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BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*): Western North Atlantic Northern Migratory Coastal Stock

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 (Rosel *et al.* 2009; 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 1987-1988 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 (Rosel *et al.* 2009; 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 and Potter 1995; Rosel *et al.* 2009). Aerial surveys conducted between 1978 and 1982 (CETAP 1982) north of Cape Hatteras, North Carolina, identified 2 concentrations of bottlenose dolphins, 1 inshore of the 25-m isobath and the other offshore of the 50m 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).

To address the question of distribution of coastal and offshore morphotypes in waters south of Cape Hatteras, tissue samples were collected from large vessel surveys during the summers of 1998 and 1999, from systematic biopsy sampling efforts in nearshore waters from New Jersey to central Florida conducted in the summers of 2001 and 2002, and from winter biopsy collection effort in 2002 and 2003 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 2 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 2 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 2 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, 1 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 2 morphotypes. Samples collected in Georgia waters also indicated significant overlap between the 2 morphotypes with a declining probability of the coastal morphotype with increasing depth. A coastal morphotype sample was collected 112 km from shore at 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 2 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

In addition to inhabiting coastal nearshore waters, the coastal morphotype of bottlenose dolphin also inhabits inshore estuarine waters along the U.S. east coast and Gulf of Mexico (Wells *et al.* 1987; Wells *et al.* 1996; Scott *et al.* 1990; Weller 1998; Zolman 2002; Speakman *et al.* 2006; Stolen *et al.* 2007; Balmer *et al.* 2008; Mazzoil *et al.* 2008). 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 (photo-ID) 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; 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-term photo-ID study, and this study identified year-round resident dolphins repeatedly observed across multiple years (Stolen *et al.* 2007; Mazzoil *et al.* 2008).

A few published studies demonstrate that these resident animals are genetically distinct from animals in nearby coastal waters; a study conducted near Jacksonville, Florida, demonstrated significant genetic differences between animals in nearshore coastal waters and estuarine waters (Caldwell 2001; Rosel *et al*. 2009) and animals resident in the Charleston Estuarine System show significant genetic differentiation from animals biopsied in coastal waters of southern Georgia (Rosel *et al*. 2009). In addition, stable isotope ratios of ^{18}O relative to ^{16}O (referred to as depleted ^{18}O or depleted oxygen) in animals sampled along the Outer Banks of North Carolina between Cape Hatteras and Bogue Inlet during February and March were very low (Cortese 2000). One explanation for this depleted oxygen signature is that a resident group of dolphins in Pamlico Sound moves into nearby nearshore areas in the winter.

Despite evidence for genetic differentiation between estuarine and nearshore populations, the degree of spatial overlap between these populations remains unclear. Photo-ID 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 the Northern Migratory Coastal Stock

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 (Rosel *et al.* 2009), photo-ID (Zolman 2002), and satellite telemetry (Southeast Fisheries Science Center, unpublished data) data demonstrate a complex mosaic of coastal bottlenose dolphin stocks. Integrated analysis of these multiple lines of evidence suggests that there are 5 coastal stocks of bottlenose dolphins: the Northern Migratory and Southern Migratory stocks, a South Carolina/Georgia Coastal stock, a Northern Florida Coastal stock and a Central Florida Coastal stock.

Among the coastal stocks, the migratory movements and spatial distribution of the Northern Migratory stock are the best understood based on aerial survey data, tag-telemetry studies, photo-ID data and genetic studies. Bottlenose dolphins occur 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 < 9.5ºC (Garrison *et al.* 2003). 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 (SEFSC, 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 (NMFS 2001).

In addition, there are no matches in long term photo-ID studies between sites in New Jersey and those south of Cape Hatteras (Urian *et al.* 1999; NMFS 2001). Genetic analyses also indicated significant differentiation between bottlenose dolphins occupying coastal waters from the North Carolina/Virginia border to New Jersey during summer months and those in southern North Carolina and further south (NMFS 2001; Rosel *et al.* 2009). There was a lack of differentiation in nuclear microsatellite genetic data between animals from Virginia and north and those in southern North Carolina. This is consistent with some degree of seasonal spatial overlap between the Northern Migratory stock and other stocks occupying coastal waters of North Carolina (Rosel *et al.* 2009).

The available data strongly supports the presence of a distinct Northern Migratory stock. However, this stock does overlap spatially with other distinct groups of coastal bottlenose dolphins. During summer months, the degree of overlap with the Southern Migratory stock in coastal waters of northern North Carolina and Virginia is unknown. During winter months, the Northern Migratory stock moves southward to waters from Cape Lookout, North Carolina, to north of Cape Hatteras, North Carolina, based upon tag-telemetry studies. The stock overlaps spatially with the Northern North Carolina Estuarine System stock during this period. These complex seasonal spatial movements and the overlap of coastal and estuarine stocks in the waters of North Carolina greatly limit the ability to fully assess the mortality of each of these stocks.

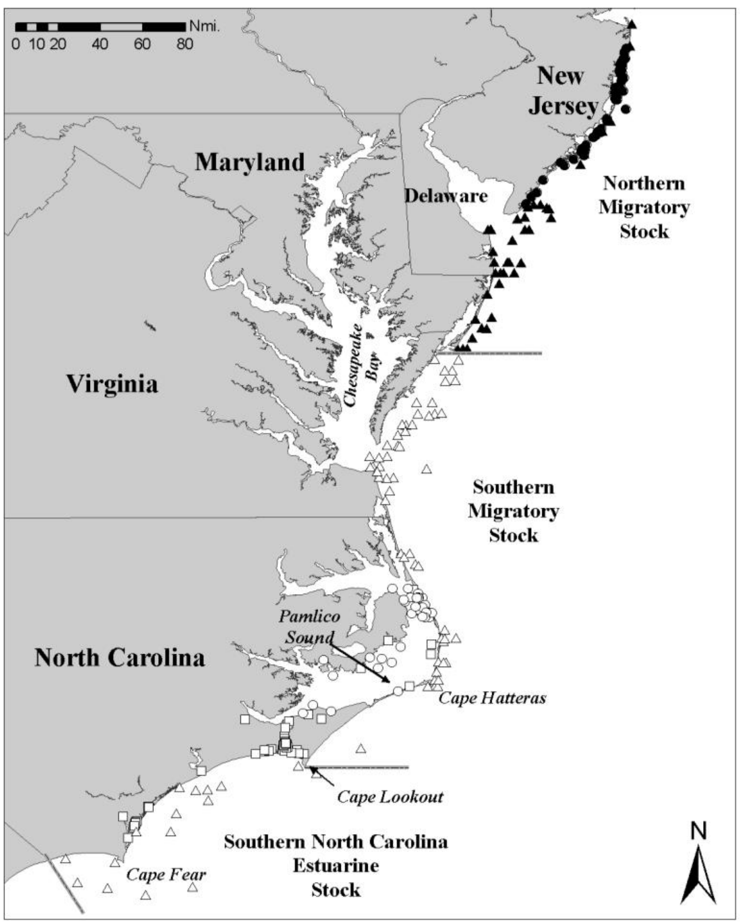

Figure 1. *The summer (July-September) distribution of bottlenose dolphin stocks occupying coastal waters from North Carolina to New Jersey. Locations are shown from aerial surveys (triangles), satellite telemetry (circles), and photo-ID studies (squares). Sightings assigned to the Northern Migratory stock are shown with filled symbols. Photo-ID data are courtesy of Duke University and the University of North Carolina at Wilmington.*

In summary, spatial distribution data, tag-telemetry studies, photo-ID studies and genetic studies demonstrate the existence of a distinct Northern Migratory stock of coastal bottlenose dolphins. During summer months (July-September), this stock occupies coastal waters from the shoreline to approximately the 25m isobath between the Chesapeake Bay mouth and Long Island, New York (Figure 1). During winter months (January-March), the stock moves south to waters of North Carolina and occupies coastal waters from Cape Lookout, North Carolina, to the North Carolina/Virginia border.

POPULATION SIZE

Aerial surveys to estimate the abundance of coastal bottlenose dolphins in the Atlantic 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 2 observer teams operating independently on the same aircraft to estimate visibility bias.

The winter 2002 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 < 9.5ºC. 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 were 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 were 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 the Northern Migratory stock were calculated using line transect methods and distance analysis (Buckland *et al.* 2001). The 2002 surveys included 2 teams of observers to derive a correction for visibility bias. The independent and joint estimates from the 2 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 region north of Cape Hatteras, North Carolina, there was complete separation between the coastal and offshore morphotypes, with only coastal animals occupying waters < 20 m deep. Therefore, all animals observed in the 0-20 m depth stratum during surveys of this region were assigned to the coastal morphotype (Garrison *et al.* 2003).

The summer surveys are best for estimating the abundance for both the Northern and Southern Migratory stocks since they overlap least with other stocks during summer months. 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 1 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. Very few bottlenose dolphins were observed in waters north of Virginia during the summer 2004 survey.

The best abundance estimate for the Northern Migratory stock is therefore from the summer 2002 survey when there was little overlap and an apparent separation from the Southern Migratory stock at approximately 37.5°N latitude. This boundary is based upon the distribution of the 2 identified clusters of animals, and it likely varies 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 2 clusters of animals (Figure 1). The resulting best abundance estimate for the Northern Migratory stock is 9,604 (CV=0.36).

Minimum Population Estimate

The minimum population size (Nmin) was calculated as the lower bound of the 60% confidence interval for a lognormally distributed mean (Wade and Angliss 1997). The best estimate for the Northern Migratory Coastal stock of bottlenose dolphins is 9,604 (CV=0.36). The resulting minimum population estimate is 7,147.

Current Population Trend

There are insufficient data to determine the population trends for this stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for the Northern Migratory stock. 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 (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size of the Northern Migratory Coastal stock of bottlenose dolphins is 7,147. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP), is assumed to be 0.5 because this stock is depleted. PBR for this stock of bottlenose dolphins is 71.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

This stock has the potential to interact with the following Category I and II fisheries: (1) mid-Atlantic gillnet; (2) Virginia pound net; (3) mid-Atlantic menhaden; (4) Atlantic blue crab trap/pot, and (5) mid-Atlantic beach/haul seine. The primary known source of fishery mortality is the mid-Atlantic coastal gillnet fishery, which affects the Northern Migratory, Southern Migratory, Northern North Carolina Estuarine System and Southern North Carolina Estuarine System stocks of bottlenose dolphin. At certain times of year, it is not possible to definitively assign mortalities observed in that fishery to a specific stock because of the overlap amongst the 4 stocks around North Carolina. Additional fishery interactions have been reported in Virginia pound nets, beach-based gillnet gear, and blue crab or other pot gear. However, none of these fisheries has systematic federal observer coverage, which prevents the estimation of total takes. 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. The total estimated average annual fishery mortality of the Northern Migratory stock ranges between a minimum of 5.92 and a maximum of 8.22 animals per year. This range reflects the uncertainty in assigning observed or reported mortalities to a particular stock.

Earlier Interactions

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 coastal morphotype bottlenose dolphins, and the sink gillnet gear in North Carolina 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). From 2001-2008, 7 additional bottlenose dolphin mortalities were observed in the mid-Atlantic gillnet fishery. Three mortalities were observed in 2001 with 1 occurring off of northern North Carolina during April and 2 occurring off of Virginia during November. Four additional mortalities were observed along the North Carolina coast near Cape Hatteras: 1 in May 2003, 1 in September 2005, 1 in September 2006 and 1 in October 2006. Because the Northern Migratory, Southern Migratory, Northern North Carolina Estuarine System and Southern North Carolina Estuarine System bottlenose dolphin stocks all occur in waters off of North Carolina, it is not possible to definitively assign all observed mortalities, or extrapolated bycatch estimates, to a specific stock. In addition, the Bottlenose Dolphin Take

Reduction Plan (BDTRP) was implemented in May 2006 resulting in changes in the gear configurations and other characteristics of the fishery.

To estimate the mortality of bottlenose dolphins in the mid-Atlantic gillnet fishery, the available data were divided into the period from 2002 through April 2006 (pre-BDTRP) and from May 2006-2008 (post-BDTRP). Three alternative approaches were used to estimate bycatch rates. First, a generalized linear model (GLM) approach was used similar to that described in Rossman and Palka (2001). This approach included all observed mortalities from 1995-2008 where the fishing gear was still in use during the period from 2002-2008. Second, a simple ratio estimator of catch per unit effort (CPUE = observed catch / observed effort) was used based directly upon the observed data. Finally, a ratio estimator pooled across years was used to estimate different CPUE values for the pre-BDTRP and post-BDTRP periods. In each case, the annual reported fishery effort (represented as reported landings) was multiplied by the estimated bycatch rate to develop annual estimates of fishery-related mortality, again similar to the approach in Rossman and Palka (2001). To account for the uncertainty in the most appropriate of these 3 alternative approaches, the average of the 3 model estimates (and the associated uncertainty) are used to estimate the mortality of bottlenose dolphins for this fishery (Table 1).

Table 1. Summary of the 2002-2008 incidental mortality of bottlenose dolphins (*Tursiops truncatus truncatus*) in the Northern Migratory stock in the commercial mid-Atlantic gillnet fisheries. The estimated annual and average mortality estimates are shown for the period prior to the implementation of the Bottlenose Dolphin Take Reduction Plan (pre-BDTRP) and after the implementation of the plan (post-BDTRP). Three alternative modeling approaches were used, and the average of the 3 was used to represent mortality estimates. The minimum and maximum estimates indicate the range of uncertainty in assigning observed bycatch to stock. Observer coverage is measured as a proportion of reported landings (tons of fish landed). Data are derived from the Northeast Observer program, NER dealer data, VMRC landings and NCDMF dealer data. Values in parentheses indicated the CV of the estimate.

Period	Year	Observer Coverage[a]	Min Annual Ratio	Min Pooled Ratio	Min GLM	Max Annual Ratio	Max Pooled Ratio	Max GLM
pre-BDTRP	2002	0.01	0	0	24.75 (0.34)	0	0	27.87 (0.33)
	2003	0.01	0	0	11.77 (0.36)	0	0	19.98 (0.30)
	2004	0.02	0	0	14.57 (0.35)	0	0	21.83 (0.33)
	2005	0.03	0	0	14.67 (0.39)	0	0	19.55 (0.32)
	Jan-Apr 2006	0.03	0	0	5.92 (0.37)	0	0	6.50 (0.37)
Annual Avg. pre-BDTRP			Minimum: 4.78 (CV=0.17)			Maximum: 6.38 (CV=0.15)		
post-BDTRP	May-Dec 2006	0.03	0	0	7.99 (0.30)	0	0	9.07 (0.29)
	2007	0.03	0	0	20.66 (0.31)	0	0	24.51 (0.31)
	2008	0.01	0	0	18.75 (0.31)	0	0	20.61 (0.31)
Annual Avg. post-BDTRP			Minimum: 5.27 (CV=0.19)			Maximum: 6.02 (CV=0.19)		

[a] Observer coverage is reported on an annual basis for the entire fishery as a proportion of the reported tons of fish landed.

There have been no observed mortalities in the mid-Atlantic gillnet fishery since 2001 that could potentially be assigned to the Northern Migratory stock. Hence, both the annual and pooled ratio estimators of bycatch rate were equal to zero in both the pre-BDTRP and post-BDTRP periods. Since the GLM approach includes information from prior to 2002, positive bycatch rates for the Northern Migratory stock were estimated (Table 1). Since observed mortalities (and effort) cannot be definitively assigned to a particular stock within certain regions and times of year, the minimum and maximum possible mortality of the Northern Migratory stock are presented for comparison to PBR (Table 1).

Based upon these analyses, the minimum mortality estimate for the Northern Migratory stock for the pre-BDTRP period was 4.78 (CV=0.17) animals per year, and that for the post-BDTRP period was 5.27 (CV=0.19) animals per year. The maximum estimates were 6.38 (CV=0.15) for the pre-BDTRP period and 6.02 (CV=0.19) for the post-BDTRP period (Table 1).

Beach Haul Seine/Beach-based Gillnet Gear

Two coastal bottlenose dolphin takes were observed in beach haul seine gear: 1 in May 1998 and 1 in December 2000. These takes occurred during a striped bass fishery within the spatial and seasonal range of the Northern Migratory stock. Beach-based gillnet gear is now considered part of the Mid-Atlantic gillnet fishery described above; however, it is not included in the observer program or resulting mortality estimates. Data from the Southeast Region Stranding Network from 2002-2008 include 2 confirmed reports of bottlenose dolphin mortalities in beach-based gillnet gear for striped bass during winter months off the coast of northern North Carolina: 1 in December 2002 and 1 in January 2008. A third possible mortality associated with this gear occurred during December 2002 (Southeast Regional Marine Mammal Stranding Network; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009). Based upon their location and time of year, these mortalities were most likely animals from the Northern Migratory stock.

Crab Pots and Other Pots

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 interactions with pot gear are a common occurrence and result in mortalities of coastal morphotype bottlenose dolphins in some regions (Burdett and McFee 2004). Southeast Regional Marine Mammal Stranding Network data (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009) from 2004 through 2008 include 13 reports of interactions between bottlenose dolphins and confirmed blue crab pot gear with the majority of these occurring in waters from Florida to South Carolina. In addition, there were 4 interactions documented with pot gear where the fishery could not be confirmed. In these cases, the gear was confirmed to be associated with a pot or trap, but may have been from a fishery other than blue crab (e.g., whelk fisheries in Virginia). None of these confirmed mortalities could be assigned to the Northern Migratory stock.

Virginia Pound Nets

Historical and recent stranding network data report interactions between bottlenose dolphins and pound nets in Virginia. Stranding data for 2004-2008 indicate 17 cases where bottlenose dolphins were removed from pound net gear, and it was determined that animals were entangled pre-mortem. In each case, the bottlenose dolphin was recovered directly from the fishing gear. Of these 17 cases, 14 were documented mortalities while 3 were released alive (S. Barco, Virginia Aquarium, unpublished data; Northeast Regional Marine Mammal Stranding Network; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009). These interactions occurred primarily inside estuarine waters near the mouth of the Chesapeake Bay and in summer months. Five of these mortalities occurred during May and June when they could have impacted either the Northern Migratory or Southern Migratory stocks.

Other Mortality

There have been occasional mortalities of bottlenose dolphins during research activities including both directed live capture studies, turtle relocation trawls, and fisheries surveys. From 2002-2008, there have been 15 reported interactions during these activities resulting in 13 documented mortalities of bottlenose dolphins. One mortality in a research beach seine was reported from June 2007 in Northern North Carolina that was consistent with the spatial range of the Northern Migratory stock, the Southern Migratory stock, or the Northern North Carolina Estuarine System stock. All mortalities from known sources including commercial fisheries and research related mortalities for the stock are summarized in Table 2.

