.* 2003).

The genetic results and spatial patterns observed in aerial surveys indicate both regional and seasonal differences in the longitudinal distribution of the two morphotypes in coastal Atlantic waters. During summer months, all biopsy samples collected from nearshore waters north of Cape Lookout, North Carolina (< 20 m deep) were of the coastal morphotype, and all samples collected in deeper waters (> 40 m deep) were of the offshore morphotype. South of Cape Lookout, the probability of an observed bottlenose dolphin group being of the coastal morphotype declined with increasing depth. In intermediate depth waters, there was spatial overlap between the two morphotypes. Offshore morphotype bottlenose dolphins were observed at depths as shallow as 13 m, and coastal morphotype dolphins were observed at depths of 31 m and 75 km from shore (Garrison *et al.* 2003).

Winter samples were collected primarily from nearshore waters in North Carolina and Georgia. The vast majority of samples collected in nearshore waters of North Carolina during winter were of the coastal morphotype; however, one offshore morphotype group was sampled during November just south of Cape Lookout only 7.3 km from shore. Coastal morphotype samples were also collected farther away from shore at 33 m depth and 39 km distance from shore. The logistic regression model for this region indicated a decline in the probability of a coastal morphotype group with increasing distance from shore; however, the model predictions were highly uncertain due to limited sample sizes and spatial overlap between the two morphotypes. Samples collected in Georgia waters also

indicated significant overlap between the two morphotypes with a declining probability of the coastal morphotype with increasing depth. A coastal morphotype sample was collected 112 km from shore and a depth of 38 m. An offshore sample was collected in 22 m depth at 40 km from shore. As with the North Carolina model, the Georgia logistic regression predictions are uncertain due to limited sample size and high overlap between the two morphotypes (Garrison *et al.* 2003).

In summary, the primary habitat of the coastal morphotype of bottlenose dolphin extends from Florida to New Jersey during summer months and in waters less than 20 m deep, including estuarine and inshore waters. South of Cape Lookout, the coastal morphotype occurs in lower densities over the continental shelf (waters between 20 m and 100 m depth) and overlaps spatially with the offshore morphotype.

Distinction Between Coastal and Estuarine Bottlenose Dolphins

There are multiple lines of evidence supporting demographic separation between bottlenose dolphins residing within estuaries along the Atlantic coast. For example, long-term photo-identification studies in waters around Charleston, South Carolina have identified communities of resident dolphins that are seen within relatively restricted home ranges year-round (Zolman 2002; Gubbins 2002; Speakman *et al.* 2006). In Biscayne Bay, Florida there is a similar community of bottlenose dolphins with evidence of year-round residents that are genetically distinct from animals residing in a nearby estuary in Florida Bay (Litz 2007). The Indian River Lagoon system in central Florida also has a long photo-identification study, and this study identified year-round resident dolphins repeatedly observed across multiple years (Stolen *et al.* 2007). There are relatively few published studies demonstrating that these resident animals are genetically distinct from animals in nearby coastal waters; however, a study conducted near Jacksonville, Florida demonstrated significant genetic differences between animals in nearshore coastal waters and estuarine waters (Caldwell 2001). In addition, stable isotope analysis of animals sampled along the Outer Banks of North Carolina between Cape Hatteras and Bogue Inlet during February and March shows very low stable isotope ratios of ^{18}O relative to ^{16}O (referred to as depleted ^{18}O or depleted oxygen, Cortese 2000). One explanation for the depleted oxygen signature is a resident group of dolphins in Pamlico Sound that move into nearby nearshore areas in the winter. The possibility of a resident group of bottlenose dolphins in Pamlico Sound is also supported by results from satellite telemetry and photo-identification (NMFS 2001). Long-term, year-round, multi-generational resident communities of dolphins have been recognized in embayments and coastal areas of the Gulf of Mexico (Wells *et al.* 1987; Wells *et al.* 1996; Scott *et al.* 1990; Weller 1998; Wells 2003), and it is not surprising to find similar patterns along the Atlantic coast.

Given the observed patterns of residency across multiple estuaries along the Atlantic coast and the evidence of demographically distinct estuarine stocks in the Gulf of Mexico (e.g., Wells 2003), it is highly likely that there is demographic separation between bottlenose dolphins residing within estuaries and those in nearshore coastal waters. However, the degree of spatial overlap between these populations remains unclear. Photo-identification studies within estuaries demonstrate seasonal immigration and emigration and the presence of transient animals (e.g., Speakman *et al.* 2006). In addition, the degree of movement of resident estuarine animals into coastal waters on seasonal or shorter time scales is poorly understood. However, for the purposes of this analysis, bottlenose dolphins inhabiting primarily estuarine habitats are considered distinct from those inhabiting coastal habitats. Bottlenose dolphin stocks inhabiting coastal waters are the focus of this report.

