COMMON 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 common bottlenose dolphins is continuously distributed along the Atlantic coast south of Long Island, New York, around the Florida peninsula and into the Gulf of Mexico. Based on differences in mitochondrial DNA haplotype frequencies, coastal 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 residing in coastal waters of the western North Atlantic (McLellan *et al.* 2003; Rosel *et al.* 2009).

The coastal morphotype is morphologically and genetically distinct from the larger, more robust morphotype that occupies 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 two concentrations of bottlenose dolphins, one near the coast within the 25-m isobath and the other offshore of the 50-m isobath and concentrated at the continental shelf edge. The lowest density of bottlenose dolphins was observed over the continental shelf. 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).
the distribution of coastal and offshore morphotypes in waters south of Cape Hatteras, tissue samples were collected in coastal, shelf and slope waters from New England to Florida between 1997 and 2006. Genetic analyses using mitochondrial DNA sequences of these biopsies identified individual animals to the coastal or offshore morphotype. Using the genetic results from all surveys combined, a logistic regression was used to model the probability that a particular bottlenose dolphin group was of the coastal morphotype as a function of environmental variables including depth, sea surface temperature and distance from shore. These models were used to partition the bottlenose dolphin groups observed during aerial surveys between the two morphotypes (Garrison *et al.* 2003).

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

Winter samples were collected primarily from coastal waters in North Carolina and Georgia and the vast majority of them were of the coastal morphotype; however, one offshore morphotype group was sampled during November just south of Cape Lookout only 7.3 km from shore. Coastal morphotype samples were also collected farther away from shore at 33 m depth and 39 km from shore. The logistic regression model for this region indicated a decline in the probability of a coastal morphotype group with increasing distance from shore; however, the model predictions were highly uncertain due to limited sample sizes and spatial overlap between the two morphotypes. Samples collected in Georgia waters also indicated significant overlap between the two morphotypes with a declining probability of the coastal morphotype with increasing depth. A coastal morphotype sample was collected 112 km from shore 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 two morphotypes (Garrison *et al.* 2003).

In summary, the primary habitat of the coastal morphotype of bottlenose dolphin extends from Florida to New Jersey during summer months and in waters less than 20 m deep, including estuarine and inshore waters. South of

Cape Lookout, the coastal morphotype occurs in lower densities over the continental shelf (waters between 20 m and 100 m depth) and overlaps spatially with the offshore morphotype.

Distinction between Coastal and Estuarine Bottlenose Dolphins

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 *et al.* 2012). 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 coastal 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).

Despite evidence for genetic differentiation between estuarine and coastal 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 (Hohn and Hansen, 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.

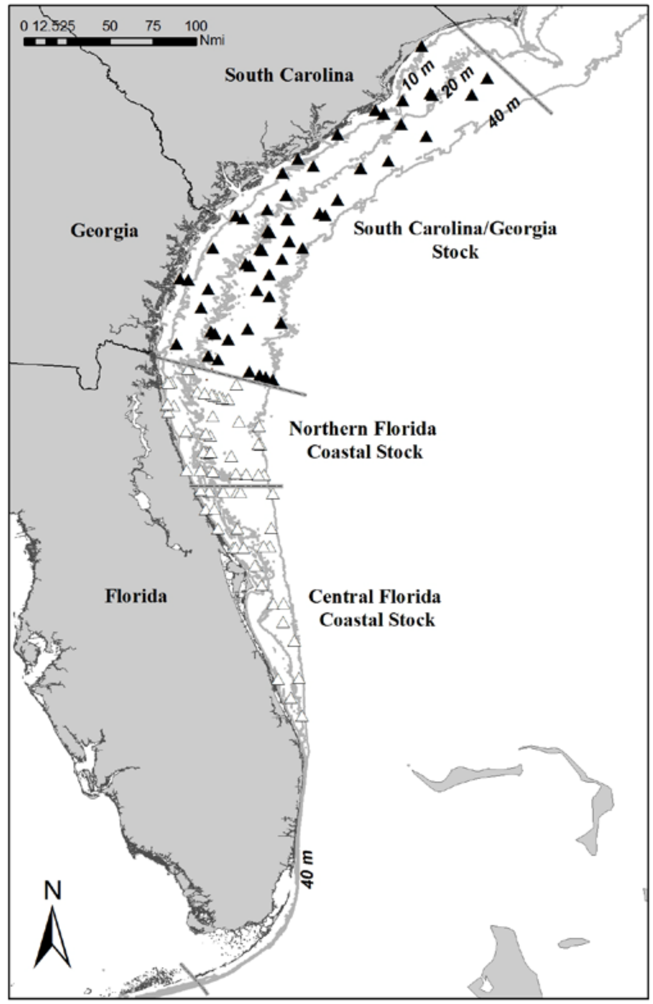

Figure 1. *The South Carolina/Georgia Coastal stock of bottlenose dolphins (North Carolina/South Carolina border to the Georgia/Florida border). Symbols represent all sightings of bottlenose dolphin groups from NMFS 2010 and 2011 aerial surveys; dark symbols- groups within the boundaries of this stock. In waters >20 m, sightings may include the offshore morphotype of bottlenose dolphins.*

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 *et al.* 2003) indicated that in waters less than 10 m depth, 70% of the bottlenose dolphins were of the coastal morphotype. Between 10 and 20 m depth, the percentage of animals of the coastal morphotype dropped precipitously and at depths >40 m 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 10-30 m depth complicating the ability to define ocean-side boundaries for the South Carolina/Georgia Coastal Stock.