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 1987-1988 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 in estuaries near Charleston, South Carolina, and Beaufort, North Carolina (Hansen *et al.* 2004), and in portions of Biscayne Bay, Florida (Litz *et al.* 2007). 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 and little study of contaminant loads in migrating coastal dolphins, the exposure to environmental pollutants and subsequent effects on population health is an area of concern and active research.

Table 2. Summary of annual reported and estimated mortality of bottlenose dolphins from the Northern Migratory stock. Where minimum and maximum values are reported, there is uncertainty in the assignment of mortalities to this particular stock due to spatial overlap with other bottlenose dolphin stocks in certain areas and seasons. The reported mortalities in Virginia pound net, beach-based gillnet and crab pot fisheries are confirmed reports and are likely an underestimate of total mortalities in these fisheries.

Year	**Mid-Atlantic Gillnet**	**Virginia Pound Net**	**Beach-based Gillnet Gear**	**Blue Crab Pot**	**Other Pot**	**Fishery Research**	**Total**
2004	Min = 4.9 Max = 7.3	Min = 0 Max = 3	0	0	0	0	Min = 4.9 Max = 10.3
2005	Min = 4.9 Max = 6.5	0	0	0	0	0	Min = 4.9 Max = 6.5
2006	Min = 4.6 Max = 5.2	0	0	0	0	0	Min = 4.6 Max = 5.2
2007	Min = 6.9 Max = 8.2	Min = 0 Max = 2	0	0	0	Min = 0 Max = 1	Min = 6.9 Max = 11.2
2008	Min = 6.3 Max = 6.9	0	1	0	0	0	Min = 7.3 Max = 7.9
Annual Average Mortality (2004-2008)				Minimum Estimated = 5.92 Maximum Estimated = 8.22			

Strandings

Between 2004 and 2008, 484 bottlenose dolphins stranded along the Atlantic coast between North Carolina and New York that could be assigned to the Northern Migratory stock (Table 3; Northeast Regional Marine Mammal Stranding Network; Southeast Regional Marine Mammal Stranding Network; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009). The assignment of animals to a particular stock is impossible in some seasons and regions, particularly in North Carolina, Virginia and Maryland. Therefore, it is likely that the counts below include some animals from either the Southern Migratory or Northern North Carolina Estuarine System stocks. In addition, stranded carcasses are not routinely identified to either the offshore or coastal morphotype of bottlenose dolphin, therefore it is possible that some of the reported strandings were of the offshore form. In most cases, it was not possible to determine if a human interaction had occurred due to the decomposition state of the stranded animal. However, in cases where a determination could be made, the incidence of evidence of fisheries interactions was high, particularly in Virginia and North Carolina where the percentages of stranded animals with evidence of fisheries interaction were 57% and 45% respectively when a determination could be made. It should be recognized that evidence of human interaction does not indicate cause of death, but rather only that there was evidence of interaction with a fishery (e.g., line marks, net marks) or evidence of a boat strike, gunshot wound, mutilation, etc., at some point in the animal's life. Evidence of fishery interaction is by far the most common type of human interaction reported.

Table 3. Strandings of bottlenose dolphins from North Carolina to New York that can possibly be assigned to the Northern Migratory stock. Assignments to stock were based upon the understanding of the seasonal movements of this stock. However, in waters of North Carolina, Virginia and Maryland there is likely overlap with other stocks during particular times of year. HI = Evidence of Human Interaction, CBD = Cannot Be Determined whether an HI occurred or not. NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009.

State	2004			2005			2006			2007			2008		
Type	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD
North Carolina[a]	5	2	16	0	2	17	0	3	11	2	2	16	2	2	9
Virginia[b]	15	12	32	9	16	17	10	1	30	6	4	22	9	4	43
Maryland[b]	1	4	3	1	0	1	2	3	6	1	2	6	2	0	1
Delaware	1	11	4	1	1	7	2	0	8	0	0	13	0	0	3
New Jersey	2	11	2	0	7	6	3	9	3	3	5	3	0	8	3
New York	0	0	0	0	0	0	0	4	3	0	6	3	0	0	0
Annual Total	121			85			98			94			86		

[a] Strandings for North Carolina include data for November-April north of Cape Lookout when Northern Migratory animals may be in coastal waters. The stock identity of these strandings is highly uncertain and likely also includes animals from the Northern North Carolina Estuarine System stock.

[b] Strandings from Virginia and Maryland were assigned to stock based upon both location and time of year. Some of the strandings assigned to the Northern Migratory stock could possibly be assigned to the Southern Migratory stock or Northern North Carolina Estuarine System stock.

STATUS OF STOCK

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 and again in 2008 and 2009 to recognize resident estuarine stocks and migratory and resident coastal stocks. The total U.S. fishery-related mortality and serious injury for the Northern Migratory stock cannot be directly estimated because of the spatial overlap among the stocks of bottlenose dolphins that occupy waters of North Carolina. In addition, several fisheries are unobserved and the reported mortalities are minimum estimates. The total mortality is therefore unlikely to be less than 10% of the calculated PBR, and thus cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This stock retains the depleted designation as a result of its origins from the coastal migratory stock. The species is not listed as threatened or endangered under the Endangered Species Act, but this is a strategic stock due to the depleted listing under the MMPA.

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BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*): Western North Atlantic Southern Migratory Coastal Stock

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 (Rosel *et al.* 2009; 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 1987-1988 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 (Rosel *et al.* 2009; 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 and Potter 1995; Rosel *et al.* 2009). Aerial surveys conducted between 1978 and 1982 (CETAP 1982) north of Cape Hatteras, North Carolina, identified 2 concentrations of bottlenose dolphins, 1 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).

To address the question of distribution of coastal and offshore morphotypes in waters south of Cape Hatteras, tissue samples were collected from large vessel surveys during the summers of 1998 and 1999, from systematic biopsy sampling efforts in nearshore waters from New Jersey to central Florida conducted in the summers of 2001 and 2002, and from winter biopsy collection effort in 2002 and 2003 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 2 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 2 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 2 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, 1 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 2 morphotypes. Samples collected in Georgia waters also indicated significant overlap between the 2 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 2 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

In addition to inhabiting coastal nearshore waters, the coastal morphotype of bottlenose dolphin also inhabits inshore estuarine waters along the U.S. east coast and Gulf of Mexico (Wells *et al.* 1987; Wells *et al.* 1996; Scott *et al.* 1990; Weller 1998; Zolman 2002; Speakman *et al.* 2006; Stolen *et al.* 2007; Balmer *et al.* 2008; Mazzoil *et al.* 2008). 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 (photo-ID) 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; 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-term photo-ID study, and this study identified year-round resident dolphins repeatedly observed across multiple years (Stolen *et al.* 2007; Mazzoil *et al.* 2008).

A few published studies demonstrate that these resident animals are genetically distinct from animals in nearby coastal waters; a study conducted near Jacksonville, Florida, demonstrated significant genetic differences between animals in nearshore coastal waters and estuarine waters (Caldwell 2001; Rosel *et al*. 2009), and animals resident in the Charleston Estuarine System show significant genetic differentiation from animals biopsied in coastal waters of southern Georgia (Rosel *et al*. 2009). In addition, stable isotope ratios of ^{18}O relative to ^{16}O (referred to as depleted ^{18}O or depleted oxygen) in animals sampled along the Outer Banks of North Carolina between Cape Hatteras and Bogue Inlet during February and March were very low (Cortese 2000). One explanation for this depleted oxygen signature is that a resident group of dolphins in Pamlico Sound moves into nearby nearshore areas in the winter.

Despite evidence for genetic differentiation between estuarine and nearshore populations, the degree of spatial overlap between these populations remains unclear. Photo-ID 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 the Southern Migratory Coastal Stock

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 (Rosel *et al.* 2009), photo-ID (Zolman 2002), and satellite telemetry (Southeast Fisheries Science Center, unpublished data) data demonstrate a complex mosaic of coastal bottlenose dolphin stocks. Integrated analysis of these multiple lines of evidence suggests that there are 5 coastal stocks of bottlenose dolphins: the Northern Migratory and Southern Migratory stocks, a South Carolina/Georgia Coastal stock, a Northern Florida Coastal stock and a Central Florida Coastal stock.

Among the coastal stocks, the migratory movements and spatial distribution of the Southern Migratory stock are the most poorly understood. Stable isotope analysis conducted using biopsy samples from free-ranging animals sampled in estuarine, nearshore coastal and offshore habitats suggests migratory movement of animals in coastal waters between Georgia in the winter and southern North Carolina during the summer and fall. In that study, $^{15}N\backslash^{14}N$, and $^{34}S\backslash^{32}S$ ratios of animals sampled off of Georgia during winter months were similar to those of animals sampled in waters off of southern North Carolina, near Cape Fear, during winter months (Knoff 2004). 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 2004 just south of Cape Fear, North Carolina. One of these animals remained along the South Carolina and southern North Carolina coasts throughout the winter (January-February) while the other migrated south to Northern Florida through February. In the spring (March-June), these animals moved further north of the tagging site to Cape Hatteras, North Carolina. The tags did not last beyond June, and therefore the distribution of these animals during summer months is unknown (Southeast Fisheries Science Center, unpublished data).

Genetic analyses indicate significant differentiation between bottlenose dolphins occupying coastal waters from the North Carolina/Virginia border to New Jersey during summer months and those in southern North Carolina and further south (Rosel *et al.* 2009). In addition, tagging studies of animals occupying New Jersey waters during the summer indicate that animals from the Northern Migratory stock do not move south of Cape Lookout, North Carolina during winter months. These data demonstrate that the Northern Migratory stock is distinct from the potential Southern Migratory stock. However, there is limited capability to demonstrate genetic differentiation of the Southern Migratory stock from other coastal and estuarine bottlenose dolphin stocks because the Southern Migratory stock overlaps spatially with at least 1 other stock of bottlenose dolphins throughout the year.

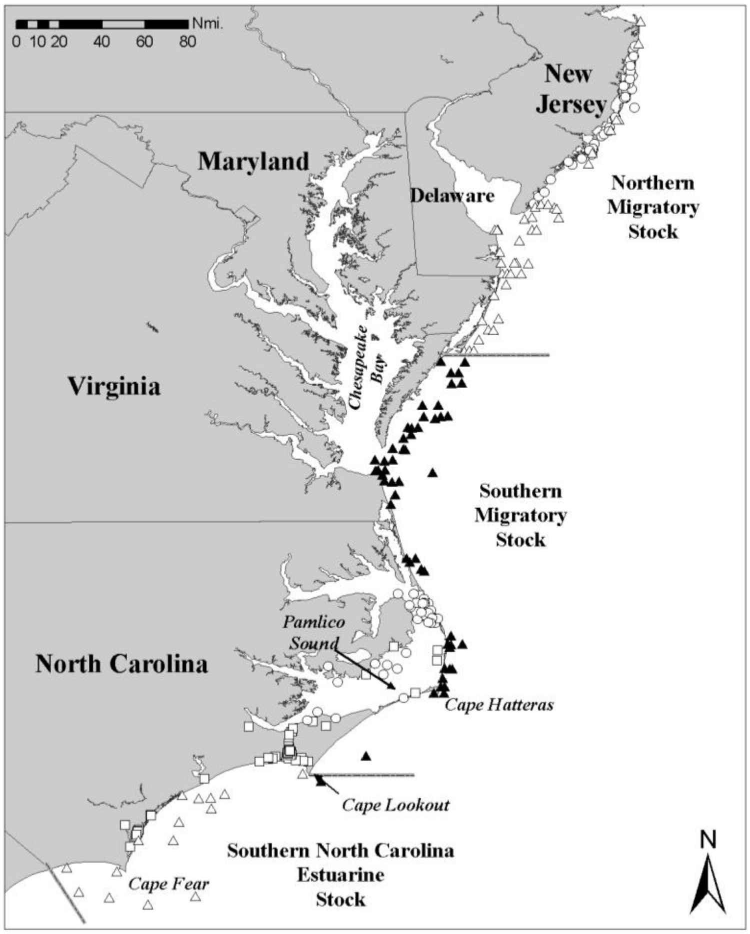

Figure 1. *The summer (July-September) distribution of bottlenose dolphin stocks occupying coastal waters from North Carolina to New Jersey. Locations are shown from aerial surveys (triangles), satellite telemetry (circles), and photo-ID studies (squares). Sightings assigned to the Southern Migratory stock are shown with filled symbols. Photo-ID data are courtesy of Duke University and the University of North Carolina at Wilmington.*

In summary, the limited data available supports the definition of a Southern Migatory stock of coastal morphotype bottlenose dolphins; however, there is a large amount of uncertainty in its spatial movements. The seasonal movements are best described by tag telemetry data. During the fall (October-December), this stock occupies waters of southern North Carolina (South of Cape Lookout) where it overlaps spatially with the Southern North Carolina Estuarine System stock in coastal waters. In winter months (January-March), the Southern Migratory stock moves as far south as northern Florida where it overlaps spatially with the South Carolina/Georgia and Northern Florida Coastal stocks. In spring (April-June), the stock moves north to waters of North Carolina where it overlaps with the Southern North Carolina Estuarine System stock and the Northern North Carolina Estuarine System stock. In summer months (July-September), the stock is presumed to occupy coastal waters north of Cape Lookout, North Carolina, to the eastern shore of Virginia (Figure 1). It is possible that these animals also occur inside the Chesapeake Bay and in nearshore coastal waters where there is evidence that Northern North Carolina Estuarine System stock animals also occur.

POPULATION SIZE

Aerial surveys to estimate the abundance of coastal bottlenose dolphins in the Atlantic 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 2 observer teams operating independently on the same aircraft to estimate visibility bias.

The winter 2002 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 < 9.5ºC. During the summer survey, 6,734 km of trackline were completed between Sandy Hook, New Jersey, and Ft. Pierce, Florida. All tracklines in the 0-20m 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 were 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 were 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 were calculated using line transect methods and distance analysis (Buckland *et al.* 2001). The 2002 surveys included 2 teams of observers to derive a correction for visibility bias. The independent and joint estimates from the 2 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 region north of Cape Hatteras, North Carolina, there was complete separation between the coastal and offshore morphotypes, with only coastal animals occupying waters < 20 m deep. Therefore, all animals observed in the 0-20 m depth stratum during surveys of this region were assigned to the coastal morphotype (Garrison *et al.* 2003).

The summer surveys are best for estimating the abundance for both the Northern and Southern Migratory stocks since they overlap least with other stocks during summer months. 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 1 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. Very few bottlenose dolphins were observed in waters north of Virginia during the summer 2004 survey.

The best abundance estimate for the Southern Migratory stock is therefore from the summer 2002 survey when there was little overlap and an apparent separation from the Northern Migratory stock at approximately 37.5°N latitude. This boundary is based upon the distribution of the 2 identified clusters of animals, and it likely varies 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 2 clusters of animals (Figure 1). The resulting best abundance estimate for the Southern Migratory stock is 12,482 (CV=0.32).

Minimum Population Estimate

The minimum population size (Nmin) was calculated as the lower bound of the 60% confidence interval for a lognormally distributed mean (Wade and Angliss 1997). The best estimate for the Southern Migratory Coastal stock of bottlenose dolphins is 12,482 (CV=0.32). The resulting minimum population estimate is 9,591.

Current Population Trend

There are insufficient data to determine the population trends for this stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for the Southern Migratory stock. 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 (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size of the Southern Migratory Coastal stock of bottlenose dolphins is 9,591. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP), is assumed to be 0.5 because this stock is depleted. PBR for this stock of bottlenose dolphins is 96.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

This stock has the potential to interact with the following Category I and II fisheries: (1) mid-Atlantic gillnet; (2) Virginia pound net; (3) mid-Atlantic menhaden; (4) Atlantic blue crab trap/pot; (5) mid-Atlantic beach/haul seine; (6) Southeastern U.S. Atlantic shark gillnet; and (7) Southeast Atlantic gillnet. The primary known source of fishery mortality is the mid-Atlantic gillnet fishery, which affects the Northern Migratory, Southern Migratory, Northern North Carolina Estuarine System and Southern North Carolina Estuarine System stocks of bottlenose dolphin. At certain times of year, it is not possible to definitively assign mortalities observed in that fishery to a specific stock. Additional commercial fisheries that may impact the Southern Migratory stock are Virginia pound nets, blue crab or other pot fisheries, the shark gillnet and the shrimp trawl fishery. With the exception of the shark gillnet fishery, these fisheries, lack systematic federal observer coverage, which prevents the estimation of total takes. 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. The total estimated average annual fishery mortality of the Southern Migratory stock ranges between a minimum of 24.0 and a maximum of 55.0 animals per year. This range reflects the uncertainty in assigning observed or reported mortalities to a particular stock.

Earlier Interactions

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 coastal morphotype bottlenose dolphins, and sink gillnet gear in North Carolina 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). From 2001-2008, 7 additional bottlenose dolphin mortalities were observed in the mid-Atlantic gillnet fishery. Three mortalities were observed in 2001 with 1 occurring off of northern North Carolina during April and 2 occurring off of Virginia during November. Four additional mortalities were observed along the North Carolina coast near Cape Hatteras: 1 in May 2003, 1 in September 2005, 1 in September 2006 and 1 in October 2006. Because the Northern Migratory, Southern Migratory, Northern North Carolina Estuarine System and Southern North Carolina Estuarine System bottlenose dolphin stocks all occur in waters off of North Carolina, it is not possible to definitively assign all observed mortalities, or extrapolated bycatch estimates, to a specific stock. In addition, the Bottlenose Dolphin Take Reduction Plan (BDTRP) was implemented in May 2006 resulting in changes in the gear configurations and other characteristics of the fishery.

To estimate the mortality of bottlenose dolphins in the mid-Atlantic gillnet fishery, the available data were divided into the period from 2002 through April 2006 (pre-BDTRP) and from May 2006 through 2008 (post-BDTRP). Three alternative approaches were used to estimate bycatch rates. First, a generalized linear model (GLM) approach was used similar to that described in Rossman and Palka (2001). This approach included all observed mortalities from 1995-2008 where the fishing gear was still in use during the period from 2002-2008. Second, a simple ratio estimator of catch per unit effort (CPUE = observed catch / observed effort) was used based directly upon the observed data. Finally, a ratio estimator pooled across years was used to estimate different CPUE values for the pre-BDTRP and post-BDTRP periods. In each case, the annual reported fishery effort (represented as reported landings) was multiplied by the estimated bycatch rate to develop annual estimates of fishery-related mortality similar to the approach in Rossman and Palka (2001). To account for the uncertainty in the most appropriate of these 3 alternative approaches, the average of the 3 model estimates (and the associated uncertainty) are used to estimate the mortality of bottlenose dolphins for this fishery (Table 1).