Definition of Coastal Stocks

Initially, a single stock of coastal morphotype bottlenose dolphins was thought to migrate seasonally between New Jersey (summer months) and central Florida based on seasonal patterns in strandings during a large scale mortality event occurring during 1987-1988 (Scott *et al.* 1988). However, re-analysis of stranding data (McLellan *et al.* 2003) and extensive analysis of genetic, photo-identification, satellite telemetry, and stable isotope studies demonstrate a complex mosaic of coastal bottlenose dolphin stocks (NMFS, 2001). In the northern part of the range, the patterns reported include seasonal residency, year-round residency with large home ranges, and migratory or transient movements (Barco and Swingle 1996). There are strong seasonal differences in the spatial distribution of bottlenose dolphins in coastal waters. North of Cape Lookout, North Carolina, bottlenose dolphins were observed along the North Carolina coast and as far north as Long Island, New York during summer months (CETAP 1982, Kenney 1990, Garrison *et al.* 2003). During winter months, bottlenose dolphins are rarely observed north of the North Carolina-Virginia border, and their northern distribution appears to be limited by water temperatures $< 9.5\text{ }^{\circ}\text{C}$ (Garrison *et al.* 2003; Kenney 1990). Bottlenose dolphin densities are highest during winter months along the North Carolina coast south of Cape Hatteras (Garrison *et al.* 2003; Torres *et al.* 2005). Seasonal variation in the densities

of animals observed off Virginia Beach, Virginia also indicates the seasonal migration of dolphins northward during summer months and then south during winter (Barco and Swingle 1996). Four dolphins tagged during 2003 and 2004 off the coast of New Jersey in late summer moved south to North Carolina and inhabited waters near and just south of Cape Hatteras during winter months. These animals then moved north to New Jersey again during the following summer (NMFS, Southeast Fisheries Science Center, unpublished data). Similarly, dolphins tagged off Virginia Beach, Virginia during the late summer occupied the area between Cape Hatteras and Cape Lookout during winter months (NMFS 2001). There is no evidence suggesting that these animals moved farther south than Cape Lookout during winter months, and there are genetic differences between animals sampled in North Carolina and areas further south (NMFS 2001). In addition, there are no matches in long term photo-identification studies between sites in New Jersey and those south of Cape Hatteras (Urian *et al.* 1999; NMFS 2001). These studies are the basis for the definition of the Northern Migratory stock in this and previous stock assessment reports.

Satellite tag telemetry studies also provide evidence for a stock of dolphins migrating seasonally along the coast between North Carolina and northern Florida. Two dolphins were tagged during November just south of Cape Fear, North Carolina. One of these animals remained along the South Carolina and southern North Carolina coasts throughout the winter while the other migrated south to northern Florida through February. In the spring, these animals moved farther north of the tagging site to Cape Hatteras. The tags did not last beyond June, and therefore the distribution of these animals during summer months is unknown (NMFS, Southeast Fisheries Science Center, unpublished data). However, there are no available genetic data to test conclusively whether or not this migrating group represents a distinct stock. Available data do demonstrate significant genetic differences between animals sampled off southern North Carolina during summer months and groups both farther north (i.e., Northern Migratory animals) and farther south. Given the observed migration patterns, a prospective Southern Migratory stock of coastal bottlenose dolphins moving between North Carolina in the summer and along the south Atlantic coast during the winter is defined.

In addition to these two migrating coastal stocks, there is evidence for coastal resident stocks. In North Carolina, additional satellite telemetry studies and movements of tracked freeze-branded animals demonstrate that some animals occurring in coastal waters do not migrate and instead reside along the North Carolina coast or in Pamlico Sound year-round (NMFS 2001). Photo-identification studies at multiple sites in North Carolina indicate frequent exchange of animals between Beaufort, North Carolina (Cape Lookout) and Wilmington, North Carolina (Cape Fear, Urian *et al.* 1999). However, there was little exchange of animals between southern North Carolina (i.e., south of Cape Lookout) and northern North Carolina or points further north (Urian *et al.* 1999, NMFS 2001). In addition, genetic analyses of samples from northern Florida, Georgia, central South Carolina (primarily the estuaries around Charleston), and southern North Carolina using both mitochondrial DNA and nuclear microsatellite markers indicate significant genetic differences between these areas (NMFS 2001). As a result, the previously defined Southern North Carolina stock is retained in this revised stock structure. There is also evidence for genetic differences between animals occupying the northern and central Florida coast (NMFS 2001). The spatial extent of these stocks, their potential seasonal movements, and their relationships with estuarine stocks are poorly understood. However, based upon the available genetic and photo-identification data, prospective stocks of coastal residents are defined.

In summary, this stock assessment report identifies seven prospective stocks of coastal morphotype bottlenose dolphins inhabiting nearshore coastal waters along the Atlantic coast (Figure 1). This prospective stock structure differs from that described in previous stock assessment reports in that 1) the Southern Migratory stock is a new identified group, 2) the previously defined summer Northern North Carolina stock is presumed to correspond primarily to the Southern Migratory stock and is redefined to exclude estuarine residents, and 3) the seasonal management unit framework of using half-year PBR values for some stocks and designating a winter mixed North Carolina management unit has been discarded. In addition, whereas the previous stock structure included estuarine residents, and incorporated available estuarine abundance estimates into N_{\min} and PBR, the revised structure does not include estuarine resident stocks. For the Central Florida, Northern Florida, Georgia, South Carolina, and Southern North Carolina stocks, the latitudinal boundaries remain the same as those in previous stock assessments and do not change seasonally (Table 1). The summertime boundaries between the Southern Migratory and Northern Migratory stocks are redefined based upon a spatial analysis described below. During winter months, the Northern Migratory stock migrates south and occupies waters along the North Carolina coast north of Cape Lookout. Available tagging and photo-identification data suggest that animals inhabiting North Carolina estuaries also move

onto the coast during winter and overlap with these Northern Migratory animals. Similarly, the Southern Migratory stock overlaps with the Northern Florida, Georgia, South Carolina, and Southern North Carolina stocks during winter months. The assignment of mortality to the appropriate stocks along the North Carolina coast during winter months remains problematic. This revised structure is provisional while additional analysis of available genetic data is conducted to confirm the separations amongst coastal resident stocks and verify distinctions between coastal and estuarine stocks. Additional field sampling will be required to adequately describe the Southern Migratory stock.