POPULATION SIZE

The best available estimate for the South Carolina/Georgia Coastal Stock of bottlenose dolphins in the western North Atlantic is 4,377 (CV=0.43; Table 1). This estimate is from aerial surveys conducted during the summers of 2010 and 2011 covering waters from Florida to New Jersey.

Earlier abundance estimates

Earlier abundance estimates for the South Carolina/Georgia Coastal stock were derived from aerial surveys conducted during the summer of 2002 and 2004. Survey tracklines were set perpendicular to the shoreline and included coastal waters to depths of 40 m. These surveys employed two observer teams operating independently on the same aircraft to estimate visibility bias. 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. Observed bottlenose dolphin groups from these were partitioned between the coastal and offshore morphotypes based upon analysis of available biopsy samples (Garrison *et al.* 2003). The previous best abundance estimate was based upon a weighted average of the estimates from the 2002 and 2004 aerial surveys. This estimate was 7,738 (CV=0.23).

Recent surveys and abundance estimates

The Southeast Fisheries Science Center conducted aerial surveys of continental shelf waters along the U.S. East Coast from southeastern Florida to Cape May, New Jersey, during the summers of 2010 and 2011. The surveys were conducted along tracklines oriented perpendicular to the shoreline that were latitudinally spaced 20 km apart and covered waters from the shoreline to the continental shelf break. The summer 2010 survey was conducted during 24 July–14 August 2010, and 7,944 km of on-effort tracklines completed. A total of 127 bottlenose dolphin groups were observed including 1,541 animals. During the 2011 summer survey, 8,665 km of trackline were completed between Cape May, New Jersey and Ft. Pierce, Florida. The survey was conducted during 6 July - 29 July 2011. The 2011 survey also included more closely spaced “fine-scale” tracklines in waters offshore of New Jersey and Virginia within areas being evaluated for the placement of offshore energy installations. A total of 112 bottlenose dolphin groups were sighted including 1,339 animals.

Both the summer 2010 and 2011 surveys were conducted using a two-team approach to develop estimates of visibility bias using the independent observer approach with Distance analysis (Laake and Borchers 2004). However, the detection functions from both surveys indicated a decreased probability of detection near the trackline, which limited the effectiveness of the method for correcting for visibility bias due to a relatively small number of sightings made by both teams near the trackline. Abundance estimates were therefore derived by combining the sightings from both teams during a survey and “left-truncating” the data by analyzing only sightings occurring greater than 100 m from the trackline during the 2010 survey and 50 m during the 2011 survey (Buckland *et al.* 2001). Detection functions were fit to these left-truncated data accounting for the effects of survey conditions (e.g., sea state, glare, water color) on the detection probabilities. A logistic regression model was used to estimate the probability that a given group of dolphins observed during the aerial survey was of the coastal vs. offshore morphotype as a function of water depth (Garrison *et al.* 2003). This probability was incorporated into the abundance estimation to derive an estimate of coastal morphotype dolphins observed during the 2010 and 2011 aerial surveys. A bootstrap resampling approach was used to estimate the variance of the estimates. The resulting abundance estimates assume that detection probability at the truncation distance is equal to 1. While the estimates could not be explicitly corrected for this assumption, analyses of the summer 2010 data suggest that this bias is likely small.

The abundance estimates for the South Carolina/Georgia Coastal Stock were based upon tracklines and sightings occurring between the North Carolina/South Carolina border and the Georgia/Florida border and in waters from the shoreline to the 40-m isobath. The abundance estimate derived from the summer 2010 survey was 6,350 (CV=0.53), and the estimate from the summer 2011 survey was 2,160 (CV=0.59). The best estimate is a weighted average of these two with higher weighting given to the more precise estimate from 2010. The resulting best estimate is 4,377 (CV=0.43).

Table 1. Summary of abundance estimates for the western North Atlantic South Carolina/Georgia Coastal Stock of bottlenose dolphins. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Summer 2002 and 2004	Georgia/Florida border to South Carolina/North Carolina border	7,738	0.23
Summer 2010 and 2011	Georgia/Florida border to South Carolina/North Carolina border	4,377	0.43

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 4,377 (CV=0.43). The resulting minimum population estimate is 3,097.

Current Population Trend

There are limited data available to assess population trends for this stock. The estimates from the 2002/2004 and 2010/2011 surveys are not significantly different from each other; however, it should be noted that the relatively large CVs limit the power to detect significant differences. The statistical power to detect a trend in abundance for this species is poor due to the relatively imprecise estimates and long survey interval. For example, the power to detect a precipitous decline (i.e., 50% decrease in 15 years) in abundance with estimates of low precision (e.g., CV > 0.30) remains below 80% (alpha = 0.30) unless surveys are conducted on an annual basis (Taylor *et al.* 2007).