Table 1. Summary of the 2002-2008 incidental mortality of bottlenose dolphins (*Tursiops truncatus truncatus*) in the Southern Migratory stock in commercial mid-Atlantic gillnet fisheries. The estimated annual and average mortality estimates are shown for the period prior to the implementation of the Bottlenose Dolphin Take Reduction Plan (pre-BDTRP) and after the implementation of the plan (post-BDTRP). Three alternative modeling approaches were used, and the average of the 3 was used to represent mortality estimates. The minimum and maximum estimates indicate the range of uncertainty in assigning observed bycatch to stock. Observer coverage is measured as a proportion of reported landings (tons of fish landed). Data are derived from the Northeast Observer program, NER dealer data, VMRC landings and NCDMF dealer data. Values in parentheses indicated the CV of the estimate.

Period	Year	Observer Coverage[a]	Min Annual Ratio	Min Pooled Ratio	Min GLM	Max Annual Ratio	Max Pooled Ratio	Max GLM
pre-BDTRP	2002	0.01	0	29.17 (0.97)	6.71 (0.40)	0	67.83 (0.68)	24.22 (0.45)
	2003	0.01	0	34.77 (0.68)	12.35 (0.36)	63.56 (0.99)	47.08 (0.97)	14.00 (0.40)
	2004	0.02	0	81.52 (0.97)	18.93 (0.39)	0	88.56 (0.68)	31.71 (0.45)
	2005	0.03	114.84 (1)	74.05 (0.68)	19.41 (0.42)	123.18 (1.02)	91.01 (0.97)	26.61 (0.45)
	Jan-Apr 2006	0.03	0	0	0.00	0	0	0.32 (0.42)
Annual Avg. pre-BDTRP			Minimum: 21.81 (CV=0.13)			Maximum: 34.03 (CV=0.12)		
post-BDTRP	May-Dec 2006	0.03	0	0	12.10 (0.48)	174.98 (0.70)	44.29 (0.69)	18.99 (0.51)
	2007	0.03	0	0	10.75 (0.35)	0	36.62 (0.69)	18.33 (0.44)
	2008	0.01	0	0	28.54 (0.51)	0	86.60 (0.69)	36.45 (0.52)
Annual Avg. post-BDTRP			Minimum: 5.71 (CV=0.31)			Maximum: 41.91 (CV=0.14)		

[a] Observer coverage is reported on an annual basis for the entire fishery as a proportion of the reported tons of fish landed.

There have been 4 observed takes in the mid-Atlantic gillnet fishery since 2001 that could potentially be assigned to the Southern Migratory stock. Three of these occurred relatively close to shore and in areas with potential overlap with the Northern North Carolina Estuarine System stock. A fourth occurred several kilometers from shore in northern North Carolina during summer months, and therefore is most likely to be from the Southern Migratory stock. These interactions are reflected in positive values for both the pooled and annual ratio estimators (Table 1). Since observed mortalities (and effort) cannot be definitively assigned to a particular stock within certain regions and times of year, the minimum and maximum possible mortality of the Southern Migratory stock are presented for comparison to PBR (Table 1).

Based upon these analyses, the minimum mortality estimate for the Southern Migratory stock for the pre-BDTRP period was 21.81 (CV=0.13) animals per year, and that for the post-BDTRP period was 5.71 (CV=0.31) animals per year. The maximum estimates were 34.03 (CV=0.12) for the pre-BDTRP period and 41.91 (CV=0.14) for the post-BDTRP period (Table 1).

Crab Pots and Other Pots

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 interactions with pot gear are a common occurrence and result in mortalities of coastal morphotype bottlenose dolphins in some regions (Burdett and McFee 2004). Southeast Regional Marine Mammal Stranding Network data (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009) from 2004 through 2008 include 13 reports of interactions between bottlenose dolphins and confirmed blue crab pot gear with the majority of these occurring in waters from Florida to South Carolina. In addition, there were 4 interactions documented with pot gear where the fishery could not be confirmed. In these cases, the gear was confirmed to be associated with a pot or trap, but may have been from a fishery other than blue crab (e.g., whelk fisheries in Virginia). There was 1 mortality in pot gear where the fishery type could not be confirmed in Virginia. This mortality was reported in August 2007 and could be assigned to either the Southern Migratory or the NNCES stock.

Virginia Pound Nets

Historical and recent stranding network data report interactions between bottlenose dolphins and pound nets in Virginia. Stranding data for 2004-2008 indicate 17 cases where bottlenose dolphins were removed from pound net gear, and it was determined that animals were entangled pre-mortem. In each case, the bottlenose dolphin was recovered directly from the fishing gear. Of these 17 cases, 14 were documented mortalities while 3 were released alive (S. Barco, Virginia Aquarium, unpublished data; Northeast Regional Marine Mammal Stranding Network; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009). These interactions occurred primarily inside estuarine waters near the mouth of the Chesapeake Bay and in summer months. Five of these mortalities occurred during May and June when they could have impacted either the Northern Migratory or Southern Migratory stocks. The other 9 mortalities occurred during the summer (July-September) when they could have impacted either the Southern Migratory or the Northern North Carolina Estuarine System stocks. The overall impact of the Virginia Pound Net fishery on the Southern Migratory stock is unknown due to the limited information on the stock's movements, particularly whether or not it occurs within waters inside the mouth of the Chesapeake Bay.

Southeastern U.S. Atlantic Shark Gillnet Fishery and Southeast Atlantic Gillnet Fishery

Gillnet fisheries targeting finfish and sharks operate in southeast waters between North Carolina and southern Florida. Historically, a drift net fishery targeting coastal sharks operated in waters in northern Florida during winter months that could have interacted with the Southern Migratory stock. Bottlenose dolphin takes (n=2) in the drift net fisheries in this area were documented in 2002 and 2003 (Garrison 2007). Currently, gillnet fisheries include a number of different fishing methods and gear types including drift nets, "strike" fishing and anchored ("sink") gillnets. The majority of this fishing is reported from waters of North Carolina and central Florida, and very little effort is reported during winter months (January-March) within the range of the Southern Migratory stock. There have been no observed recent bottlenose dolphin takes within the stock boundaries.

Southeastern U.S. Shrimp Trawl Fishery

In August 2002 in Beaufort County, South Carolina, a fisherman self-reported a dolphin entanglement in a commercial shrimp trawl. However, this is outside of the seasonal range of the Southern Migratory stock in these waters, and there is relatively little effort during winter months when the fishery could possibly interact with this stock. 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.

Other Mortality

There have been occasional mortalities of bottlenose dolphins during research activities including directed live capture studies, turtle relocation trawls and fisheries surveys. From 2002-2008, there have been 15 reported interactions during research activities resulting in 13 documented mortalities of bottlenose dolphins. A mortality occurring in a turtle relocation trawl off of North Carolina during March of 2002 could have been attributed to either the Southern Migratory stock or the Northern North Carolina Estuarine System stock. One mortality in a research beach seine was reported from June 2007 in northern North Carolina that was consistent with the spatial range of the Northern Migratory stock, the Southern Migratory stock or the Northern North Carolina Estuarine System stock. All mortalities from known sources including commercial fisheries and research related mortalities for each provisional stock are summarized in Table 2.

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 1987-1988 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 in estuaries near Charleston, South Carolina, and Beaufort, North Carolina (Hansen *et al.* 2004), and in portions of Biscayne Bay, Florida (Litz *et al.* 2007). 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 and little study of contaminant loads in migrating coastal dolphins, the exposure to environmental pollutants and subsequent effects on population health is an area of concern and active research.

Table 2. Summary of annual reported and estimated mortality of bottlenose dolphins from the Southern Migratory stock. Where minimum and maximum values are reported, there is uncertainty in the assignment of mortalities to this particular stock due to spatial overlap with other bottlenose dolphin stocks in certain areas and seasons. The reported mortalities in Virginia pound net and pot fisheries are confirmed reports and are likely an underestimate of total mortalities in these fisheries.

Year	Mid-Atlantic Gillnet	Virginia Pound Net	Blue Crab Pot	Other Pot	Research	Total
2004	Min = 33.5 Max = 40.1	Min = 0 Max = 6	0	0	0	Min = 33.5 Max = 46.1
2005	Min = 69.4 Max = 80.3	Min = 0 Max = 1	0	0	0	Min = 69.4 Max = 81.3
2006	Min = 4.0 Max = 79.5	Min = 0 Max = 2	0	0	0	Min = 4.0 Max = 81.5
2007	Min = 3.6 Max = 18.3	Min = 0 Max = 3	0	Min = 0 Max = 1	Min = 0 Max = 1	Min = 3.6 Max = 23.3
2008	Min = 9.5 Max = 41.0	Min = 0 Max = 2	0	0	0	Min = 9.5 Max = 43.0

Annual Average Mortality (2004-2008)	Minimum Estimated = 24.00 Maximum Estimated = 55.04

Strandings

Between 2004 and 2008, 588 bottlenose dolphins stranded along the Atlantic coast between Florida and Maryland that could potentially be assigned to the Southern Migratory stock (Table 3; Northeast Regional Marine Mammal Stranding Network; Southeast Regional Marine Mammal Stranding Network; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009). The assignment of animals to a particular stock is impossible in some seasons and regions. During spring and summer months in North Carolina, Virginia and Maryland, the stock overlaps with the Northern Migratory, Northern North Carolina Estuarine System and the Southern North Carolina Estuarine System stocks. During fall and winter months, the stock overlaps with the Southern North Carolina Estuarine System stock, the South Carolina/Georgia Coastal stock, and the Northern Florida Coastal stock. Therefore, the counts below include an unknown number of animals from these other stocks. In addition, stranded carcasses are not routinely identified to either the offshore or coastal morphotype of bottlenose dolphin, therefore it is possible that some of the reported strandings were of the offshore form. In most cases, it was not possible to determine if a human interaction had occurred due to the decomposition state of the stranded animal. However, in cases where a determination could be made, the incidence of evidence of fisheries interactions was high, particularly in Virginia and North Carolina where the percentages of stranded animals with evidence of fisheries interaction were 61% and 44% respectively when a determination could be made. It should be recognized that evidence of human interaction does not indicate cause of death, but rather only that there was evidence of interaction with a fishery (e.g., line marks, net marks) or evidence of a boat strike, gunshot wound, mutilation, etc., at some point in the animal's life. Evidence of fishery interaction is by far the most common type of human interaction reported.

Table 3. Strandings of bottlenose dolphins from North Carolina to New York that can possibly be assigned to the Northern Migratory stock. Assignments to stock were based upon the understanding of the seasonal movements of this stock. However, in waters of North Carolina, Virginia and Maryland there is likely overlap with other stocks during particular times of year. HI = Evidence of Human Interaction, CBD = Cannot Be Determined whether an HI occurred or not. NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009.

State	**2004**			**2005**			**2006**			**2007**			**2008**		
Type	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD
Maryland[a]	1	3	1	1	0	3	1	2	4	1	0	3	1	0	0
Virginia[a]	20	12	36	12	18	25	13	4	36	11	5	30	13	4	44
North Carolina[b]	9	10	28	6	7	35	1	4	22	6	8	25	5	5	25
South Carolina[c] (Dec-Mar)	1	3	5	2	6	4	1	2	8	0	8	10	1	1	5
Georgia[d] (Jan-Feb)	0	0	2	0	1	1	0	0	2	1	1	1	0	0	3

Florida[d] (Jan-Feb)	0	2	1	0	0	3	0	0	4	0	0	8	0	0	1
Annual Total	134			124			104			118			108		

[a] Strandings from Virginia and Maryland were assigned to stock based upon location and time of year with most occurring between May and September that could be assigned to the Southern Migratory stock. Some of these strandings could also be assigned to the Northern Migratory stock or Northern North Carolina Estuarine System stock.

[b] Strandings from North Carolina were assigned based on location and time of year. During summer and fall, some of these strandings could also be assigned to the Northern North Carolina Estuarine System or Southern North Carolina Estuarine System stocks.

[c] Strandings in coastal waters from South Carolina during December-March are potentially from the Southern Migratory stock or the South Carolina/Georgia Coastal resident stock.

[d] Strandings in Georgia and northern Florida during January and February could also be assigned to the South Carolina/Georgia or the Northern Florida Coastal resident stocks, respectively.

STATUS OF STOCK

From 1995 to 2001, NMFS recognized only a single migratory stock of coastal morphotype bottlenose dolphins in the western North Atlantic, and the entire stock was listed as depleted. This stock structure was revised in 2002 to recognize both multiple stocks and seasonal management units and again in 2008 and 2009 to recognize resident estuarine stocks and migratory and resident coastal stocks. The total U.S. fishery-related mortality and serious injury for the Southern Migratory stock cannot be directly estimated because of the spatial overlap among the stocks of bottlenose dolphins that occupy waters of North Carolina. In addition, several fisheries are unobserved and the reported mortalities are minimum estimates. The total mortality is therefore unlikely to be less than 10% of the calculated PBR, and thus cannot be considered to be insignificant and approaching zero mortality and serious injury rate. This stock retains the depleted designation as a result of its origins from the coastal migratory stock. The species is not listed as threatened or endangered under the Endangered Species Act, but this is a strategic stock due to the depleted listing under the MMPA.

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BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*): Western North Atlantic South Carolina/Georgia Coastal Stock

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 (Duffield and Wells 2002; Rosel *et al.* 2009). 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 1987-1988 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 (McLellan *et al.* 2003; Rosel *et al.* 2009).

The coastal morphotype is morphologically and genetically distinct from the larger, more robust morphotype primarily occupying habitats further offshore (Mead and Potter 1995; Hoelzel *et al.* 1998; Rosel *et al.* 2009). Aerial surveys conducted between 1978 and 1982 (CETAP 1982) north of Cape Hatteras, North Carolina, identified 2 concentrations of bottlenose dolphins, 1 inshore of the 25m isobath and the other offshore of the 50m 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 <25m 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).

To address the question of distribution of coastal and offshore morphotypes in waters south of Cape Hatteras, tissue samples were collected during large vessel surveys during the summers of 1998 and 1999, during systematic biopsy sampling efforts in nearshore waters from New Jersey to central Florida conducted in the summers of 2001 and 2002, and during winter biopsy collection efforts in 2002 and 2003, 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 2 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 2 morphotypes in coastal Atlantic waters. During summer months, all biopsy samples collected from nearshore waters north of Cape Lookout, North Carolina (<20m deep) were of the coastal morphotype, and all samples collected in deeper waters (>40m 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 2 morphotypes. Offshore morphotype bottlenose dolphins were observed at depths as shallow as 13m, and coastal morphotype dolphins were observed at depths of 31m and 75km 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, 1 offshore morphotype group was sampled during November just south of Cape Lookout only 7.3km from shore. Coastal morphotype samples were also collected farther away from shore at 33m depth and 39km 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 2 morphotypes. Samples collected in Georgia waters also indicated significant overlap between the 2 morphotypes with a declining probability of the coastal morphotype with increasing depth. A coastal morphotype sample was collected 112km from shore at a depth of 38 m. An offshore sample was collected in 22m depth at 40km 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 2 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 20m deep, including estuarine and inshore waters. South of Cape Lookout, the coastal morphotype occurs in lower densities over the continental shelf (waters between 20m and 100m depth) and overlaps spatially with the offshore morphotype.

Distinction between Coastal and Estuarine Bottlenose Dolphins

In addition to inhabiting coastal nearshore waters, the coastal morphotype of bottlenose dolphin also inhabits inshore estuarine waters along the U.S. east coast and Gulf of Mexico (Wells *et al.* 1987; Scott *et al.* 1990; Wells *et al.* 1996; Weller 1998; Zolman 2002; Speakman *et al.* 2006; Stolen *et al.* 2007; Balmer *et al.* 2008; Mazzoil *et al*. 2008). 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 (photo-ID) 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; 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). A long-term photo-ID study in the Indian River Lagoon system in central Florida has also identified year-round resident dolphins repeatedly observed across multiple years (Stolen *et al.* 2007; Mazzoil *et al.* 2008).

A few published studies demonstrate that these resident animals are genetically distinct from animals in nearby coastal waters. A study conducted near Jacksonville, Florida, demonstrated significant genetic differences between animals in nearshore coastal waters and estuarine waters (Caldwell 2001; Rosel *et al*. 2009) and animals resident in the Charleston estuarine system show significant genetic differentiation from animals biopsied in coastal waters of southern Georgia (Rosel *et al*. 2009). In addition, stable isotope ratios of ^{18}O relative to ^{16}O (referred to as depleted ^{18}O or depleted oxygen) in animals sampled along the Outer Banks of North Carolina between Cape Hatteras and Bogue Inlet during February and March were very low (Cortese 2000). One explanation for this depleted oxygen signature is that a resident group of dolphins in Pamlico Sound moves into nearby nearshore areas in the winter.

Despite evidence for genetic differentiation between estuarine and nearshore populations, the degree of spatial overlap between these populations remains unclear. Photo-ID 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 the South Carolina/Georgia Coastal Stock

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 (Rosel *et al.* 2009), photo-ID (Zolman 2002) and satellite telemetry (NMFS unpublished data) data demonstrate a complex mosaic of coastal bottlenose dolphin stocks. Integrated analysis of these multiple lines of evidence suggests that there are 5 coastal stocks of bottlenose dolphins: the Northern Migratory and Southern Migratory stocks, a South Carolina/Georgia Coastal stock, a Northern Florida Coastal stock and a Central Florida Coastal stock.

The spatial extent of these stocks, their potential seasonal movements, and their relationships with estuarine stocks are poorly understood. Migratory movement and spatial distribution of the Northern Migratory stock is best understood based on tag-telemetry, photo-ID and aerial survey data. This stock migrates seasonally between coastal waters of central North Carolina and New Jersey. It is not thought to overlap with the South Carolina/Georgia Coastal stock in any season. The Southern Migratory stock is defined primarily on satellite tag telemetry studies and is thought to migrate south from waters of southern Virginia and north central North Carolina in the summer to waters south of Cape Fear and as far south as coastal Florida during winter months.

During summer months when the Southern Migratory stock is found in waters north of Cape Fear, North Carolina, bottlenose dolphins are still seen in coastal waters of South Carolina, Georgia and Florida, indicating the presence of additional stocks of coastal animals. Speakman *et al*. (2006) using photo-ID studies documented dolphins in coastal waters off Charleston, South Carolina, that are not known resident members of the estuarine stock. Genetic analyses of samples from northern Florida, Georgia and central South Carolina (primarily the estuaries around Charleston), using both mitochondrial DNA and nuclear microsatellite markers, indicate significant genetic differences between these areas (NMFS 2001; Rosel *et al*. 2009). This stock assessment report addresses the South Carolina/Georgia Coastal stock, which is present in coastal Atlantic waters from the North Carolina/South Carolina border south to the Georgia/Florida border (Figure 1). There is no obvious boundary defining the offshore extent of this stock. The combined genetic and logistic regression analysis (Garrison 2007) indicated that in waters less than 10m depth, 70% of the bottlenose dolphins were of the coastal morphotype. Between 10 and 20m depth, the percentage of animals of the coastal morphotype dropped precipitously and at depths >40m nearly all (>90%) animals were of the offshore morphotype. However, in winter months, the Southern Migratory stock (also of the coastal morphotype) moves into this region in waters 10-30m depth complicating the ability to define ocean-side boundaries for the South Carolina/Georgia Coastal stock.