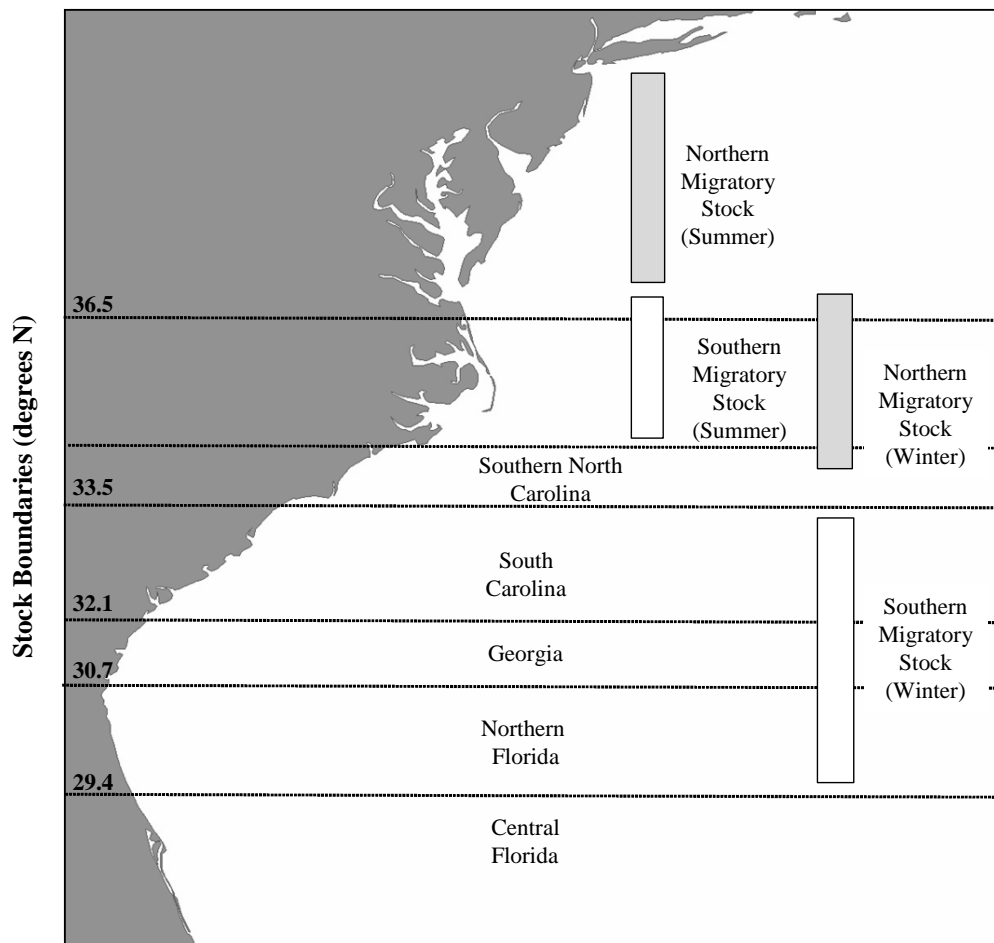


Figure 1. Seasonal distribution and spatial boundaries for prospective stocks of the coastal morphotype of bottlenose dolphin along the Atlantic coast.

POPULATION SIZE

Aerial surveys to estimate the abundance of coastal bottlenose dolphins were conducted during winter (January-February) and summer (July-August) of 2002. Survey tracklines were set perpendicular to the shoreline and included coastal waters to depths of 40 m. The surveys employed a stratified design so that most effort was expended in waters shallower than 20 m deep where a high proportion of observed bottlenose dolphins were expected to be of the coastal morphotype. Survey effort was also stratified to optimize coverage in seasonal management units. The surveys employed two observer teams operating independently on the same aircraft to estimate visibility bias.

The winter survey included the region from the Georgia/Florida state line to the southern edge of Delaware Bay. A total of 6,411 km of trackline was completed during the survey, and 185 bottlenose dolphin groups were sighted including 2,114 individual animals. No bottlenose dolphins were sighted north of Chesapeake Bay corresponding to water temperatures < 9.5 °C. During the summer survey, 6,734 km of trackline were completed between Sandy Hook, New Jersey and Ft. Pierce, Florida. All tracklines in the 0-20 m stratum were completed throughout the survey range while offshore lines were completed only as far south as the Georgia-Florida state line. A total of 185 bottlenose dolphin groups was sighted during summer including 2,544 individual animals.