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 3,097. 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 31.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The total annual human-caused mortality and serious injury within the South Carolina/Georgia Coastal Stock Stock during 2007-2011 is unknown. There were 4 dolphins either recovered dead with fishing gear attached and/or observed dead in fishing gear. Two of the dead dolphins had hook/line gear entanglements/ingestions; 1 had commercial blue crab pot gear attached; and 1 was an observed take in a cannonball jellyfish trawl fishery. These represent minimum known counts of fishery-caused mortality and serious injury.

New Serious Injury Guidelines

NMFS updated its serious injury designation and reporting process, which uses guidance from previous serious injury workshops, expert opinion, and analysis of historic injury cases to develop new criteria for distinguishing serious from non-serious injury (Angliss and DeMaster 1998; Andersen *et al*. 2008; NOAA 2012). NMFS defines serious injury as an "*injury that is more likely than not to result in mortality*". Injury determinations for stock assessments revised in 2013 or later incorporate the new serious injury guidelines, based on the most recent 5-year period for which data are available.

Fishery Information

Four 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, the Southeastern U.S. Atlantic shrimp trawl fishery and the Atlantic blue crab/trap pot fishery. Two Category III fisheries have the potential to interact with this stock: the Georgia cannonball jellyfish trawl fishery and the Atlantic Ocean commercial passenger fishing vessel (hook and line) fishery. 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 are reported annually within the bounds of the South Carolina/Georgia Coastal Stock. There has been occasional observer coverage of sets within the stock boundaries. No takes have been observed.

Southeastern U.S. Shrimp Trawl Fishery

In 2002 in Beaufort County, South Carolina, a fisherman self-reported a dolphin entanglement in a commercial shrimp trawl. In 2006 in Beaufort County, South Carolina, a dolphin was incidentally taken in a shrimp trawl during fishery trawl research. 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. However, during 2007-2011, 1 stranded carcass was found entangled around its peduncle in commercial blue crab pot, line and buoy gear. Two additional strandings had rope abrasions at the insertion of flukes and on their peduncles consistent with crab pot entanglement, but no gear was present to confirm.

Georgia Cannonball Jellyfish Trawl Fishery

During 2007-2011, 1 bottlenose dolphin was incidentally captured by a commercial fishing vessel trawling for cannonball jellyfish. This mortality occurred during 2011 several miles off the Georgia coast.

Hook and Line Fisheries

During 2007-2011, 2 dolphins were documented with ingested hook and line gear. During 2010 in the South Carolina/Georgia Coastal Stock area, 1 dolphin was documented with ingested recreational sportfishery gear wrapped around its goosebeak. In 2011 an additional animal was documented with ingested hook and line gear. These mortalities were included in the stranding database.

Other Mortality

There were 149 stranded bottlenose dolphins documented between 2007 and 2011 in the waters of the South Carolina/Georgia Coastal Stock (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 13 September 2012). It was not possible to determine whether or not there was evidence of human interaction for 86 of these strandings, and for 50 it was determined there was no evidence of human interaction. The remaining 13 showed evidence of human interactions, including 6 fishery interactions, 2 mutilations, 2 cases of live stranded animals being carried to deeper water by the public, and 3 cases of wounds and line impressions of unknown origin. As mentioned above, 1 of the fishery interactions was a carcass found entangled in commercial blue crab pot gear. Two other fishery interactions had rope abrasions consistent with crab pot entanglement, but no gear was present to confirm. Two fishery interactions consisted of ingested hook and line gear, wrapped around the goosebeak in one case and found in the animal's stomach in the second case. It is worth noting that during winter months, the South Carolina/Georgia Coastal Stock overlaps with the Southern Migratory Coastal Stock and it is currently not possible to distinguish between them. Hence during winter months, stranded dolphins could come from either of these two stocks. Some (42) of the 149 strandings are also included in the stranding total for the Southern Migratory Coastal Stock.

An Unusual Mortality Event (UME) was declared in South Carolina during February-May 2011. Fourteen strandings assigned to the South Carolina/Georgia Coastal Stock were considered to be part of the UME. The cause of this UME is still under investigation.

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

Bottlenose dolphins are not listed as threatened or endangered under the Endangered Species Act, but the South Carolina/Georgia Coastal Stock is a strategic stock due to the depleted listing under the Marine Mammal Protection Act. 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. PBR for the South Carolina/Georgia Coastal Stock is 31 and so the zero mortality rate goal, 10% of PBR, is 3.1. The documented annual average of human-caused mortality for this stock for 2007 – 2011 ranges from 0.8 to 1.2. However, there are several commercial fisheries operating within this stock's boundaries and these fisheries have little to no observer coverage. Therefore, the documented mortalities must be considered minimum estimates of total fishery-related mortality. Insufficient information is available to determine whether the total fishery-related mortality and serious injury for this stock is insignificant and approaching a zero mortality and serious injury rate. The status of this stock relative to OSP is unknown. There are insufficient data to determine population trends for this stock.

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