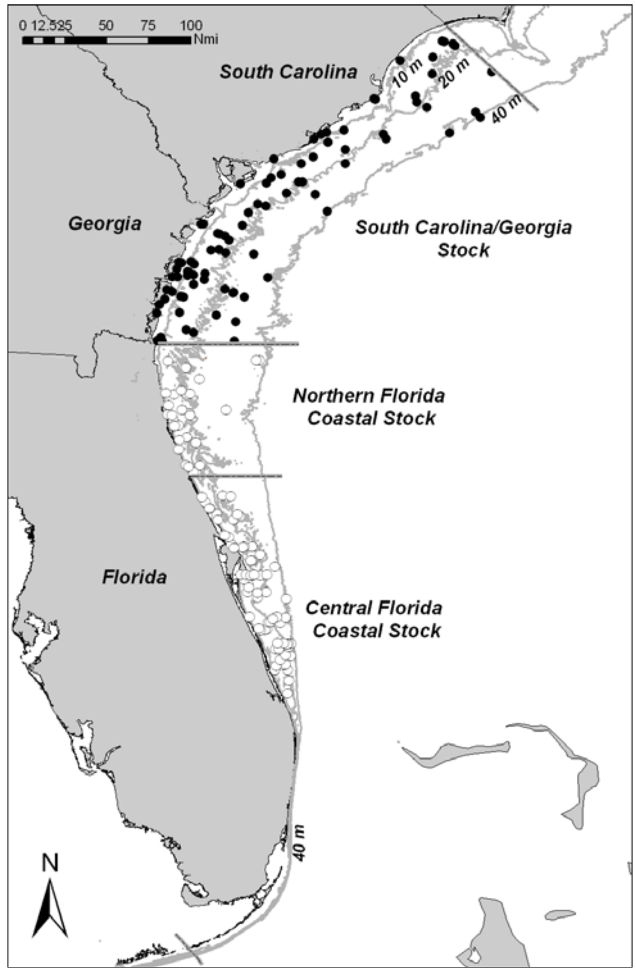

Figure 1. *The South Carolina/Georgia Coastal Stock of bottlenose dolphins (North Carolina/South Carolina border to the Georgia/Florida border). Circles represent all sightings of bottlenose dolphin groups from NMFS 2002 and 2004 aerial surveys; dark circles- groups within the boundaries of this stock. In waters >20m, sightings may include the offshore morphotype of bottlenose dolphins.*

POPULATION SIZE

Aerial surveys to estimate the abundance of coastal bottlenose dolphins in the Atlantic 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 40m. The surveys employed a stratified design so that most effort was expended in waters shallower than 20m 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 2 observer teams operating independently on the same aircraft to estimate visibility bias.

The winter 2002 survey included the region from the Georgia/Florida state line to the southern edge of Delaware Bay. A total of 6,411km 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 where water temperatures were <9.5ºC. During the summer survey, 6,734km of trackline were completed between Sandy Hook, New Jersey, and Ft. Pierce, Florida. All tracklines in the 0-20m 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 were 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 0-20m and 20-40m strata with the majority of effort in the shallow depth stratum. The survey was conducted between 16 July and 31 August and covered 7,189km of trackline. There were 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 5,457km 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 2 teams of observers to derive a correction for visibility bias. The independent and joint estimates from the 2 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).

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.

For the South Carolina/Georgia Coastal stock, the mean of the summer 2002 and 2004 abundance estimates provided the best estimate of abundance. During winter months, this stock overlaps spatially with the Southern Migratory stock and hence winter survey data are inappropriate for estimating abundance of the South Carolina/Georgia Coastal stock. The abundance estimate for this stock from the summer 2002 survey was 8,518 (CV=0.37) and that from summer 2004 was 7,379 (CV=0.29). The best abundance estimate is the inverse-variance weighted average of these 2 surveys and is 7,738 (CV=0.23).

Minimum Population Estimate

The minimum population size (Nmin) for the stock was calculated as the lower bound of the 60% confidence interval for a log-normally distributed mean (Wade and Angliss 1997). The best estimate for the South Carolina/Georgia Coastal stock is 7,738 (CV=0.23). The resulting minimum population estimate is 6,399.

Current Population Trend

There are insufficient data to determine the population trends for this stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for the western North Atlantic 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 (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size of the South Carolina/Georgia Coastal stock of bottlenose dolphins is 6,272. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP), is assumed to be 0.5 because this stock is depleted. PBR for this stock of bottlenose dolphins is 64.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Three Category II fisheries have the potential to interact with the South Carolina/Georgia Coastal stock of bottlenose dolphins – the Southeastern U.S. Atlantic shark gillnet fishery, the Southeast Atlantic gillnet fishery and the Atlantic blue crab/trap pot fishery. In addition, the Southeastern U.S. Atlantic shrimp trawl fishery (Category III) has the potential to interact with this stock. Only limited observer data are available for these and other fisheries that may interact with this stock. 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.

Southeastern U.S. Atlantic Shark Gillnet Fishery and Southeast Atlantic Gillnet Fishery

Gillnet fisheries targeting finfish and sharks operate in southeast waters between North Carolina and southern Florida. These fisheries include a number of different fishing methods and gear types including drift nets, “strike” fishing, and anchored (“sink”) gillnets. The majority of this fishing is reported from waters of North Carolina and central Florida. A small number of trips (average 35 annually from 2004-2008) are reported within the bounds of the South Carolina/Georgia Coastal stock. There has been no observer coverage of sets within the stock boundaries, and therefore there have been no observed takes.

Southeastern U.S. Shrimp Trawl Fishery

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.

Atlantic Blue Crab/Trap Pot Fishery

The blue crab trap pot fishery only rarely fishes in coastal waters of South Carolina and Georgia during winter months. Thus coastal dolphins rarely have the opportunity to encounter trap pots. During 2004-2008, no stranded animals assigned to the South Carolina/Georgia Coastal stock showed evidence of entanglement in trap pot gear.

Other Mortality

There were 128 stranded bottlenose dolphins recovered between 2004 and 2008 in the waters of the South Carolina/Georgia Coastal stock (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009). It was not possible to determine whether or not there was evidence of human interaction for 75 of these strandings and for 48 it was determined there was no evidence of human interaction. The remaining 5 showed evidence of human interaction and 1 of those showed evidence of fishery interaction- an animal was found in 2005 with hook and line in the mouth. Two animals had lacerations, again unknown whether ante-mortem or post-mortem, and 1 had human debris in the forestomach. Finally, 1 of the 6 animals with human interaction determinations was caught in a research trawl in 2006, although it is unknown whether the animal was dead prior to being caught in the trawl. It is worth noting that during winter months, the South Carolina/Georgia Coastal stock overlaps with the Southern Migratory stock and it is currently not possible to distinguish between them. Hence during winter months, stranded dolphins could come from either of these 2 stocks.

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 1987-1988 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 inhabiting 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 dolphins, the exposure to environmental pollutants and subsequent effects on population health is an area of concern and active research.

STATUS OF STOCK

From 1995 to 2001, NMFS recognized only a single migratory stock of coastal bottlenose dolphins in the western North Atlantic, and the entire stock was listed as depleted. This stock structure was revised in 2002 to recognize both multiple stocks and seasonal management units and again in 2008 and 2010 to recognize resident estuarine stocks and migratory and resident coastal stocks. This stock retains the depleted designation as a result of its origins from the originally delineated depleted coastal migratory stock. The total U.S. fishery-related mortality and serious injury for the South Carolina/Georgia Coastal stock is unknown. There are several commercial fisheries overlapping with the stock boundaries; however, these have little to no observer coverage. Insufficient information is available to determine whether the total fishery mortality and serious injury for this stock is insignificant and approaching a zero mortality and serious injury rate. The species is not listed as threatened or endangered under the Endangered Species Act, but this is a strategic stock due to the depleted listing under the MMPA.

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BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*): Western North Atlantic Northern Florida Coastal Stock

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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 (Duffield and Wells 2002; Rosel *et al.* 2009). 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 1987-1988 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 (McLellan *et al.* 2003; Rosel *et al.* 2009).

The coastal morphotype is morphologically and genetically distinct from the larger, more robust morphotype primarily occupying habitats further offshore (Mead and Potter 1995; Hoelzel *et al.* 1998; Rosel *et al.* 2009). Aerial surveys conducted between 1978 and 1982 (CETAP 1982) north of Cape Hatteras, North Carolina, identified 2 concentrations of bottlenose dolphins, 1 inshore of the 25m isobath and the other offshore of the 50m 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 <25m 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).

To address the question of distribution of coastal and offshore morphotypes in waters south of Cape Hatteras, tissue samples were collected during large vessel surveys during the summers of 1998 and 1999, during systematic biopsy sampling efforts in nearshore waters from New Jersey to central Florida conducted in the summers of 2001 and 2002, and during winter biopsy collection efforts in 2002 and 2003, 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 2 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 2 morphotypes in coastal Atlantic waters. During summer months, all biopsy samples collected from nearshore waters north of Cape Lookout, North Carolina (<20m deep) were of the coastal morphotype, and all samples collected in deeper waters (>40m 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 2 morphotypes. Offshore morphotype bottlenose dolphins were observed at depths as shallow as 13m, and coastal morphotype dolphins were observed at depths of 31m and 75km 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, 1 offshore morphotype group was sampled during November just south of Cape Lookout only 7.3km from shore. Coastal morphotype samples were also collected farther away from shore at 33m depth and 39km 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 2 morphotypes. Samples collected in Georgia waters also indicated significant overlap between the 2 morphotypes with a declining probability of the coastal morphotype with increasing depth. A coastal morphotype sample was collected 112km from shore at a depth of 38m. An offshore sample was collected in 22m depth at 40km 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 2 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 20m deep, including estuarine and inshore waters. South of Cape Lookout, the coastal morphotype occurs in lower densities over the continental shelf (waters between 20m and 100m depth) and overlaps spatially with the offshore morphotype.

Distinction between Coastal and Estuarine Bottlenose Dolphins

In addition to inhabiting coastal nearshore waters, the coastal morphotype of bottlenose dolphin also inhabits inshore estuarine waters along the U.S. east coast and Gulf of Mexico (Wells *et al.* 1987; Scott *et al.* 1990; Wells *et al.* 1996; Weller 1998; Zolman 2002; Speakman *et al.* 2006; Stolen *et al.* 2007; Balmer *et al.* 2008; Mazzoil *et al.* 2008). 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 (photo-ID) 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; 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). A long-term photo-ID study in the Indian River Lagoon system in central Florida has also identified year-round resident dolphins repeatedly observed across multiple years (Stolen *et al.* 2007; Mazzoil *et al.* 2008).

A few published studies demonstrate that these resident animals are genetically distinct from animals in nearby coastal waters. A study conducted near Jacksonville, Florida, demonstrated significant genetic differences between animals in nearshore coastal waters and estuarine waters (Caldwell 2001; Rosel *et al*. 2009) and animals resident in the Charleston estuarine system show significant genetic differentiation from animals biopsied in coastal waters of southern Georgia (Rosel *et al*. 2009). In addition, stable isotope ratios of ^{18}O relative to ^{16}O (referred to as depleted ^{18}O or depleted oxygen) in animals sampled along the Outer Banks of North Carolina between Cape Hatteras and Bogue Inlet during February and March were very low (Cortese 2000). One explanation for this depleted oxygen signature is that a resident group of dolphins in Pamlico Sound moves into nearby nearshore areas in the winter.

Despite evidence for genetic differentiation between estuarine and nearshore populations, the degree of spatial overlap between these populations remains unclear. Photo-ID 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 the Northern Florida Coastal Stock

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 (Rosel *et al.* 2009), photo-ID (Zolman 2002) and satellite telemetry (NMFS unpublished data) data demonstrate a complex mosaic of coastal bottlenose dolphin stocks. Integrated analysis of these multiple lines of evidence suggests that there are 5 coastal stocks of bottlenose dolphins: the Northern Migratory and Southern Migratory stocks, a South Carolina/Georgia Coastal stock, a Northern Florida Coastal stock and a Central Florida Coastal stock.

The spatial extent of these stocks, their potential seasonal movements, and their relationships with estuarine stocks are poorly understood. Migratory movement and spatial distribution of the Northern Migratory stock is best understood based on tag-telemetry, photo-ID and aerial survey data. This stock migrates seasonally between coastal waters of central North Carolina and New Jersey. It is not thought to overlap with the South Carolina/Georgia Coastal stock in any season. The Southern Migratory stock is defined primarily on satellite tag telemetry studies and is thought to migrate south from waters of southern Virginia and north central North Carolina in the summer to waters south of Cape Fear and as far south as coastal Florida during winter months. While it is possible that this stock overlaps during winter with the northern range of the Northern Florida Coastal stock, more data are needed to confirm this overlap.

During summer months when the Southern Migratory stock is found in waters north of Cape Fear, North Carolina, bottlenose dolphins are still seen in coastal waters of South Carolina, Georgia and Florida, indicating the presence of additional stocks of coastal animals. Speakman *et al.* (2006) using photo-ID studies documented dolphins in coastal waters off Charleston, South Carolina, that are not known resident members of the estuarine stock. Genetic analyses of samples from northern Florida, Georgia and central South Carolina (primarily the estuaries around Charleston), using both mitochondrial DNA and nuclear microsatellite markers, indicate significant genetic differences between these areas (NMFS 2001; Rosel *et al*. 2009). This stock assessment report addresses the Northern Florida Coastal stock, which is present in coastal Atlantic waters from the Georgia/Florida border south to 29.4°N (Figure 1). There is no obvious boundary defining the offshore extent of this stock. The combined genetic and logistic regression analysis (Garrison *et al.* 2003) indicated that in waters less than 10m depth, 70% of the bottlenose dolphins were of the coastal morphotype. Between 10 and 20m depth, the percentage of animals of the coastal morphotype dropped precipitously and at depths >40m nearly all (>90%) animals were of the offshore morphotype. However, in winter months, the Southern Migratory stock (also of the coastal morphotype) moves into this region in waters 10-30m depth complicating the ability to define ocean-side boundaries for the Northern Florida Coastal stock.

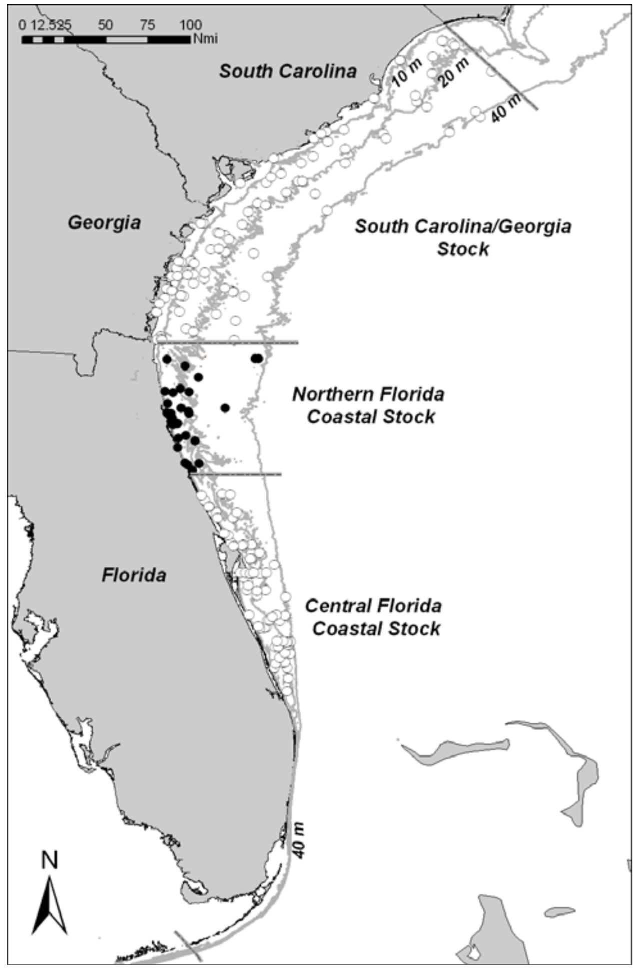

Figure 1. *The Northern Florida Coastal Stock of bottlenose dolphins (Georgia/Florida border to 29.4°N). Circles represent all sightings of bottlenose dolphin groups from NMFS 2002 and 2004 aerial surveys; dark circles- groups within the boundaries of this stock. In waters >20m, sightings may include the offshore morphotype of bottlenose dolphins.*

POPULATION SIZE

Aerial surveys to estimate the abundance of coastal bottlenose dolphins in the Atlantic 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 40m. The surveys employed a stratified design so that most effort was expended in waters shallower than 20m 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 2 observer teams operating independently on the same aircraft to estimate visibility bias.

The winter 2002 survey included the region from the Georgia/Florida state line to the southern edge of Delaware Bay. A total of 6,411km 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 where water temperatures were <9.5ºC. During the summer survey, 6,734km of trackline were completed between Sandy Hook, New Jersey, and Ft. Pierce, Florida. All tracklines in the 0-20m 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 0-20m and 20-40m strata with the majority of effort in the shallow depth stratum. The survey was conducted between 16 July and 31 August and covered 7,189km of trackline. There were 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 5,457km 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 2 teams of observers to derive a correction for visibility bias. The independent and joint estimates from the 2 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 Northern Florida Coastal stock, the mean of the summer 2002 and 2004 abundance estimates provided the best estimate of abundance. During winter months, this stock overlaps spatially with the Southern Migratory stock, and hence winter survey data are inappropriate for estimating abundance. There is strong 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. The abundance estimate for this stock from the summer 2002 survey was 737 (CV=0.47) and that from summer 2004 was 5,391 (CV=0.27). The best abundance estimate is the unweighted average of these 2 surveys and is 3,064 (CV=0.24). It is unknown why the abundance estimates from 2002 and 2004 differ by nearly an order of magnitude. Survey methodologies did not differ significantly between the years, although a larger amount of survey effort was expended in the Northern Florida and Central Florida strata during 2004 than in 2002. The disparity most likely represents variability in dolphin spatial distribution between those 2 years. Because the 2 abundance estimates differ so dramatically, using an inverse-variance weighted mean when combining the estimates would heavily weight the smaller of the 2 estimates, and therefore would likely introduce negative bias into the estimate of stock size. Therefore, an unweighted mean of the 2002 and 2004 abundance estimates was calculated and used as the best estimate of stock abundance.

Minimum Population Estimate

The minimum population size (Nmin) for the stock was calculated as the lower bound of the 60% confidence interval for a log-normally distributed mean (Wade and Angliss 1997). The best estimate for the Northern Florida Coastal stock is 3,064 (CV=0.24). The resulting minimum population estimate is 2,511.