In summer 2004, an additional aerial survey between central Florida and New Jersey was conducted. As with the 2002 surveys, effort was stratified into 0-20 m and 20-40 m strata with the majority of effort in the shallow depth stratum. The survey was conducted between 16 July and 31 August and covered 7,189 km of trackline. There was a total of 140 sightings of bottlenose dolphins including 3,093 individual animals. A winter survey was conducted between 30 January and 9 March, 2005 covering waters from the mouth of Chesapeake Bay through central Florida. The survey covered 5,457 km of trackline and observed 135 bottlenose dolphin groups accounting for 957 individual animals.

Abundance estimates for bottlenose dolphins in each stock were calculated using line transect methods and distance analysis (Buckland *et al.* 2001). The 2002 surveys included two teams of observers to derive a correction for visibility bias. The independent and joint estimates from the two survey teams were used to quantify the probability that animals available to the survey on the trackline were missed by the observer teams, or perception bias, using the direct duplicate estimator (Palka 1995). The resulting estimate of the probability of seeing animals on the trackline was applied to abundance estimates for the summer 2004 and winter 2005 surveys. Observed bottlenose dolphin groups were also partitioned between the coastal and offshore morphotypes based upon analysis of available biopsy samples (Garrison *et al.* 2003).

For the Central Florida, Northern Florida, Georgia, South Carolina, and Southern North Carolina stocks, the mean of the summer 2002 and 2004 abundance estimates provided the best estimate of abundance (Table 1). During winter months, these stocks overlap spatially with either the Southern Migratory or Northern Migratory stocks. There is apparent inter-annual variation in the abundance estimates and observed spatial distribution of bottlenose dolphins in this region that may indicate movements of animals in response to environmental variability. However, at this time there is no tag telemetry or genetic evidence supporting the presence of additional migratory stocks along the southern portion of the survey range. The survey abundance estimates for these stocks were stratified based upon the fixed boundaries shown in Figure 1.

The summer surveys are also the best for estimating the abundance for both the Northern and Southern Migratory stocks since they overlap least with other stocks during summer months. The Southern Migratory stock most likely occupies waters along the coast of North Carolina north of Cape Lookout during summer months. There is a resident population of animals within Pamlico Sound (e.g., Read *et al.* 2003), and some of these animals may also occur along the coast and overlap with the Southern Migratory group. However, for the purposes of this assessment, we are assuming that the majority of the animals in this area belong to the Southern Migratory stock.

An analysis of summer survey data from 1995, 2002, and 2004 demonstrated strong inter-annual variation in the spatial distribution of presumed Southern Migratory and Northern Migratory stock animals. Two groups of dolphins in each survey year were identified using a multivariate cluster analysis of sightings based on water temperature, depth, and latitude. One group ranged from Cape Lookout, North Carolina to just north of the Chesapeake Bay mouth, and one ranged farther north along the eastern shore of Virginia to New Jersey. The southern group (i.e., the Southern Migratory stock) was found in water temperatures between 26.5 and 28.0 °C, and the northern group (i.e., the Northern Migratory stock) occurred in cooler waters between 24.5 and 26.0 °C. The spatial distribution of these groups was strongly correlated with water temperatures and varied between years. During the summer of 2004, water temperatures were significantly cooler than those during 2002, and animals from both groups were distributed farther south and overlapped spatially. The best abundance estimate for these two groups is therefore from the summer 2002 survey when there was little overlap and an apparent separation between the two stocks at approximately 37.5°N latitude. This boundary is based upon the distribution of the two identified clusters of animals, and it will vary between years as a function of varying water temperatures. Abundance estimates from the summer 2002 survey were derived for these stocks by post-stratifying survey effort and sightings into the identified spatial range of the two clusters of animals (Table 1).

Table 1. Estimates of abundance and the associated CV, n_{min} , and PBR for each stock of WNA coastal bottlenose dolphins . All estimates are derived from summer aerial surveys conducted in 2002 and/or 2004 as noted in the table. The recovery factor (Fr) used to calculate PBR for each stock is based upon the CV of the mortality estimate based on the guidelines in Wade and Angliss (1997).

Stock	Abundance Summer 2002 (CV)	Abundance Summer 2004 (CV)	Best Estimate (CV)	Nmin	Recovery Factor (Fr)	PBR
Northern Migratory	7,489 (0.36)	NA ^a	7,489 (0.36)	5,582	0.5	56
Southern Migratory	10,341 (0.33)	NA ^a	10,341 (0.33)	7,889	0.5	79
Southern North Carolina	3,654 (1.11)	5,983 (0.43)	4,818 (0.50)	3,241	0.5	32
South Carolina	2,284 (0.27)	1,620 (0.56)	1,952 (0.28)	1,548	0.5	15
Georgia	6,234 (0.50)	5,759 (0.55)	5,996 (0.37)	4,434	0.5	44
Northern Florida	737 (0.47)	5,391 (0.27)	3,064 (0.24)	2,502	0.5	25
Central Florida	718 (0.51)	11,918 (0.27)	6,317 (0.26)	5,109	0.5	51

^a During the summer 2004 survey, a cluster analysis indicated a high degree of spatial overlap between these two stocks, preventing a reliable abundance estimate.

Minimum Population Estimate

The minimum population size (Nmin) for each stock was calculated as the lower bound of the 60% confidence interval for a lognormally distributed mean (Wade and Angliss 1997). Minimum population sizes for each stock are shown in Table 1.