Current Population Trend

There are insufficient data to determine the population trends for this stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for the western North Atlantic 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 (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size of the Northern Florida Coastal stock of bottlenose dolphins is 2,502. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP), is assumed to be 0.5 because this stock is depleted. PBR for this stock of bottlenose dolphins is 25.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Three Category II fisheries have the potential to interact with the Northern Florida Coastal stock of bottlenose dolphins – the Southeastern U.S. Atlantic shark gillnet fishery, the Southeast Atlantic gillnet fishery and the Atlantic blue crab/trap pot fishery. In addition, the Southeastern U.S. Atlantic shrimp trawl fishery (Category III) may interact with this stock. Only limited observer data are available for these and other fisheries that may interact with this stock. 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.

Southeastern U.S. Atlantic Shark Gillnet Fishery and Southeast Atlantic Gillnet Fishery

Gillnet fisheries targeting finfish and sharks operate in southeast waters between North Carolina and southern Florida. Historically, a drift net fishery targeting coastal sharks operated in waters including within the Northern Florida Coastal stock boundaries during winter months. Bottlenose dolphin takes (n=2) in the drift net fisheries were documented in 2002 and 2003 just south of the range of the Northern Florida Coastal stock (Garrison 2007). Currently, gillnet fisheries include a number of different fishing methods and gear types including drift nets, "strike" fishing, and anchored ("sink") gillnets. The majority of this fishing is reported from waters of North Carolina and central Florida. Gillnet trips (average 211 annually from 2004-2008) are reported within the bounds of the Northern Florida Coastal stock. There have been no observed bottlenose dolphin takes within the stock boundaries, but there was no observer coverage in 2008, so it was not possible to observe any takes (Table 1).

Table 1. Summary of the 2004-2008 incidental mortality of bottlenose dolphins (*Tursiops truncatus truncatus*) by stock in the southeast gillnet fisheries in water of the Northern Florida Coastal stock. Data include years sampled (Years), number of vessels reporting effort 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).

Stock	Years	Vessels	Data Type [a]	Observer Coverage [b]	Observed Serious Injury	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Northern Florida Coastal	2004-2008		Obs. Data, SEFSC FVL	0.14, 0.09, 0.02, 0.03, 0	0, 0, 0, 0, unk	0, 0, 0, 0, unk	0, 0, 0, 0, NA	NA	0* (*no observer coverage in 2008)

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 trips with effort inside the stock boundaries. Reported fishery effort includes a number of different fishing methods and target species that cannot be separated.

[b] Percent observer coverage is reported on a per trip basis as limited by reporting to the FVL. Multiple sets may occur on any given trip.

Atlantic Blue Crab/Trap Pot Fishery

During 2004-2008, no stranded animals assigned to the Northern Florida Coastal stock showed evidence of entanglement in trap pot gear.

Southeastern U.S. Shrimp Trawl Fishery

The shrimp trawl fishery operates in waters off the Florida coast. However, there has been little to no observer coverage of this fishery in the last decade. No other bottlenose dolphin mortality or serious injury related to shrimp trawling along the Florida coast has been reported to NMFS.

Other Mortality

Seventy-eight stranded bottlenose dolphins were recovered between 2004 and 2008 in the waters of the Northern Florida Coastal stock (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009). It was not possible to determine whether or not there was evidence of human interaction for 67 of these strandings, and for 8 it was determined there was no evidence of human interaction. The remaining 3 showed evidence of human interaction but none showed evidence of fishery interaction, although 1 animal had rope marks on the caudal peduncle that may have been from a fishery interaction but it is not possible to determine this without examining the rope, which was not found on the animal at the time of stranding. It is worth noting that during winter months, the Northern Florida Coastal stock likely overlaps with the Southern Migratory stock and it is currently not possible to distinguish between them. Hence during winter months, stranded dolphins could come from either of these 2 stocks.

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 1987-1988 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 inhabiting 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 dolphins, the exposure to environmental pollutants and subsequent effects on population health is an area of concern and active research.

STATUS OF STOCK

From 1995 to 2001, NMFS recognized only a single migratory stock of coastal bottlenose dolphins in the western North Atlantic, and the entire stock was listed as depleted. This stock structure was revised in 2002 to recognize both multiple stocks and seasonal management units and again in 2008 and 2010 to recognize resident estuarine stocks and migratory and resident coastal stocks. The total U.S. fishery-related mortality and serious injury for the Northern Florida Coastal stock likely is less than 10% of the calculated PBR, and thus can be considered to be insignificant and approaching zero mortality and serious injury rate. However, there are commercial fisheries overlapping with this stock that have no observer coverage. This stock retains the depleted designation as a result of its origins from the originally delineated depleted coastal migratory stock. The species is not listed as threatened or endangered under the Endangered Species Act, but this is a strategic stock due to the depleted listing under the MMPA.

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BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*): Western North Atlantic Central Florida Coastal Stock

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 (Duffield and Wells 2002; Rosel *et al.* 2009). 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 1987-1988 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 (McLellan *et al.* 2003; Rosel *et al.* 2009).

The coastal morphotype is morphologically and genetically distinct from the larger, more robust morphotype primarily occupying habitats further offshore (Mead and Potter 1995; Hoelzel *et al.* 1998; Rosel *et al.* 2009). Aerial surveys conducted between 1978 and 1982 (CETAP 1982) north of Cape Hatteras, North Carolina, identified 2 concentrations of bottlenose dolphins, 1 inshore of the 25m isobath and the other offshore of the 50m 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 <25m 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).

To address the question of distribution of coastal and offshore morphotypes in waters south of Cape Hatteras, tissue samples were collected from large vessel surveys during the summers of 1998 and 1999, from systematic biopsy sampling efforts in nearshore waters from New Jersey to central Florida conducted in the summers of 2001 and 2002, and from winter biopsy collection effort in 2002 and 2003, 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 2 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 2 morphotypes in coastal Atlantic waters. During summer months, all biopsy samples collected from nearshore waters north of Cape Lookout, North Carolina (<20m deep) were of the coastal morphotype, and all samples collected in deeper waters (>40m 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 2 morphotypes. Offshore morphotype bottlenose dolphins were observed at depths as shallow as 13m, and coastal morphotype dolphins were observed at depths of 31m and 75km 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, 1 offshore morphotype group was sampled during November just south of Cape Lookout only 7.3km from shore. Coastal morphotype samples were also collected farther away from shore at 33m depth and 39km 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 2 morphotypes. Samples collected in Georgia waters also indicated significant overlap between the 2 morphotypes with a declining probability of the coastal morphotype with increasing depth. A coastal morphotype sample was collected 112km from shore at a depth of 38m. An offshore sample was collected in 22m depth at 40km 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 2 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 20m deep, including estuarine and inshore waters. South of Cape Lookout, the coastal morphotype occurs in lower densities over the continental shelf (waters between 20m and 100m depth) and overlaps spatially with the offshore morphotype.

Distinction between Coastal and Estuarine Bottlenose Dolphins

In addition to inhabiting coastal nearshore waters, the coastal morphotype of bottlenose dolphin also inhabits inshore estuarine waters along the U.S. east coast and Gulf of Mexico (Wells *et al.* 1987; Scott *et al.* 1990; Wells *et al.* 1996; Weller 1998; Zolman 2002; Speakman *et al.* 2006; Stolen *et al.* 2007; Balmer *et al.* 2008; Mazzoil *et al.* 2008). 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 (photo-ID) 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; 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). A long-term photo-ID study in the Indian River Lagoon system in central Florida has also identified year-round resident dolphins repeatedly observed across multiple years (Stolen *et al.* 2007; Mazzoil *et al.* 2008).

A few published studies demonstrate that these resident animals are genetically distinct from animals in nearby coastal waters. A study conducted near Jacksonville, Florida, demonstrated significant genetic differences between animals in nearshore coastal waters and estuarine waters (Caldwell 2001; Rosel *et al*. 2009) and animals resident in the Charleston estuarine system show significant genetic differentiation from animals biopsied in coastal waters of southern Georgia (Rosel *et al*. 2009). In addition, stable isotope ratios of ^{18}O relative to ^{16}O (referred to as depleted ^{18}O or depleted oxygen) in animals sampled along the Outer Banks of North Carolina between Cape Hatteras and Bogue Inlet during February and March were very low (Cortese 2000). One explanation for this depleted oxygen signature is that a resident group of dolphins in Pamlico Sound moves into nearby nearshore areas in the winter.

Despite evidence for genetic differentiation between estuarine and nearshore populations, the degree of spatial overlap between these populations remains unclear. Photo-ID 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 the Central Florida Coastal Stock

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 (Rosel *et al.* 2009), photo-ID (Zolman 2002) and satellite telemetry (NMFS unpublished data) data demonstrate a complex mosaic of coastal bottlenose dolphin stocks. Integrated analysis of these multiple lines of evidence suggests that there are 5 coastal stocks of bottlenose dolphins: the Northern Migratory and Southern Migratory stocks, a South Carolina/Georgia Coastal stock, a Northern Florida Coastal stock and a Central Florida Coastal stock.

The spatial extent of these stocks, their potential seasonal movements, and their relationships with estuarine stocks are poorly understood. Migratory movement and spatial distribution of the Northern Migratory stock is best understood based on tag-telemetry, photo-ID and aerial survey data and migrates seasonally between coastal waters of central North Carolina and New Jersey. It is not thought to overlap with the South Carolina/Georgia Coastal stock in any season. The Southern Migratory stock is defined primarily based on satellite tag telemetry studies and is thought to migrate south from waters of southern Virginia and north central North Carolina in the summer to waters south of Cape Fear and as far south as coastal Florida during winter months. It is unclear whether this stock overlaps with the Central Florida Coastal stock in any season.

During summer months when the Southern Migratory stock is found in waters north of Cape Fear, North Carolina, bottlenose dolphins are still seen in coastal waters of South Carolina, Georgia and Florida, indicating the presence of additional stocks of coastal animals. Speakman *et al.* (2006) using photo-ID studies documented dolphins in coastal waters off Charleston, South Carolina, that are not known resident members of the estuarine stock. Genetic analyses of samples from northern Florida, Georgia and central South Carolina (primarily the estuaries around Charleston), using both mitochondrial DNA and nuclear microsatellite markers, indicate significant genetic differences between these areas (NMFS 2001; Rosel *et al*. 2009). This stock assessment report addresses the Central Florida Coastal stock, which is present in coastal Atlantic waters from 29.4°N south to the western end of Vaca Key (~24.69°N –81.11°W) where the stock boundary for the Florida Keys stock begins (Figure 1). There has been little study of bottlenose dolphin stock structure in coastal waters of southern Florida, therefore the southern boundary of the Central Florida stock is uncertain. There is no obvious boundary defining the offshore extent of this stock.

The combined genetic and logistic regression analysis (Garrison *et al.* 2003) indicated that in waters less than 10m depth, 70% of the bottlenose dolphins were of the coastal morphotype. Between 10 and 20m depth, the percentage of animals of the coastal morphotype dropped precipitously, and at depths >40m nearly all (>90%) animals were of the offshore morphotype. These spatial patterns may not apply in the Central Florida Coastal stock, as there is a significant change in the bathymetric slope and a close approach of the Gulf Stream to the shoreline south of Cape Canaveral.

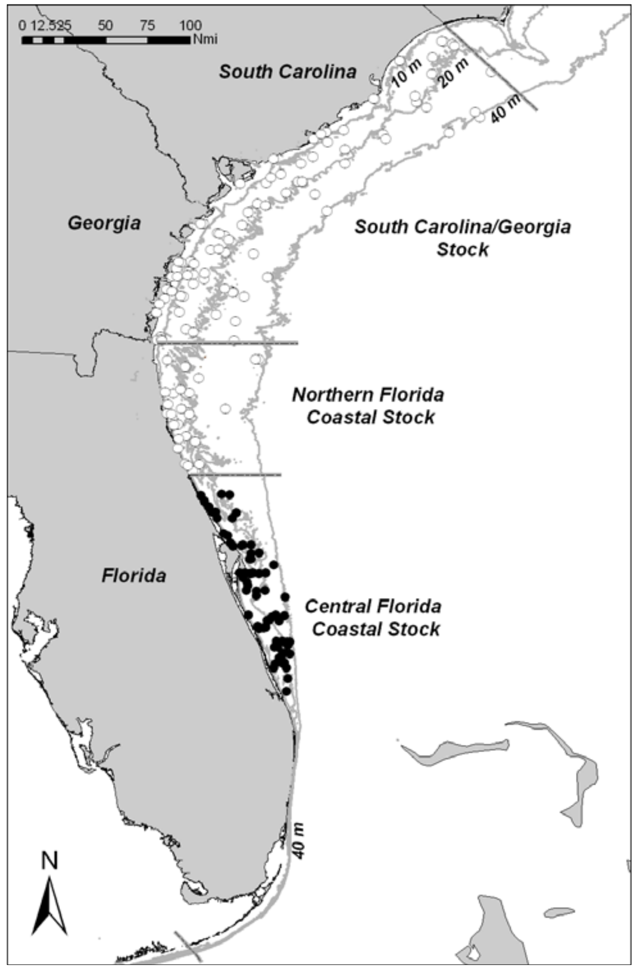

Figure 1. *The Central Florida Coastal stock of bottlenose dolphins (29.4°N to Vaca Key). Circles represent all sightings of bottlenose dolphin groups from NMFS 2002 and 2004 aerial surveys; dark circles- groups within the boundaries of this stock. In waters >20m, sightings may include the offshore morphotype of bottlenose dolphins.*

POPULATION SIZE

Aerial surveys to estimate the abundance of coastal bottlenose dolphins in the Atlantic 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 40m. The surveys employed a stratified design so that most effort was expended in waters shallower than 20m 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 2 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 6,411km 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 where water temperatures were <9.5ºC. During the summer survey, 6,734km of trackline were completed between Sandy Hook, New Jersey, and Ft. Pierce, Florida. All tracklines in the 0-20m 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 were 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 0-20m and 20-40m strata with the majority of effort in the shallow depth stratum. The survey was conducted between 16 July and 31 August and covered 7,189km 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 5,457km 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 2 teams of observers to derive a correction for visibility bias. The independent and joint estimates from the 2 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 Coastal stock, the mean of the summer 2002 and 2004 abundance estimates provided the best estimate of abundance. There is strong 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. The abundance estimate for this stock from the summer 2002 survey was 718 (CV=0.51) and that from summer 2004 was 11,918 (CV=0.27). The best abundance estimate is the unweighted average of these 2 surveys and is 6,318 (CV=0.26). It is unknown why the abundance estimates from 2002 and 2004 differ by nearly an order of magnitude. Survey methodologies did not differ significantly between the years, although a larger amount of survey effort was expended in the Northern Florida and Central Florida strata during 2004 than in 2002. The disparity most likely represents variability in dolphin spatial distribution between those 2 years. Because the 2 abundance estimates differ so dramatically, using an inverse-variance weighted mean when combining the estimates would heavily weight the smaller of the 2 estimates, and therefore would likely introduce negative bias into the estimate of stock size. Therefore, an unweighted mean of the 2002 and 2004 abundance estimates was calculated and used as the best estimate of stock abundance.

Minimum Population Estimate

The minimum population size (Nmin) for each stock was calculated as the lower bound of the 60% confidence interval for a log-normally distributed mean (Wade and Angliss 1997). The best estimate for the Central Florida Coastal stock is 6,318 (CV=0.26). The resulting minimum population estimate is 5,094.

Current Population Trend

There are insufficient data to determine the population trends for this stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are not known for the western North Atlantic 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 (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size of the Central Florida Coastal stock of bottlenose dolphins is 5,109. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP), is assumed to be 0.5 because this stock is depleted. PBR for this stock of bottlenose dolphins is 51.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Three Category II fisheries have the potential to interact with the Central Florida Coastal stock of bottlenose dolphins – the Southeastern U.S. Atlantic shark gillnet fishery, the Southeast Atlantic gillnet fishery and the Atlantic blue crab/trap pot fishery. In addition, the following Category III fisheries may interact with this stock: Southeastern U.S. Atlantic shrimp trawl fishery; Florida spiny lobster trap/pot; and Southeastern U.S. Atlantic, Gulf of Mexico stone crab trap/pot. Only limited observer data are available for these and other fisheries that may interact with this stock. 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.

Southeastern U.S. Atlantic Shark Gillnet Fishery and Southeast Atlantic Gillnet Fishery

Gillnet fisheries targeting finfish and sharks operate in southeast waters between North Carolina and southern Florida. Historically, a drift net fishery targeting coastal sharks operated in waters including within the Central Florida Coastal stock boundaries during winter months. Bottlenose dolphin takes (n=2) were observed in the drift net fisheries targeting sharks in 2002 and 2003 (Garrison 2007). Currently, gillnet fisheries include a number of different fishing methods and gear types including drift nets, "strike" fishing, and anchored ("sink") gillnets. The majority of this fishing is reported from waters of North Carolina and central Florida. However, there has been a significant reduction in the amount of drift gillnet fishing targeting sharks during the last several years. Gillnet trips (average 766 annually from 2004-2008) are reported within the bounds of the Central Florida Coastal stock. There have been no observed bottlenose dolphin takes within the stock boundaries since 2003 (Table 1).

Table 1. Summary of the 2004-2008 incidental mortality of bottlenose dolphins (*Tursiops truncatus truncatus*) by stock in the southeast gillnet fisheries in water of the Central Florida Coastal stock. Data include years sampled (Years), number of vessels reporting effort 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).

Stock	Years	Vessels	Data Type [a]	Observer Coverage [b]	Observed Serious Injury	Observed Mortality	Estimated Mortality	Estimated CVs	Mean Annual Mortality
Central Florida Coastal	2004-2008		Obs. Data, SEFSC FVL	0.07, 0.09, 0.07, 0.02, 0.05	0, 0, 0, 0, 0	0, 0, 0, 0, 0	0, 0, 0, 0, 0	NA	0

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 trips with effort inside the stock boundaries. Reported fishery effort includes a number of different fishing methods and target species that cannot be separated.

[b] Percent observer coverage is reported on a per trip basis as limited by reporting to the FVL. Multiple sets may occur on any given trip.

Atlantic Blue Crab/Trap Pot Fishery

During 2004-2008, no stranded animals assigned to the Central Florida Coastal stock were confirmed to have been entangled in commercial trap pot gear.

Southeastern U.S. Shrimp Trawl Fishery

The shrimp trawl fishery operates in waters off the Florida coast. However, there has been little to no observer coverage of this fishery in the last decade. No other bottlenose dolphin mortality or serious injury related to shrimp trawling along the Florida coast has been reported to NMFS.

Other Mortality

Eighty-two stranded bottlenose dolphins were recovered between 2004 and 2008 in the waters of the Central Florida Coastal stock (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009). It was not possible to determine whether or not there was evidence of human interaction for 60 of these strandings and for 16 it was determined there was no evidence of human interaction. The remaining 6 showed evidence of human interaction. Three animals were reported entangled in gear consistent with a trap pot fishery, but gear was only recovered for 1 animal, possibly lobster pot gear. One animal was entangled in high test monofilament. The 5th animal had scars consistent with net entanglement and the last an old bullet in the skull. Neither of the last 2 findings was thought to be the cause of the mortality.