Current Population Trend

There are insufficient data to determine the population trend for these stocks.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for the WNA coastal morphotype. The maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of the minimum population size, one-half the maximum productivity rate, and a recovery factor (Wade and Angliss 1997). This group of prospective stocks incorporates the range of the former WNA coastal migratory stock that was defined as depleted under MMPA guidelines. At least some of these stocks are likely depleted relative to their optimum sustainable population (OSP) size due both to mortality during the 1987-1988 die-off and high incidental mortality in fisheries. Given the known population structure within the coastal morphotype bottlenose dolphins, it is appropriate to apply PBR separately to each stock so as to achieve the goals of the MMPA (Table 1; Wade and Angliss 1997).

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

The primary known source of fishery mortality is the mid-Atlantic coastal gillnet fishery, which affects the Northern Migratory, Southern Migratory, and Southern North Carolina stocks. The five-year average mortality due to this fishery is currently unknown. In addition, an estimated 1 (CV = 0.36) mortalities occurred annually in the shark gillnet fisheries off the coast of Florida during 2002-2006, affecting the Central Florida management unit. Only limited observer data are available for other fisheries that may interact with WNA coastal bottlenose dolphins. Therefore, the total average annual mortality estimate is a lower bound of the actual annual human-caused mortality for each stock. Detailed fishery information is presented in Appendix III.

Earlier Interactions

Prior to 1977, there was no documentation of marine mammal bycatch in distant-water fleet (DWF) activities off the northeast coast of the U.S. A fishery observer program, which has collected fishery data and information on incidental bycatch of marine mammals, was established in 1977 with the implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA).

Stranding data for 1993-1997 document interactions between WNA coastal bottlenose dolphins and pound nets in Virginia. Two bottlenose dolphin carcasses were found entangled in the leads of pound nets in Virginia during 1993-1997, an average of 0.4 bottlenose dolphin mortalities per year. A third record of an entangled bottlenose dolphin in Virginia in 1997 may have been associated with this fishery. This entanglement involved a bottlenose dolphin carcass found near a pound net with twisted line marks consistent with the twine in the nearby pound net lead rather than with monofilament gillnet gear.

One bottlenose dolphin was recovered dead from a shrimp trawl in Georgia in 1995 (Southeast Region Marine Mammal Stranding Network, unpublished data), and another was taken in 1996 near the mouth of Winyah Bay, South Carolina, during a research survey. In August 2002 in Beaufort County, South Carolina, a fisherman self-reported a dolphin entanglement in a commercial shrimp trawl. No other bottlenose dolphin mortality or serious injury has been reported to NMFS. There has been very little systematic observer coverage of this fishery during the last decade.

The Atlantic menhaden purse seine fishery historically reported an annual incidental take of 1 to 5 bottlenose dolphins (NMFS 1991, pp. 5-73). However, no observer data are available, and this information has not been updated for some time.

Mid-Atlantic Gillnet

This fishery has the highest documented level of mortality of WNA coastal morphotype bottlenose dolphins, and the North Carolina sink gillnet fishery is its largest component in terms of fishing effort and observed takes. Of 12 observed mortalities between 1995 and 2000, 5 occurred in sets targeting spiny or smooth dogfish, 1 was in a set targeting "shark" species, 2 occurred in striped bass sets, 2 occurred in Spanish mackerel sets, and the remainder were in sets targeting kingfish, weakfish, or finfish generically (Rossman and Palka 2001). Only two bottlenose dolphin mortalities were observed in 2001-2002, and both occurred in the winter just north of the North Carolina/Virginia border. Based on the prospective stock structure described here, these mortalities are most likely from the Northern Migratory stock. Four additional mortalities were observed during summer along the North Carolina coast near Cape Hatteras: one in 2003, one in 2004, and two in 2006. These mortalities are most likely to have impacted the prospective Southern Migratory stock. The methodology for estimating total mortality is currently being revised to account for the prospective stock structure and improved understanding of the seasonal

spatial distribution of these stocks. In addition, the Bottlenose Dolphin Take Reduction Plan was implemented in May 2006, and there has been insufficient time to collect data to support mortality analyses and assess the effectiveness of the plan. Therefore, it is currently not possible to estimate total mortality from the gillnet fisheries for these prospective stocks. The mortality estimates will be updated in the 2009 stock assessment report.