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 1987-1988 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 inhabiting 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 dolphins, the exposure to environmental pollutants and subsequent effects on population health is an area of concern and active research.

STATUS OF STOCK

From 1995 to 2001, NMFS recognized only a single migratory stock of coastal bottlenose dolphins in the western North Atlantic, and the entire stock was listed as depleted. This stock structure was revised in 2002 to recognize both multiple stocks and seasonal management units and again in 2008 and 2010 to recognize resident estuarine stocks and migratory and resident coastal stocks. The total U.S. fishery-related mortality and serious injury for the Central Florida Coastal stock likely is less than 10% of the calculated PBR, and thus can be considered to be insignificant and approaching zero mortality and serious injury rate. However, there are commercial fisheries overlapping with this stock that have no observer coverage. This stock retains the depleted designation as a result of its origins from the originally delineated depleted coastal migratory stock. The species is not listed as threatened or endangered under the Endangered Species Act, but this is a strategic stock due to the depleted listing under the MMPA.

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BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*)
Northern North Carolina Estuarine System Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The coastal morphotype of bottlenose dolphin is continuously distributed along the Atlantic coast south of Long Island, New York, to the Florida peninsula, including inshore waters of the bays, sounds and estuaries. Several lines of evidence support a distinction between dolphins inhabiting coastal waters near the shore and those present primarily in the inshore waters of the bays, sounds and estuaries. Photo-identification (photo-ID) and genetic studies support the existence of resident estuarine animals in several areas (Caldwell 2001; Gubbins 2002; Zolman 2002; Gubbins *et al.* 2003; Mazzoil *et al.* 2005; Litz 2007), and similar patterns have been observed in bays and estuaries along the Gulf of Mexico coast (Wells *et al.* 1987; Balmer *et al.* 2008). Recent genetic analyses using both mitochondrial DNA and nuclear microsatellite markers found significant differentiation between animals biopsied along the coast and those biopsied within the estuarine systems at the same latitude (NMFS unpublished data). Similar results have been found off the west coast of Florida (Sellas *et al.* 2005; Balmer *et al.* 2008).

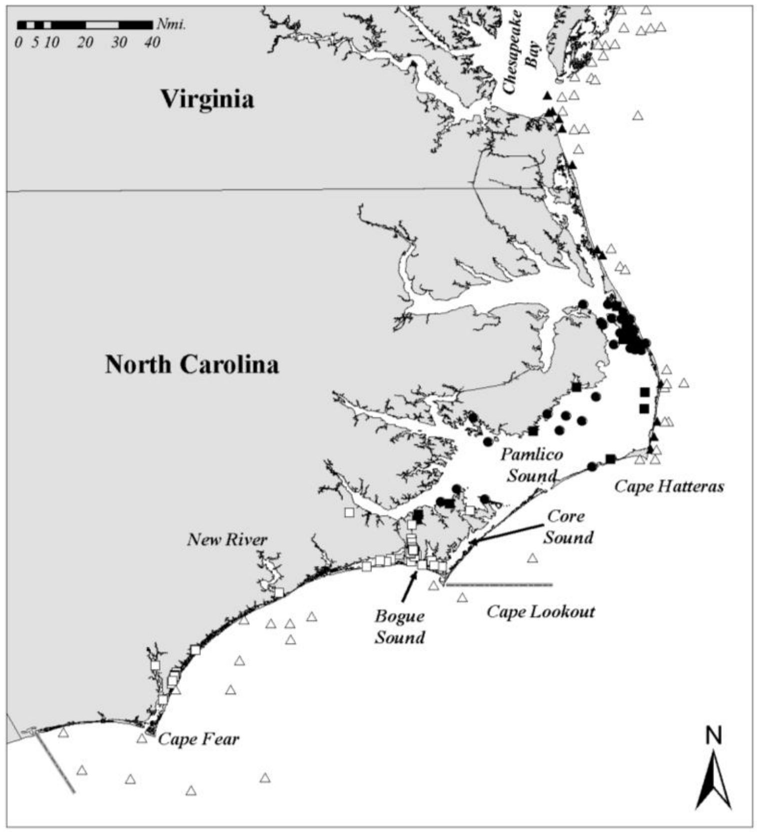

Figure 1. *The summer (July-September) distribution of bottlenose dolphins occupying coastal and estuarine waters in North Carolina and Virginia. Locations are shown from aerial surveys (triangles), satellite telemetry (circles) and photo-identification studies (squares). Sightings assigned to the Northern North Carolina Estuarine System stock are shown with filled symbols. Photo-identification data are courtesy of Duke University and the University of North Carolina at Wilmington.*

The Northern North Carolina Estuarine System (NNCES) stock is defined as animals that occupy estuarine waters of Pamlico Sound during summer months (July-August). The ranging patterns of bottlenose dolphins in photo-ID studies supports the presence of a group of dolphins within these waters that are distinct from both dolphins occupying estuarine and coastal waters in southern North Carolina and animals in the Northern and Southern Migratory stocks that occupy coastal waters of North Carolina at certain times of the year (Read *et al.* 2003; NMFS 2001; NMFS unpublished data). In addition, stable isotope analysis of animals sampled along the beaches of North Carolina between Cape Hatteras and Bogue Inlet during February and March showed very low stable isotope ratios of ^{18}O relative to ^{16}O (referred to as "depleted oxygen"; Cortese 2000). One explanation for the depleted oxygen signature is a resident group of dolphins in Pamlico Sound that move into nearby coastal waters in the winter (NMFS 2001). The estuarine waters of Pamlico Sound had previously been included in the abundance estimates and stock assessment reports for the Northern migratory stock and the winter “mixed” North Carolina management unit of coastal bottlenose dolphins (Waring *et al.* 2007). However, they are now recognized as a distinct stock based upon these differences in seasonal ranging patterns and stable isotope signatures.

The seasonal movements of the NNCES stock are best described using a combination of tag telemetry and long-term photo-ID studies. Animals captured and released near Beaufort, North Carolina, were fitted with satellite-linked transmitters during November 1999 (3 animals), April 2000 (8 animals) and April 2006 (5 animals) (NMFS unpublished data). In addition, long-term photo-ID studies have been conducted in waters of North Carolina that include records of both these tagged animals and animals that were captured and freeze-branded near Beaufort, North Carolina, during summer months (Duke University unpublished data; University of North Carolina at Wilmington unpublished data; NMFS unpublished data). Of these tagged or freeze-branded animals, 18 occupied waters of northern Pamlico Sound during summer months and hence were identified as belonging to the NNCES stock. The NNCES stock occurs primarily within the waters of Pamlico Sound north of Core Sound during summer months (July-August). There is evidence that some of these animals also move into nearshore coastal waters along the northern coast of North Carolina and into coastal waters of Virginia and perhaps into Chesapeake Bay. One animal that was tagged near Virginia Beach in September 1998 was observed to move south into waters of Pamlico Sound and had a photo-ID record within the sound during July (NMFS unpublished data). In addition, there are photo-ID matches between inshore waters of Virginia Beach, Virginia, and Pamlico Sound (Urian, pers. comm.) that also demonstrate movements of NNCES animals between these areas. Therefore, it is presumed that the spatial range of NNCES animals during summer and fall months (July-October) includes Pamlico Sound, nearshore (< 1km from shore) coastal waters of northern North Carolina, and nearshore and estuarine waters of Virginia (Figure 1).

There are fewer tag-telemetry data for assigned NNCES animals during winter months. However, photo-ID studies, available tag data and stable isotope data indicate that the stock moves out of the waters of Pamlico Sound into coastal waters south of Cape Hatteras during late fall and through winter (November-April). Tag telemetry records show that NNCES animals move as far south as the New River during winter months (January-February) (NMFS unpublished data). The Northern Migratory stock also occupies the nearshore coastal waters of North Carolina during these months, and hence there is likely overlap between these stocks, particularly between Cape Hatteras and Cape Lookout.

The movements of animals from the NNCES stock are distinct from those of the Southern North Carolina Estuarine System stock (SNCES). Some of the animals tagged or freeze-branded near Beaufort moved south to Cape Fear and occupied nearshore coastal and estuarine waters during winter months. During summer and fall, these animals moved north and occupied inshore and nearshore coastal waters near Cape Lookout including Bogue Sound and Core Sound. It is probable that there is spatial overlap between these 2 estuarine stocks during late summer and fall in the waters near Beaufort. However, SNCES stock animals were not observed to move north of Cape Lookout in coastal waters nor into the main portion of Pamlico Sound during summer (NMFS unpublished data; Duke University unpublished data; University of North Carolina at Wilmington unpublished data). These movement patterns are consistent with those in resightings of individual dolphins during a photo-ID study that sampled much of the estuarine waters of North Carolina (Read *et al.* 2003). Read *et al.* (2003) suggested that movement patterns, differences in group sizes, and habitats are consistent with 2 stocks of animals occupying estuarine waters of North Carolina. Finally, genetic analysis of samples from animals in waters of southern North Carolina (between Cape Lookout and the North Carolina/South Carolina border) demonstrate significant differentiation from animals occupying waters from Virginia and further north and waters of South Carolina (Rosel *et al.* 2009).

In summary, during summer and fall months (July-October), the NNCES stock occupies waters of Pamlico Sound and nearshore coastal and estuarine waters of northern North Carolina to Virginia Beach (Figure 1). It likely overlaps with animals from the Southern Migratory stock in coastal waters during these months. During late fall and winter (November-March), the NNCES stock moves out of estuarine waters and occupies nearshore coastal waters between the New River and Cape Hatteras. It overlaps with the Northern Migratory stock during this period, particularly between Cape Lookout and Cape Hatteras. It appears that the region near Cape Lookout including Bogue Sound and Core Sound is an area of overlap with the SNCES stock during late summer.

POPULATION SIZE

Read *et al.* (2003) provided the first and only available abundance estimate of bottlenose dolphins that occur within the estuarine portion of the NNCES stock range. This estimate was based on a photo-ID mark-recapture survey of a portion of North Carolina waters inshore of the barrier islands, conducted during July 2000. Because the survey did not sample all of the estuarine waters where dolphins are known to occur, the estimates of abundance may be negatively biased. Read *et al.* (2003) estimated the number of animals in the inshore waters of North Carolina equivalent to that of the NNCES stock to be 919 (95% CI 730 - 1,190, CV=0.13). Gubbins *et al.* (2003) also conducted a photo-ID mark-recapture study and provided an abundance estimate (513, CV=0.13) for inshore and nearshore waters near Beaufort, North Carolina, but this area represented only a small portion of the NNCES stock area and included animals in coastal waters. Goodman *et al.* (2007) conducted seasonal, strip-transect aerial surveys of southwestern Pamlico Sound from July 2004 through April 2006. Their survey area sampled approximately 25% or less of the waters within the NNCES stock boundaries. Mean seasonal abundance estimates ranged from a low of 54 (CV=0.46) during June-August 2005 (summer), to a high of 426 (CV=0.35) during September-November 2004 (autumn), but seasonal patterns were not consistent among years. For example, the estimate for spring of 2005 was only 71 (CV=0.39) while the estimate for spring of 2006 was 323 (CV=0.35). The abundance estimate from Read *et al.* (2003) is the best abundance estimate for the stock in estuarine waters; however, this estimate is more than 8 years old, and hence cannot be used to calculate N_{min} or PBR.

Since both tag-telemetry studies and photo-ID records indicate that some portion of the NNCES stock occurs in coastal waters between Cape Hatteras, North Carolina, and Virginia during summer months, it is appropriate to include animals from summer aerial surveys of these areas in the abundance estimate. Aerial surveys to estimate the abundance of coastal bottlenose dolphins in the Atlantic 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 40m. The surveys employed a stratified design so that most effort was expended in waters shallower than 20m deep where a high proportion of observed bottlenose dolphins were expected to be of the coastal morphotype. The surveys employed 2 observer teams operating independently on the same aircraft to estimate visibility bias. Abundance estimates were calculated using line transect methods and distance analysis (Buckland *et al.* 2001). The 2002 surveys included 2 teams of observers to derive a correction for visibility bias. The independent and joint estimates from the 2 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).

During the summer survey, 6,734km of trackline were completed between Sandy Hook, New Jersey, and Ft. Pierce, Florida. All tracklines in the 0-20m 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 were 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 0-20m and 20-40m strata with the majority of effort in the shallow depth stratum. The survey was conducted between 16 July and 31 August and covered 7,189km of trackline. There were a total of 140 sightings of bottlenose dolphins including 3,093 individual animals. During the summer of 2004, water temperatures were significantly cooler than those during 2002 and earlier surveys conducted in 1995, and animals distributed farther south and overlapped spatially. It is probable that both the Northern Migratory and Southern Migratory stocks occurred in waters of northern North Carolina during the summer of 2004.

The best abundance estimate for the Northern North Carolina Estuarine System stock in coastal waters is therefore from the summer 2002 survey when there was less overlap among stocks. Survey data were post-stratified to estimate the abundance of dolphins within a strip extending from the shoreline to 1km from shore between Cape Lookout, North Carolina, and Virginia Beach, Virginia. Tag-telemetry records indicated that NNCES animals rarely ventured further away from shore. However, animals from the Southern Migratory stock do occur within this strip during summer months. Therefore, the estimate of abundance within this strip includes both NNCES animals and Southern Migratory animals and hence overestimates abundance. The resulting best abundance estimate for the NNCES stock in coastal waters is 468 (CV=0.32).

The best available abundance estimate for the NNCES stock is the combined abundance from estuarine and coastal waters. This combined estimate is 1,387 (CV=0.17). However, this estimate includes data that are more than 8 years old from Read *et al.* (2003). Hence, the abundance of the NNCES stock is currently unknown.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20^{th} percentile of the log-normal distribution as specified by Wade and Angliss (1997). Because the only available comprehensive abundance for this stock is derived from data that are more than 8 years old, they may not be used to calculate the minimum population estimate, and as a result the minimum population estimate for the NNCES stock of bottlenose dolphins is unknown.

Current Population Trend

There are insufficient data to determine the population trends for this stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. 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 (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size of the NNCES stock of bottlenose dolphins is unknown. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP), is assumed to be 0.5 because this stock is of unknown status. PBR for this stock of bottlenose dolphins is undetermined.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

The NNCES stock interacts with 3 Category II fisheries: the Atlantic blue crab trap/pot fishery, North Carolina long haul seine fishery and North Carolina inshore gillnet fishery. There is no systematic federal observer coverage of these fisheries by the National Marine Fisheries Service (NMFS), although the North Carolina Division of Marine Fisheries operates systematic coverage of the fall flounder gillnet fishery in Pamlico Sound (Price 2008). As a result, information about interactions with North Carolina inshore fisheries is based solely on stranding data and it is not possible to estimate the annual number of interactions or mortalities in these fisheries. The NNCES stock may also interact with the mid-Atlantic gillnet fishery, the mid-Atlantic haul/beach seine fishery and the Virginia Pound Net fishery. The magnitude of the interaction with each of these fisheries is unknown because of both uncertainty in the movement patterns of the stock and the spatial overlap between the NNCES stock and other bottlenose dolphin stocks in coastal waters. The total estimated average annual fishery mortality on the NNCES stock ranges between a minimum of 4.1 and a maximum of 22.6 animals per year. This range reflects the uncertainty in assigning observed or reported mortalities to a particular stock.

Mid-Atlantic Gillnet

This fishery has the highest documented level of mortality of coastal morphotype bottlenose dolphins, and the sink gillnet gear in North Carolina 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). From 2001-2008, 7 additional bottlenose dolphin mortalities were observed in the mid-Atlantic gillnet fishery. Three mortalities were observed in 2001 with 1 occurring off of northern North Carolina during April and 2 occurring off of Virginia during November. Four additional mortalities were observed along the North Carolina coast near Cape Hatteras: 1 in May 2003, 1 in September 2005, 1 in September 2006 and 1 in October 2006. Because the Northern Migratory, Southern Migratory, Northern North Carolina Estuarine System and Southern North Carolina Estuarine System bottlenose dolphin stocks all occur in waters off of North Carolina, it is not possible to definitively assign all observed mortalities, or extrapolated bycatch estimates, to a specific stock. In addition, the Bottlenose Dolphin Take Reduction Plan (BDTRP) was implemented in May 2006 resulting in changes in the gear configurations and other characteristics of the fishery.

To estimate the mortality of bottlenose dolphins in the mid-Atlantic gillnet fishery, the available data were divided into the period from 2002 through April 2006 (pre-BDTRP) and from May 2006–2008 (post-BDTRP). Three alternative approaches were used to estimate bycatch rates. First, a generalized linear model (GLM) approach was used similar to that described in Rossman and Palka (2001). This approach included all observed mortalities from 1995-2008 where the fishing gear was still in use during the period from 2002-2008. Second, a simple ratio estimator of catch per unit effort (CPUE = observed catch / observed effort) was used based directly upon the observed data. Finally, a ratio estimator pooled across years was used to estimate different CPUE values for the pre-BDTRP and post-BDTRP periods. In each case, the annual reported fishery effort (represented as reported landings) was multiplied by the estimated bycatch rate to develop annual estimates of fishery-related mortality, again similar to the approach in Rossman and Palka (2001). To account for the uncertainty in the most appropriate of these 3 alternative approaches, the average of the 3 model estimates (and the associated uncertainty) are used to estimate the mortality of bottlenose dolphins for this fishery (Table 1). It should be noted that the extrapolated estimates of total mortality include landings from inshore waters where the NNCES stock is likely to occur.

Table 1. Summary of the 2002-2008 incidental mortality of bottlenose dolphins (*Tursiops truncatus truncatus*) in the Northern North Carolina Estuarine System stock in the commercial mid-Atlantic coastal gillnet fisheries. The estimated annual and average mortality estimates are shown for the period prior to the implementation of the Bottlenose Dolphin Take Reduction Plan (pre-BDTRP) and after the implementation of the plan (post-BDTRP). Three alternative modeling approaches were used, and the average of the 3 was used to represent mortality estimates. The minimum and maximum estimates indicate the range of uncertainty in assigning observed bycatch to stock. Observer coverage is measured as a proportion of reported landings (tons of fish landed). Data are derived from the Northeast Observer program, NER dealer data and NCDMF dealer data. Values in parentheses indicated the CV of the estimate.

Period	Year	Observer Coverage[a]	Min Annual Ratio	Min Pooled Ratio	Min GLM	Max Annual Ratio	Max Pooled Ratio	Max GLM
pre-BDTRP	2002	0.01	0	0	15.64 (0.63)	0	39.45 (0.92)	33.69 (0.38)
	2003	0.01	0	0	11.03 (0.58)	49.46 (0.94)	12.77 (0.92)	19.29 (0.36)
	2004	0.02	0	0	12.10 (0.62)	0	28.46 (0.92)	28.42 (0.34)
	2005	0.03	0	0	11.84 (0.60)	0	22.58 (0.92)	23.01 (0.37)
	Jan-Apr 2006	0.03	0	0	1.40 (0.50)	0	0	1.99 (0.37)
Annual Avg. pre-BDTRP			Minimum: 3.47 (CV=0.30)			Maximum: 19.79 (CV=0.11)		
post-BDTRP	May-Dec 2006	0.03	0	0	5.08 (0.42)	73.37 (0.69)	18.84 (0.68)	12.46 (0.36)
	2007	0.03	0	0	8.32 (0.43)	0	24.47 (0.68)	18.77 (0.34)
	2008	0.01	0	0	8.14 (0.42)	0	21.91 (0.68)	16.77 (0.34)
Annual Avg. post-BDTRP			Minimum: 2.39 (CV=0.25)			Maximum: 18.99 (CV=0.11)		

[a] Observer coverage is reported on an annual basis for the entire fishery as a proportion of the reported tons of fish landed.

There have been 3 observed takes in the mid-Atlantic gillnet fishery since 2001 that could potentially be assigned to the Northern North Carolina Estuarine System stock. However, in each of these cases, the take could potentially be assigned to the Southern Migratory stock since they occurred in near-shore coastal waters of northern North Carolina. Since observed mortalities (and effort) cannot be definitively assigned to a particular stock within certain regions and times of year, the minimum and maximum possible mortality on the NNCES stock are presented for comparison to PBR (Table 1).

Based upon these analyses, the minimum mortality estimate for the NNCES stock for the pre-BDTRP period was 3.47 (CV=0.30) animals per year, and that for the post-BDTRP period was 2.39 (CV=0.25) animals per year. The maximum estimates were 19.79 (CV=0.11) for the pre-BDTRP period and 18.99 (CV=0.11) for the post-BDTRP period (Table 1).

Beach Haul Seine/Beach-based Gillnet Gear

Two coastal bottlenose dolphin takes were observed in beach haul seine gear: 1 in May 1998 and 1 in December 2000. These takes occurred during a striped bass fishery within the spatial and seasonal range of the Northern Migratory stock. Beach-based gillnet gear is now considered part of the mid-Atlantic gillnet fishery described above; however, it is not included in the observer program or resulting mortality estimates. Data from the Southeast Region Stranding Network from 2002 to 2008 include 2 confirmed reports of bottlenose dolphin mortalities in beach-based gillnet gear for striped bass during winter months off the coast of northern North Carolina: 1 in December 2002 and 1 in January 2008. A third possible mortality associated with this gear occurred during December 2002 (Southeast Regional Marine Mammal Stranding Network; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009). Based upon their location and time of year, these mortalities were most likely animals from the Northern Migratory stock rather than the NNCES stock since they occurred north of Cape Hatteras in winter months.

Crab Pots and Other Pots

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 interactions with pot gear are a common occurrence and result in mortalities of coastal morphotype bottlenose dolphins in some regions (Burdett and McFee 2004). Southeast Regional Marine Mammal Stranding Network data (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009) from 2004 through 2008 include 13 reports of interactions between bottlenose dolphins and confirmed blue crab pot gear with the majority of these occurring in waters from Florida to South Carolina. In addition, there were 4 interactions documented with pot gear where the fishery could not be confirmed. In these cases, the gear was confirmed to be associated with a pot or trap, but may have been from a fishery other than blue crab (e.g., whelk fisheries in Virginia). Of the confirmed blue crab pot interactions, there was 1 reported mortality in this 5 year period in waters of Virginia and North Carolina. This case occurred in August 2004 and is most likely assigned to the NNCES stock. There was 1 mortality in pot gear where the fishery type could not be confirmed in Virginia. This mortality was reported in August 2007 and could be assigned to either the Southern Migratory or the NNCES stock.

Virginia and North Carolina Pound Nets

Historical and recent stranding network data report interactions between bottlenose dolphins and pound nets in Virginia. Stranding data for 2004-2008 indicate 17 cases where bottlenose dolphins were removed from pound net gear, and it was determined that animals were entangled pre-mortem. In each case, the bottlenose dolphin was recovered directly from the fishing gear. Of these 17 cases, 14 were documented mortalities while 3 were released alive (S. Barco, Virginia Aquarium, unpublished data; Northeast Regional Marine Mammal Stranding Network; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009). These interactions occurred primarily inside estuarine waters near the mouth of the Chesapeake Bay and in summer months. Nine of these mortalities occurred during the summer (July-September) when they could have impacted either the Southern Migratory or the Northern North Carolina Estuarine System stocks. The overall impact of the Virginia Pound Net fishery on the Northern North Carolina Estuarine System stock is unknown due to the limited information on the stock's movements, particularly whether or not it occurs within waters inside the mouth of the Chesapeake Bay. In addition, 1 bottlenose dolphin was recovered dead from pound net gear in North Carolina during August 2004. This mortality is most likely assigned to the NNCES stock.

Other Mortality

There have been occasional mortalities of bottlenose dolphins during research activities including both directed live capture studies and fisheries surveys. From 2002 to 2009, there have been 15 reported interactions during research activities resulting in 13 documented mortalities of bottlenose dolphins. A mortality occurring in a turtle relocation trawl off of North Carolina during March 2002 could have been attributed to either the Southern Migratory stock or the NNCES stock. One mortality in a research beach seine was reported from June 2007 in northern North Carolina that was consistent with the spatial range of the Northern Migratory stock, the Southern Migratory stock or the NNCES stock. Finally, a mortality was observed in July 2007 in a research net in the Neuse River that is most likely from the NNCES stock.

Three bottlenose dolphins that were captured, tagged with satellite-linked transmitters, and released near Beaufort, North Carolina, during April 2006 by the NMFS as part of a long-term stock delineation research project were believed to have died shortly thereafter as a result of the capture or tagging (NMFS unpublished data). Two of the animals were recovered stranded but because of advanced decomposition of the carcasses cause of death could not be determined. One of these 2 animals was known from long-term photo-ID and was likely of the Southern North Carolina Estuarine System stock. The third animal has not been observed subsequent to release, but patterns in the data received from its satellite tag were similar to that of the other 2 and indicated the fates were similar. These last 2 animals were, based on satellite-derived locations, most likely from the NNCES stock. All known human-caused mortalities including both commercial fisheries and research related mortalities are summarized in Table 2.

This stock inhabits areas with significant drainage from agricultural, industrial and urban sources, and as such is exposed to contaminants in runoff from those sources. The blubber of 47 bottlenose dolphins captured and released in and around Beaufort contained contaminant levels of some level, and 7 had unusually high levels of the pesticide methoxychlor (Hansen *et al.* 2004). While there are no estimates of indirect human-caused mortality from pollution or habitat degradation, Schwacke *et al.* (2002) found that the levels of polychlorinated biphenyls (PCBs) observed in Beaufort female bottlenose dolphins would likely impair reproductive success, especially of primiparous females.

Table 2. Summary of annual reported and estimated mortality of bottlenose dolphins from the Northern North Carolina Estuarine System stock. Where minimum and maximum values are reported, there is uncertainty in the assignment of mortalities to this particular stock due to spatial overlap with other bottlenose dolphin stocks in certain areas and seasons. The reported mortalities in Virginia Pound Net, beach-based gillnet and crab pot fisheries are confirmed reports and are likely an underestimate of total mortalities in these fisheries.

Year	**Mid-Atlantic Gillnet**	**Virginia Pound Net**[a]	**Beach-based Gillnet**	**Blue Crab Pot**	**Other Pot**	**Research**	**Total**
2004	Min = 4.0 Max = 18.9	Min = 1 Max = 4	0	1	0	0	Min = 6.0 Max = 23.9
2005	Min = 4.0 Max= 15.2	Min = 0 Max = 1	0	0	0	0	Min = 4.0 Max = 16.2
2006	Min = 2.2 Max = 35.6	Min = 0 Max = 2	0	0	0	2	Min = 4.2 Max = 39.6
2007	Min = 2.8 Max = 14.4	Min = 0 Max = 1	0	0	Min = 0 Max = 1	Min = 1 Max = 2	Min = 3.8 Max = 18.4
2008	Min = 2.7 Max = 12.9	Min = 0 Max = 2	0	0	0	0	Min = 2.7 Max = 14.9
Annual Average Mortality (2004-2008)				Minimum Estimated = 4.1 Maximum Estimated = 22.6			

[a] Pound nets also include a mortality observed in North Carolina in 2004.

Strandings

Between 2004 and 2008, 422 bottlenose dolphins stranded along the Atlantic coast in North Carolina and Virginia that could be assigned to the NNCES stock (Table 3; Northeast Regional Marine Mammal Stranding Network, Southeast Regional Marine Mammal Stranding Network; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009). The assignment of animals to a particular stock is impossible in some seasons and regions, particularly in coastal waters of North Carolina and Virginia. Therefore, it is likely that the counts below include some animals from either the

Southern Migratory or Northern Migratory stocks. Within estuarine waters of North Carolina, where the probability is very high that strandings are from the NNCES stock, there were a total of 73 strandings in this 5 year period. In addition, stranded carcasses are not routinely identified to either the offshore or coastal morphotype of bottlenose dolphin, therefore it is possible that some of the reported strandings were of the offshore form. In most cases, it was not possible to determine if a human interaction had occurred due to the decomposition state of the stranded animal. However, in cases where a determination could be made, the incidence of evidence of fisheries interactions was high. In cases where a determination could be made, 65% of stranded animals from Virginia, 41% of cases from coastal waters of North Carolina and 82% (14/17) of cases from North Carolina estuarine waters had evidence of human interaction. It should be recognized that evidence of human interaction does not indicate cause of death, but rather only that there was evidence of interaction with a fishery (e.g., line marks, net marks) or evidence of a boat strike, gunshot wound, mutilation, etc., at some point in the animal's life. Evidence of fishery interaction is by far the most common type of human interaction reported.

Table 3. Strandings of bottlenose dolphins from North Carolina and Virginia that can possibly be assigned to the Northern North Carolina Estuarine System (NNCES) stock. Strandings observed in North Carolina are separated into those occurring within Pamlico Sound and other estuaries (Estuary) vs. coastal waters. Assignments to stock were based upon the understanding of the seasonal movements of this stock. However, particularly in coastal waters, there is likely overlap between the NNCES stock and other bottlenose dolphin stocks. HI = Evidence of Human Interaction, CBD = Cannot Be Determined whether an HI occurred or not. NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009.

State	**2004**			**2005**			**2006**			**2007**			**2008**		
Type	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD
North Carolina - Coastal	6	8	25	7	7	41	1	7	25	5	8	26	5	5	28
North Carolina - Estuary	6	1	9	2	0	7	4	2	11	2	0	19	0	0	10
Virginia[a]	13	5	10	7	9	13	9	3	17	6	3	19	8	1	22
Annual Total	83			93			79			88			79		

[a] Strandings from Virginia include primarily waters inside Chesapeake Bay during late summer through fall. It is likely that the NNCES stock overlaps with the Southern migratory stock in this area.

STATUS OF STOCK

From 1995 to 2001, NMFS recognized only a single migratory stock of coastal bottlenose dolphins in the western North Atlantic, and the entire stock was listed as depleted as a result of the 1987-1988 mortality event. Scott *et al.* (1988) suggested that dolphins residing in the bays, sounds and estuaries adjacent to these coastal waters were not affected by the mortality event, and these animals were explicitly excluded from the depleted listing (Federal Register: 54(195), 41654-41657; 56(158), 40594-40596; 58(64), 17789-17791).

The status of the NNCES stock relative to OSP is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine population trends for this stock. The annual average of human caused mortality for this stock ranges between a minimum of 4.1 and a maximum of 22.6, but this is an underestimate of total mortality associated with commercial fisheries. The most recent abundance estimate is greater than 8 years old, and therefore PBR is undetermined. There is insufficient information available to determine whether the total fishery-related mortality and serious injury for this stock is insignificant and approaching zero mortality and serious injury rate. However, the total human-caused mortality and serious injury is most likely greater than 10% of PBR and may approach or exceed PBR. Because the stock size is currently unknown, and relatively few mortalities and serious injuries would exceed PBR, the NMFS considers this stock to be a strategic stock.

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BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*)
Southern North Carolina Estuarine System Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The coastal morphotype of bottlenose dolphin is continuously distributed along the Atlantic coast south of Long Island, New York, to the Florida peninsula, including inshore waters of the bays, sounds and estuaries. Several lines of evidence support a distinction between dolphins inhabiting primarily coastal waters near the shore and those present primarily in the inshore waters of the bays, sounds and estuaries. Photo-identification (photo-ID) and genetic studies support the existence of resident estuarine animals in several areas (e.g., Caldwell 2001; Gubbins 2002; Zolman 2002; Gubbins *et al.* 2003; Mazzoil *et al.* 2005; Litz 2007), and similar patterns have been observed in bays and estuaries along the Gulf of Mexico coast (e.g., Wells *et al.* 1987). Recent genetic analyses using both mitochondrial DNA and nuclear microsatellite markers found significant differentiation between animals biopsied along the coast and those biopsied within the estuarine systems at the same latitude (NMFS unpublished data). Similar results have been found off the west coast of Florida (Sellas *et al.* 2005; Balmer *et al.* 2008).

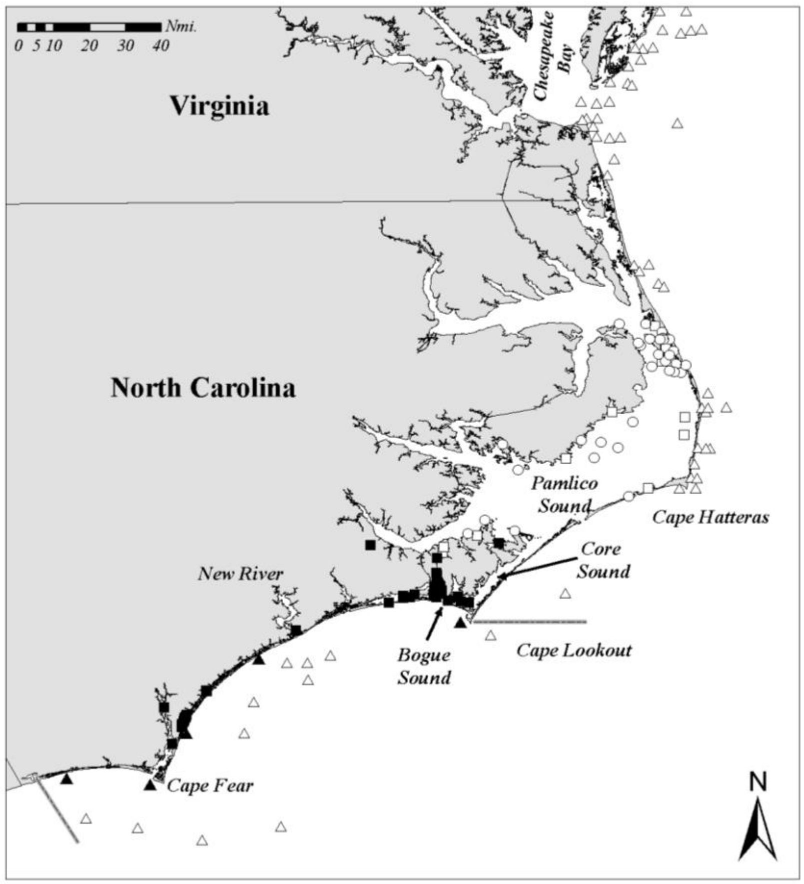

Figure 1. *The summer (July-September) distribution of bottlenose dolphins occupying coastal and estuarine waters in North Carolina and Virginia. Locations are shown from aerial surveys (triangles), satellite telemetry (circles) and photo-identification studies (squares). Sightings assigned to the Southern North Carolina Estuarine System stock are shown with filled symbols. Photo-identification data are courtesy of Duke University and the University of North Carolina at Wilmington.*

The Southern North Carolina Estuarine System (SNCES) stock is defined as animals occupying estuarine and nearshore coastal waters between the North Carolina/South Carolina border and the New River during winter months that do not undertake large scale migratory movements. Their range includes estuarine waters near Cape Fear and inshore waters of the Intracoastal Waterway along the southern North Carolina coast during fall and winter months (November–February). The ranging patterns of bottlenose dolphins in photo-ID studies supports the presence of a group of dolphins within these waters that are distinct from both dolphins occupying estuarine and coastal waters in northern North Carolina and animals from the Northern and Southern Migratory stocks that occupy coastal waters of North Carolina at certain times of the year (Read *et al.* 2003; NMFS 2001; NMFS unpublished data). In addition, genetic analysis of samples from animals in waters of southern North Carolina (between Cape Lookout and the North Carolina/South Carolina border) demonstrate significant differentiation from animals occupying waters from Virginia and further north and waters of South Carolina (NMFS 2001; Rosel *et al.* 2009). In prior stock assessment reports, the animals within this region were referred to as the "Southern North Carolina" coastal stock during summer months, and were part of the winter “mixed” North Carolina management unit of coastal bottlenose dolphins (Waring *et al.* 2009). However, they are now recognized as a distinct stock based upon these differences in seasonal ranging patterns and genetic analyses.

The seasonal movements of the SNCES stock are best described using a combination of tag telemetry and long-term photo-ID studies. Animals captured and released near Beaufort, North Carolina, were fitted with satellite-linked transmitters during November 1999 (3 animals), April 2000 (8 animals) and April 2006 (5 animals) (NMFS unpublished data). In addition, long-term photo-ID studies have been conducted in waters of North Carolina that include records of both these tagged animals and animals that were captured and freeze-branded near Beaufort, North Carolina, during summer months (Duke University unpublished data; University of North Carolina at Wilmington unpublished data; NMFS unpublished data). Two animals were tagged at Holden Beach, just south of Cape Fear during November 2004, and they remained within waters of North Carolina throughout the 9 month period when their tags were operational (NMFS unpublished data). Of the tagged or freeze-branded animals, 8 occupied estuarine and coastal waters near Cape Fear during winter months (January-February) and hence were identified as belonging to the SNCES stock. The seasonal movements of these animals are presumed to represent the range of the SNCES stock. During winter through late spring (December–May) the SNCES stock occurs primarily within the waters of southern North Carolina south of the New River. This includes both estuarine, Intracoastal Waterway and nearshore coastal waters. During summer through early fall (July-October), the stock moves north along the North Carolina coast and occupies waters of Bogue Sound, Core Sound and southern Pamlico Sound (Figure 1).