Table 2. Summary of the 2002-2006 incidental mortality of bottlenose dolphins (<i>Tursiops truncatus</i>) by management unit in the commercial mid-Atlantic coastal gillnet fisheries. Data include the years sampled (Years), the number of vessels active within the fishery (Vessels), type of data used (Data Type), observer coverage (Observer Coverage), mortalities recorded by on-board observers (Observed Mortality), estimated annual mortality (Estimated Mortality), estimated CV of the annual mortality (Estimated CVs), and mean annual mortality (CV in parentheses).									
Stock	Years	Vessels	Data Type ^a	Observer Coverage ^b	Observed Serious Injury	Observed Mortality	Estimated Mortality ^d	Estimated CVs ^c	Mean Annual Mortality
Northern Migratory	2002-2006	unk	Obs. Data, NER Dealer Data	.01, .03, .03, .05, .06	0, 0, 0, 0, 0	2, 0, 0, 0, 0	unk ^e	unk ^e	unk ^e
Southern Migratory	2002-2006	unk	Obs. Data, NCDMF Dealer Data	.0, .01, .02, .02, .03	0, 0, 0, 0, 0	0, 1, 0, 1, 2	unk ^e	unk ^e	unk ^e
Southern North Carolina	2002-2006	unk	Obs. Data, NCDMF Dealer Data	0, .01, .03, .01, .04	0, 0, 0, 0, 0	0, 0, 0, 0, 0	unk ^e	unk ^e	unk ^e
Total	2002-2006								unk ^e
<p>NA=Not applicable, unk = unknown or unobserved</p> <p>a Observer data (Obs. data) are used to measure bycatch rates; the data are collected within the Northeast Fisheries Science Center (NEFSC) Sea Sampling Program. The NEFSC collects weighout landings data that are used as a measure of total effort for the sink gillnet fisheries.</p> <p>b The observer coverage for the mid-Atlantic coastal sink gillnet fishery is measured as a proportion of the tons of fish landed.</p> <p>c The annual estimates of mortality are computed by summing mortality estimates over six strata for each management unit. Stratified bycatch rates are estimated by a generalized linear model (Palka and Rossman 2001). An aggregate weighted CV is then calculated by weighting the stratified bycatch rates and variances by the proportion of observed metric tons sampled within each stratum. The CV does not account for variability that may exist in the unit of total landings (mt) from each year that are used to expand the bycatch rate.</p> <p>d From November 2000 through April 2006 only 4 coastal bottlenose dolphins mortalities have been observed in the coastal habitat ranging from New Jersey to southern North Carolina. As a result, the data were too sparse to apply to the previously defined model used to estimate bycatch rates during the 1996 - 2000 time period (Palka and Rossman 2001). A traditional stratified ratio-estimator was used to estimate bycatch mortality for the seasonal management units from winter 2001 through the winter of 2006. A NEFSC Laboratory Reference Document documenting the methods and results is expected to be available for distribution in January 2008.</p> <p>e It is currently not possible to estimate total mortality due to the revisions to the stock structure and implementation of the bottlenose dolphin take reduction plan. Mortality estimates will be updated in the 2009 SAR.</p>									

South Atlantic Shark Drift Gillnet

Observed takes of bottlenose dolphins occurred primarily during winter months when the fishery operates in waters off southern Florida. Fishery observer coverage outside of this time and area has increased significantly in the last several years, and there was one observed mortality during summer months in fishing operations off Cape Canaveral, Florida. There have been no observed interactions with bottlenose dolphins since 2003 (Carlson and Betha 2006; Garrison 2007). All observed fishery takes are restricted to the Central Florida management unit of coastal bottlenose dolphin. Total bycatch mortality has been estimated for 2002-2006 following methods described in (Garrison 2007, Table 3).

Table 3. Summary of the 2002-2006 incidental mortality of bottlenose dolphins (*Tursiops truncatus*) by stock in the shark gillnet fishery in federal waters off the coast of Florida. Data include years sampled (Years), number of vessels active within the fishery (Vessels), type of data used (Data Type), annual observer coverage (Observer Coverage), mortalities recorded by on-board observers (Observed Mortality), estimated annual mortality (Estimated Mortality), estimated CV of the annual mortality (Estimated CVs), and mean annual mortality (CV in parentheses).

Seasonal Management Unit	Years	Vessels	Data Type ^a	Observer Coverage ^b	Observed Serious Injury	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Northern Florida	2002-2006	6	Obs. Data, SEFSC FVL	0.46, 0.73, 0.22, 0, 0	0, 0, 0, NA, NA	0, 0, 0, NA, NA	0, 0, 0, 0, 0	NA	0
Central Florida	2002-2006	6	Obs. Data, SEFSC FVL	1 ^c , .34, .43, 1 ^c , 1 ^c	0, 0, 0, 0, 0	1, 2, 0, 0, 0	1 ^c , 2, 1, 0 ^c , 0 ^c	0, .64, .64, 0, 0	0.8 (.36)

unk = unknown, NA = cannot be calculated

- a Observer data are used to estimate bycatch rates. The SEFSC Fishing Vessel Logbook (FVL) is used to estimate effort as total number of reported sets per bottlenose dolphin stock.
- b Observer coverage targets 100% of sets during winter months in the Central Florida stock area. There is apparent under-reporting of effort as the number of observed drift net sets routinely exceeds the number of reported drift sets for this fishery. Coverage of the drift net fishery is much lower outside of these months and in the Northern Florida stock area. In addition, the total amount of fishing effort using drift nets targeting sharks is unknown as fishermen do not report the type of gillnet set and boats fish using drift, strike, and sink nets during the same seasons (Garrison 2007)
- c The number of observed drift sets exceeded the number of reported sets, therefore the observed mortality is presumed to be the total mortality.

Beach Haul Seine

Two coastal bottlenose dolphin takes were observed in the mid-Atlantic beach haul seine fishery: 1 in May 1998 and 1 in December 2000.