The movements of animals from the SNCES stock are distinct from those of the Northern North Carolina Estuarine System stock (NNCES). During summer and fall, NNCES animals occupy waters of northern Pamlico Sound and nearshore coastal waters perhaps as far north as the Chesapeake Bay. It is probable that there is spatial overlap between these 2 estuarine stocks during late summer and fall in the waters near Beaufort. However, SNCES stock animals were not observed to move north of Cape Lookout in coastal waters nor into the main portion of Pamlico Sound during summer (NMFS unpublished data; Duke University unpublished data; University of North Carolina at Wilmington unpublished data). These movement patterns are consistent with those in resights of individual dolphins during a photo-ID study that sampled much of the estuarine waters of North Carolina (Read *et al.* 2003). Read *et al.* (2003) suggested that movement patterns, differences in group sizes, and habitats are consistent with 2 stocks of animals occupying estuarine waters of North Carolina. Finally, genetic analysis of samples from animals in waters of southern North Carolina (between Cape Lookout and the North Carolina/South Carolina border) demonstrate significant differentiation from animals occupying waters from Virginia and further north and waters of South Carolina (Rosel *et al.* 2009).

In summary, during summer and fall months (July-October), the SNCES stock occupies estuarine and nearshore coastal waters (< 3km from shore) between the North Carolina/South Carolina border and Core Sound (Figure 1). It likely overlaps with the Northern North Carolina Estuarine System stock in the northern portion of its range during late summer. During late fall through spring, the SNCES stock moves south to waters near Cape Fear. In coastal waters, it overlaps with the Southern Migratory stock during this period.

Dolphins residing in the estuaries south of this stock between the North Carolina/South Carolina border and the northern boundary of the Charleston Estuarine System stock (CES) are not currently covered in any stock assessment report. There are insufficient data to determine whether animals in this region exhibit affiliation to the CES stock or to the SNCES stock, or if there are 1 or more estuarine stocks in this region. It should be noted, however, that in this intervening region during 2003-2007, there were 11 recorded bottlenose dolphin strandings, 2 of which were confirmed fishery interactions. One of these 2 was entangled in crab pot gear, disentangled and released alive. Of the remaining 9 stranded dolphins, evidence of human interaction could not be determined for 4 and 5 were determined not to have had any human interaction (Southeast Regional Marine Mammal Stranding Network; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009).

POPULATION SIZE

Read *et al.* (2003) provided the first and only available comprehensive abundance estimate of bottlenose dolphins that occur within the proposed boundaries of the SNCES stock. This estimate is based on a photographic mark-recapture survey of North Carolina waters inshore of the barrier islands, conducted during July 2000. Read *et al.* (2003) estimated the number of animals in the inshore waters of North Carolina equivalent to that of the SNCES stock at 141 (95% CI 112 - 200, CV=0.15). However, this estimate is more than 8 years old, and hence cannot be used to calculate N_{min} or PBR.

Since both tag-telemetry studies and photo-ID records indicate that some portion of the SNCES stock occurs in coastal waters between the North Carolina/South Carolina border and Cape Lookout during summer months, it is appropriate to include animals from summer aerial surveys of these areas in the abundance estimate. Aerial surveys to estimate the abundance of coastal bottlenose dolphins in the Atlantic 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 40m. The surveys employed a stratified design so that most effort was expended in waters shallower than 20m deep where a high proportion of observed bottlenose dolphins were expected to be of the coastal morphotype. The surveys employed 2 observer teams operating independently on the same aircraft to estimate visibility bias. Abundance estimates were calculated using line transect methods and distance analysis (Buckland *et al.* 2001). The 2002 surveys included 2 teams of observers to derive a correction for visibility bias. The independent and joint estimates from the 2 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).

During the summer survey, 6,734km of trackline were completed between Sandy Hook, New Jersey, and Ft. Pierce, Florida. All tracklines in the 0-20m 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 were 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 0-20m and 20-40m strata with the majority of effort in the shallow depth stratum. The survey was conducted between 16 July and 31 August and covered 7,189km of trackline. There were a total of 140 sightings of bottlenose dolphin groups including 3,093 individual animals. During the summer of 2004, water temperatures were significantly cooler than those during 2002 and earlier surveys conducted in 1995, and animals were distributed farther south and overlapped spatially. It is probable that both the Northern Migratory and Southern Migratory stocks occurred in waters of northern North Carolina during the summer of 2004.

The best abundance estimate for the Southern North Carolina Estuarine System stock in coastal waters is therefore from the summer 2002 survey when there was less overlap among stocks. Survey data were post-stratified to estimate the abundance of dolphins within a strip extending from the shoreline to 3km from shore between the North Carolina/South Carolina border and Cape Lookout, North Carolina. Tag-telemetry records indicated that SNCES animals rarely ventured further away from shore. However, animals from the Southern Migratory stock may occur within this strip during summer months. Therefore, the estimate of abundance within this strip likely includes both SNCES animals and Southern Migratory animals and hence overestimates the abundance. The resulting best abundance estimate for the Southern North Carolina Estuarine System stock in coastal waters is 2,454 (CV=0.53).

The best available abundance estimate for the SNCES stock is the combined abundance from estuarine and coastal waters. This combined estimate is 2,595 (CV=0.28). However, this estimate includes data that are more than 8 years old from Read *et al.* (2003). Retaining only the portion of this estimate that is less than 8 years old, the best estimate is the aerial survey from coastal waters only since it accounts for approximately 95% of the stock. Thus, the best estimate of stock abundance is 2,454 (CV=0.53), but this is clearly an underestimate of total abundance since it excludes estuarine waters.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate for the Southern North Carolina Estuarine System stock of bottlenose dolphins is 2,454 (CV=0.53). The resulting minimum population estimate is 1,614.

Current Population Trend

There are insufficient data to determine the population trends for this stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. 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 (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size of the SNCES stock of bottlenose dolphins is unknown. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP), is assumed to be 0.5 because this stock is of unknown status. PBR for the SNCES stock is therefore 16. However, this is an underestimate since the abundance estimate excludes the estuarine waters occupied by this stock.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

The SNCES stock interacts with 3 Category II fisheries: the Atlantic blue crab trap/pot fishery, North Carolina long haul seine fishery and North Carolina inshore gillnet fishery. There is no systematic observer coverage of these fisheries by the National Marine Fisheries Service (NMFS), although the North Carolina Division of Marine Fisheries operates systematic coverage of the fall flounder gillnet fishery in Pamlico Sound (Price 2008). As a result, information about interactions with North Carolina inshore fisheries is based solely on stranding data and it is not possible to estimate the annual number of interactions or mortalities in these fisheries. The SNCES stock may also interact with the mid-Atlantic gillnet fishery. The magnitude of the interaction with this fishery is unknown because of both uncertainty in the movement patterns of the stock and the spatial overlap between the SNCES stock and other bottlenose dolphin stocks in coastal waters. The total estimated average annual fishery mortality on the SNCES stock ranges between a minimum of 0.6 and a maximum of 1.2 animals per year. This range reflects the uncertainty in assigning observed or reported mortalities to a particular stock.

Mid-Atlantic Gillnet

This fishery has the highest documented level of mortality of coastal morphotype bottlenose dolphins, and the sink gillnet gear in North Carolina 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). From 2001 to 2008, 7 additional bottlenose dolphin mortalities were observed in the mid-Atlantic gillnet fishery. Three mortalities were observed in 2001 with 1 occurring off of northern North Carolina during April and 2 occurring off of Virginia during November. Four additional mortalities were observed along the North Carolina coast near Cape Hatteras: 1 in May 2003, 1 in September 2005, 1 in September 2006 and 1 in October 2006. Because the Northern Migratory, Southern Migratory, Northern North Carolina Estuarine System, and Southern North Carolina Estuarine System bottlenose dolphin stocks all occur in waters off of North Carolina, it is not possible to definitively assign all observed mortalities, or extrapolated bycatch estimates, to a specific stock. In addition, the Bottlenose Dolphin Take Reduction Plan (BDTRP) was implemented in May 2006 resulting in changes in the gear configurations and other characteristics of the fishery.

To estimate the mortality of bottlenose dolphins in the mid-Atlantic gillnet fishery, the available data were divided into the period from 2002 through April 2006 (pre-BDTRP) and from May 2006–2008 (post-BDTRP). Three alternative approaches were used to estimate bycatch rates. First, a generalized linear model (GLM) approach was used similar to that described in Rossman and Palka (2001). This approach included all observed mortalities from 1995 to 2008 where the fishing gear was still in use during the period from 2002 to 2008. Second, a simple ratio estimator of catch per unit effort (CPUE = observed catch / observed effort) was used based directly upon the observed data. Finally, a ratio estimator pooled across years was used to estimate different CPUE values for the pre-BDTRP and post-BDTRP periods. In each case, the annual reported fishery effort (represented as reported landings) was multiplied by the estimated bycatch rate to develop annual estimates of fishery-related mortality, again similar to the approach in Rossman and Palka (2001). To account for the uncertainty in the most appropriate of these 3 alternative approaches, the average of the 3 model estimates (and the associated uncertainty) are used to estimate the mortality of bottlenose dolphins for this fishery (Table 1).

Table 1. Summary of the 2002-2008 incidental mortality of bottlenose dolphins (*Tursiops truncatus truncatus*) in the Southern North Carolina Estuarine System stock in the commercial mid-Atlantic gillnet fisheries. The estimated annual and average mortality estimates are shown for the period prior to the implementation of the Bottlenose Dolphin Take Reduction Plan (pre-BDTRP) and after the implementation of the plan (post-BDTRP). Three alternative modeling approaches were used, and the average of the 3 was used to represent mortality estimates. The minimum and maximum estimates indicate the range of uncertainty in assigning observed bycatch to stock. Observer coverage is measured as a proportion of reported landings (tons of fish landed). Data are derived from the Northeast Observer program, NER dealer data and NCDMF dealer data. Values in parentheses indicated the CV of the estimate.

Period	Year	Observer Coverage[a]	Min Annual Ratio	Min Pooled Ratio	Min GLM	Max Annual Ratio	Max Pooled Ratio	Max GLM
pre-BDTRP	2002	0.01	0	0	1.77 (0.35)	0	0	4.36 (0.30)
	2003	0.01	0	0	3.12 (0.42)	0	0	4.71 (0.34)
	2004	0.02	0	0	2.77 (0.43)	0	0	6.51 (0.36)
	2005	0.03	0	0	1.43 (0.41)	0	0	2.34 (0.30)
	Jan-Apr 2006	0.03	0	0	0.01 (0.70)	0	0	0.32 (0.42)
Annual Avg. pre-BDTRP			Minimum: 0.61 (CV=0.22)			Maximum: 1.22 (CV=0.18)		
post-BDTRP	May-Dec 2006	0.03	0	0	2.23 (0.51)	0	0	2.83 (0.41)
	2007	0.03	0	0	1.88 (0.52)	0	0	2.88 (0.37)
	2008	0.01	0	0	1.42 (0.48)	0	0	2.56 (0.32)
Annual Avg. post-BDTRP			Minimum: 0.61 (CV=0.30)			Maximum: 0.92 (CV=0.21)		

[a] Observer coverage is reported on an annual basis for the entire fishery as a proportion of the reported tons of fish landed.

There have been no observed mortalities in the mid-Atlantic gillnet fishery since 2001 that could potentially be assigned to the Southern North Carolina Estuarine System stock. Hence, both the annual and pooled ratio estimators of bycatch rate were equal to 0 in both the pre-BDTRP and post-BDTRP periods. Since the GLM approach includes information from prior to 2002, positive bycatch rates for the SNCES stock were estimated (Table 1). Since observed mortalities (and effort) cannot be definitively assigned to a particular stock within certain regions and times of year, the minimum and maximum possible mortality of the SNCES stock are presented for comparison to PBR (Table 1).

Based upon these analyses, the minimum mortality estimate for the SNCES stock for the pre-BDTRP period was 0.61 (CV=0.22) animals per year, and that for the post-BDTRP period was also 0.61 (CV=0.30) animals per year. The maximum estimates were 1.22 (CV=0.18) for the pre-BDTRP period and 0.92 (CV=0.21) for the post-BDTRP period (Table 1).

Crab Pots and Other Pots

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 interactions with pot gear are a common occurrence and result in mortalities of coastal morphotype bottlenose dolphins in some regions (Burdett and McFee 2004). Southeast Regional Marine Mammal Stranding Network data (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009) from 2004 through 2008 include 13 reports of interactions between bottlenose dolphins and confirmed blue crab pot gear with the majority of these occurring in waters from Florida to South Carolina. In addition, there were 4 interactions documented with pot gear where the fishery could not be confirmed. In these cases, the gear was confirmed to be associated with a pot or trap, but may have been from a fishery other than blue crab (e.g., whelk fisheries in Virginia). There were no reported interactions that were likely to impact the SNCES stock during 2004-2008.

Other Mortality

There have been occasional mortalities of bottlenose dolphins during research activities including directed live capture studies, turtle relocation trawls and fisheries surveys. From 2002 to 2009, there have been 15 reported interactions during research activities resulting in 13 documented mortalities of bottlenose dolphins. One mortality was reported from October 2006 in a fishery research trawl that was most likely from the SNCES stock.

Three bottlenose dolphins that were captured, tagged with satellite-linked transmitters, and released near Beaufort, North Carolina, during April 2006 by the NMFS as part of a long-term stock delineation research project were believed to have died shortly thereafter as a result of the capture or tagging (NMFS unpublished data). Two of the animals were recovered stranded but because of advanced decomposition of the carcasses cause of death could not be determined. One of these 2 animals was known from long-term photo-ID and was likely of the Southern North Carolina Estuarine System stock. The third animal has not been observed subsequent to release, but patterns in the data received from its satellite tag were similar to that of the other 2 and indicated the fates were similar. These last 2 animals were, based on satellite-derived locations, most likely from the NNCES stock. All known human-caused mortalities including both commercial fisheries and research related mortalities are summarized in Table 2.

This stock inhabits areas with significant drainage from agricultural, industrial and urban sources, and as such is exposed to contaminants in runoff from those sources. The blubber of 47 bottlenose dolphins captured and released in and around Beaufort contained contaminants of some level, and 7 had unusually high levels of the pesticide methoxychlor (Hansen *et al.* 2004). While there are no estimates of indirect human-caused mortality from pollution or habitat degradation, Schwacke *et al.* (2002) found that the levels of polychlorinated biphenyls (PCBs) observed in Beaufort female bottlenose dolphins would likely impair reproductive success, especially of primiparous females.

Table 2. Summary of annual reported and estimated mortality of bottlenose dolphins from the Southern North Carolina Estuarine System stock. Where minimum and maximum values are reported, there is uncertainty in the assignment of mortalities to this particular stock due to spatial overlap with other bottlenose dolphin stocks in certain areas and seasons. The reported mortalities in crab pot fisheries are confirmed reports and are likely an underestimate of total mortalities in these fisheries.

Year	Mid-Atlantic Gillnet	Blue Crab Pot	Other Pot	Research	Total
2004	Min = 0.9 Max = 2.2	0	0	0	Min = 0.9 Max = 2.2
2005	Min = 0.5 Max = 0.8	0	0	0	Min = 0.5 Max = 0.8
2006	Min = 0.7 Max = 1.1	0	0	2	Min = 0.7 Max = 1.1

2007	Min = 0.6 Max = 1.0	0	0	0	Min = 0.6 Max = 1.0
2008	Min = 0.5 Max = 0.9	0	0	0	Min = 0.5 Max = 0.9
Annual Average Mortality (2004-2008)			Minimum Estimated = 0.6 Maximum Estimated = 1.2		

Strandings

Between 2004 and 2008, 78 bottlenose dolphins stranded in coastal and estuarine waters of North Carolina that could be assigned to the SNCES stock (Table 3; Northeast Regional Marine Mammal Stranding Network, Southeast Regional Marine Mammal Stranding Network; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009). The assignment of animals to a particular stock is impossible in some seasons and regions. In particular, there is overlap between the SNCES stock and the Southern Migratory stock in coastal waters of southern North Carolina during fall and spring. There is also overlap in southern Pamlico Sound and waters of Bogue Sound with the NNCES stock during late summer and early fall. Therefore, it is likely that the counts below include some animals from either the Southern Migratory or NNCES stock. Within estuarine waters of southern North Carolina, where the probability is very high that strandings are from the SNCES stock, there were a total of 18 strandings in this 5 year period. In addition, stranded carcasses are not routinely identified to either the offshore or coastal morphotype of bottlenose dolphin, therefore it is possible that some of the reported strandings were of the offshore form. In most cases, it was not possible to determine if a human interaction had occurred due to the decomposition state of the stranded animal. However, in cases where a determination could be made, the incidence of evidence of fisheries interactions was high in coastal waters. In cases where a determination could be made, 47% of cases from coastal waters of North Carolina and 25% (2/8) of cases from North Carolina estuarine waters had evidence of human interaction. It should be recognized that evidence of human interaction does not indicate cause of death, but rather only that there was evidence of interaction with a fishery (e.g., line marks, net marks) or evidence of a boat strike, gunshot wound, mutilation, etc., at some point in the animal's life. Evidence of fishery interaction is by far the most common type of human interaction reported.

Table 3. Strandings of bottlenose dolphins from North Carolina that can possibly be assigned to the Southern North Carolina Estuarine System stock. Strandings observed in North Carolina are separated into those occurring within estuaries vs. coastal waters. Assignments to stock were based upon the understanding of the seasonal movements of this stock. However, particularly in coastal waters, there is likely overlap between the SNCES stock and other bottlenose dolphin stocks. HI = Evidence of Human Interaction, CBD = Cannot Be Determined whether an HI occurred or not. NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 21 September 2009 and 18 November 2009.

State	**2004**			**2005**			**2006**			**2007**			**2008**		
Type	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD	HI Yes	HI No	CBD
North Carolina - Coastal	4	8	10	3	4	4	2	3	2	3	1	5	4	2	5
North Carolina - Estuary	1	1	3	0	0	1	0	4	2	1	1	1	0	0	3

Annual Total	27	12	13	12	14

STATUS OF STOCK

From 1995 to 2001, NMFS recognized only a single migratory stock of coastal bottlenose dolphins in the western North Atlantic, and the entire stock was listed as depleted as a result of the 1987-1988 mortality event. Scott *et al.* (1988) suggested that dolphins residing in the bays, sounds and estuaries adjacent to these coastal waters were not affected by the mortality event and these animals were explicitly excluded from the depleted listing (Federal Register: 54(195), 41654-41657; 56(158), 40594-40596; 58(64), 17789-17791).

The status of the SNCES stock relative to OSP is unknown. The species is not listed as threatened or endangered under the Endangered Species Act. There are insufficient data to determine population trends for this stock. The annual average of human caused mortality for this stock ranges between a minimum of 0.6 and a maximum of 1.2, but this is an underestimate of total mortality associated with commercial fisheries. The most recent abundance estimate is an underestimate of stock size because it excludes estuarine waters. Based upon the available data, it seems unlikely that mortality in commercial fisheries exceeds PBR. However, the total human-caused mortality and serious injury is most likely greater than 10% of PBR. Because of uncertainty in both stock size and mortality and because relatively few mortalities and serious injuries would exceed PBR, the NMFS considers this stock to be a strategic stock.

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