Crab Pots

Between 1994 and 1998, 22 bottlenose dolphin carcasses (4.4 dolphins per year on average) recovered by the Stranding Network between North Carolina and Florida's Atlantic coast displayed evidence of possible interaction with a trap/pot fishery (i.e., rope and/or pots attached, or rope marks). Additionally, at least 5 dolphins were reported to be released alive (condition unknown) from blue crab traps/pots during this time period. During 2003, 2 bottlenose dolphins were observed entangled in crab pot lines in South Carolina, including 1 confirmed mortality, and 2 bottlenose dolphins were disentangled alive from crab pots in Virginia. In 2004, the SER stranding network reported observing 3 bottlenose dolphins (including one mortality) entangled in crab pot lines in Florida, one in Georgia, and three in South Carolina. In 2005, one entanglement was observed in Florida, one in Georgia, and one in Virginia. With the exception of the mortality in Florida during 2004, all animals were released from entangling gear and were not described to be seriously injured (SER Stranding Network). Three bottlenose dolphins were observed entangled in crab pot gear during 2006. Two occurred in South Carolina and were released alive, while one mortality occurred near Cape Canaveral, Florida. A review of stranding network data from South Carolina between 1992 and 2003 indicated that 24% of known bottlenose dolphin entanglements could be confirmed as

involving crab pots, and an additional 19% of known entanglements were probable interactions with crab pots (Burdett and McFee 2004). Since there is no systematic observer program, it is not possible to estimate the total number of interactions or mortalities associated with crab pots. However, it is clear that this interaction is a common occurrence and does result in mortalities of coastal morphotype bottlenose dolphins.

In addition to blue crab pots, there have been four documented interactions with pot fisheries in southern Florida. These include two interactions (one in 2003, one in 2006) with stone crab pots near Miami, FL and two interactions (one in 2003 and one in 2006) with spiny lobster traps also off Miami and the Florida Keys. One of these interactions (with a stone crab pot) resulted in a mortality.

Virginia Pound Nets

Stranding data for 2002-2006 indicate interactions between coastal bottlenose dolphins and pound nets in Virginia. Twenty dolphins were removed dead from pound nets and 5 were disentangled and released alive. This includes three mortalities observed during 2006. Additionally, 17 animals stranded with twisted twine line marks consistent with nearby pound net leaders (SER Stranding Network)

Other Mortality

There have been occasional mortalities of bottlenose dolphins during research activities including both directed live capture studies and fisheries surveys. In March 2002, a dolphin was entangled in the lazy line of a turtle relocation trawl off Bogue Banks, North Carolina. In August 2002, a dolphin died during a fisheries research project using a trammel net in South Carolina (NMFS Protected Resources Division). Similarly, in March and November 2004, three dolphin mortalities occurred, including a mother-calf pair, during a fisheries research project using a trammel net in Georgia (SER Stranding Network). During 2004, one female bottlenose dolphin died during a health assessment capture study in Charleston, South Carolina (NMFS Protected Resources Division). In July and October 2006, two mortalities occurred during a fisheries research project using trawl gear in South Carolina and North Carolina (SER Stranding Network). Two bottlenose dolphins tagged with an experimental transmitter package deployed during a NMFS research program in North Carolina died within several weeks of tagging during spring 2006 (NMFS Protected Resources Division). Finally, two bottlenose dolphins were killed in research trawls conducted by the South Carolina Department of Natural resources during 2006: one in July near Beaufort County, South Carolina and one in October off Brunswick City, North Carolina. All mortalities from known sources including commercial fisheries and research related mortalities for each provisional stock are summarized in Table 4.

The nearshore and estuarine habitats occupied by the coastal morphotype are adjacent to areas of high human population and some are highly industrialized. The blubber of stranded dolphins examined during the 1987-88 mortality event contained very high concentrations of organic pollutants (Kuehl *et al.* 1991). More recent studies have examined persistent organic pollutant concentrations in bottlenose dolphin tissues from several estuaries along the Atlantic coast and have likewise found evidence of high blubber concentrations particularly near Charleston, South Carolina and Beaufort, North Carolina (Hansen *et al.* 2004). The concentrations found in male dolphins from both of these sites exceeded toxic threshold values that may result in adverse effects on health or reproductive rates (Schwacke *et al.* 2002; Hansen *et al.* 2004). Studies of contaminant concentrations relative to life history parameters showed higher levels of mortality in first-born offspring and higher contaminant concentrations in these calves and in primiparous females (Wells *et al.* 2005). While there are no direct measurements of adverse effects of pollutants on estuarine dolphins, the exposure to environmental pollutants and subsequent effects on population health is an area of concern and active research.

Table 4. Total estimated mortalities from known sources for each prospective stock. The annual mean of estimated mortalities from commercial fisheries with observer programs (mid-Atlantic gillnet [Table 2] and shark gillnet [Table 3]) are shown. For other mortalities with known sources (Crab Pot, Virginia Pound Net, and Research Takes) the mortalities are direct observations, and hence underestimate the true total mortality from these sources. Dashes indicate that the fishery or mortality source does not occur within the region of the effected stock.									
Stock	Years	Mid-Atlantic Gillnet ^a	Shark Gillnet	Va. Pound Net	Crab Pot	Marine Mammal Research ^b	Other Research ^b	Annual Totals	5-year Annual Average
Northern Migratory	2002-2006	unk	-	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	unk	unk
Southern Migratory		unk	-	1, 3, 5, 4, 3	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	unk	unk
Southern North Carolina		unk	-	-	0, 0, 0, 0, 0	0, 0, 0, 0, 2	1, 0, 0, 0, 1	unk	unk
South Carolina		-	-	-	0, 1, 0, 0, 0	0, 0, 1, 0, 0	1, 0, 0, 0, 1	1, 1, 1, 0, 1	0.8
Georgia		-	0	-	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 3, 0, 0	0, 0, 3, 0, 0	0.6
Northern Florida		-	0	-	0, 0, 1, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0
Central Florida		-	1, 2, 0, 1, 0	-	0, 0, 0, 0, 1	0, 0, 0, 0, 0	0, 0, 0, 0, 0	1, 2, 1, 0, 1	0.8
^a As noted in Table 2, the Mid-Atlantic gillnet mortality cannot be estimated at this time due to changes in the stock structure and the implementation of the BDTRP. Mortality estimates will be updated in the 2009 SAR.									
^b Marine mammal research includes both live capture and tagging studies permitted under an MMPA research permit. Other research includes fisheries research trammel netting and trawls and turtle relocation trawling operations.									

Strandings

From 2002 to 2006, 1,570 bottlenose dolphins stranded along the Atlantic coast from New York to Florida (Table 5, Northeast Regional Marine Mammal Stranding Network, Southeast Regional Marine Mammal Stranding Network). Of these, it was possible to determine whether or not a human interaction had occurred for 715 (46%). For the remainder, it was not possible to make that determination. Of those cases where an evaluation was possible, 32% of the carcasses had evidence of fisheries interaction; however, it should be noted that this was not necessarily the cause of death. The highest numbers of stranded animals with evidence of fisheries interactions were observed in Virginia, North Carolina, and Florida. Stranded carcasses are not routinely identified to either the offshore or coastal morphotype of bottlenose dolphin, and it is therefore possible that some of the reported strandings were of the offshore form.

Table 5. Summary of bottlenose dolphins stranded along the Atlantic Coast . Total Stranded is separated into cases with with line or nets marks (Fishery Interaction), other indications of human interactions, no apparent human interaction, or where a determination could not be made (CBD).

	2002	2003	2004	2005	2006
New York – Total Stranded	1	2	0	0	6
--Fishery Interaction	0	0	0	0	0
--Other Human Interaction	0	0	0	0	0
--No Human Interaction	0	1	0	0	3
--CBD	1	1	0	0	3
New Jersey – Total Stranded	11	7	15	13	14
--Fishery Interaction	1	1	1	0	1
--Other Human Interaction	1	0	1	0	2
--No Human Interaction	4	5	11	7	9
--CBD	5	1	2	6	2
Delaware – Total Stranded	13	18	16	9	10
--Fishery Interaction	1	1	1	1	1
--Other Human Interaction	0	0	0	0	1
--No Human Interaction	8	13	11	1	0
--CBD	4	4	4	7	8
Maryland – Total Stranded	5	10	10	4	11
--Fishery Interaction	0	1	1	1	2
--Other Human Interaction	0	0	0	0	0
--No Human Interaction	2	8	6	0	3
--CBD	3	1	3	3	6
Virginia – Total Stranded	67	60	75	60	63
--Fishery Interaction	15	25	22	13	17
--Other Human Interaction	6	0	2	0	0
--No Human Interaction	7	12	13	20	4
--CBD	39	23	38	27	42
North Carolina – Total Stranded	92	69	89	78	66
--Fishery Interaction	13	11	15	9	6
--Other Human Interaction	2	0	1	3	1
--No Human Interaction	15	16	22	14	15
--CBD	62	42	51	52	44
South Carolina – Total Stranded	28	35	46	38	39
--Fishery Interaction	4	3	3	5	5
--Other Human Interaction	0	0	3	0	1
--No Human Interaction	13	17	22	17	12
--CBD	11	15	18	16	21
Georgia – Total Stranded	11	17	27	14	23
--Fishery Interaction	0	0	3	2	2
--Other Human Interaction	0	0	1	0	0
--No Human Interaction	0	2	9	2	4
--CBD	11	15	14	10	17
Florida – Total Stranded	82	74	81	68	93
--Fishery Interaction	8	11	7	6	8
--Other Human Interaction	2	0	2	2	6
--No Human Interaction	50	21	27	14	11
--CBD	22	42	45	46	68
TOTAL	310	292	359	284	325

STATUS OF STOCKS

The coastal migratory stock was designated as depleted under the MMPA. From 1995 to 2001, NMFS recognized only a single migratory stock of coastal bottlenose dolphins in the WNA, and the entire stock was listed as depleted. This stock structure was revised in 2002 to recognize both multiple stocks and seasonal management units. The prospective stocks described here replace these management units. This prospective stock structure continues to be evaluated using available data and will be finalized when these analyses are complete. It should be noted that the impacts of entanglements with crab pots in Georgia and South Carolina and the total mortality associated with pound nets in Virginia are unknown. Likewise, the total mortality in the mid-Atlantic gillnet fishery is currently unknown pending collection of additional data and analysis. Thus, evaluation of mortality for these stocks will not be available until the next stock assessment report. The total U.S. fishery-related mortality and serious injury for the Northern Migratory and Southern Migratory stocks likely is not less than 10% of the calculated PBR, and thus cannot be considered to be insignificant and approaching zero mortality and serious injury rate. Since one or more of the stocks may be depleted, all stocks retain the depleted designation. The species is not listed as threatened or endangered under the Endangered Species Act, but these are strategic stocks due to the depleted listing under the MMPA.

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