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COMMON BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*)
Indian River Lagoon Estuarine System Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the western North Atlantic, the coastal morphotype of common bottlenose dolphins is continuously distributed in nearshore coastal and estuarine waters along the U.S. Atlantic coast south of Long Island, New York, to the Florida peninsula. Several lines of evidence support a distinction between dolphins inhabiting coastal waters near the shore and those present 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 of the southeastern United States (e.g., Caldwell 2001; Gubbins 2002; Zolman 2002; Mazzoil *et al.* 2005; Litz *et al.* 2012), and similar patterns have been observed in bays and estuaries along the Gulf of Mexico coast (e.g., 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 in coastal and estuarine areas along the Atlantic coast (Rosel *et al.* 2009), and between those biopsied in coastal and estuarine waters at the same latitude (NMFS unpublished data). Similar results have been reported for the west coast of Florida (Sellas *et al.* 2005).

Multiple studies utilizing varying methods such as freeze-branding, photo-ID and radio telemetry support the designation of bottlenose dolphins in the Indian River Lagoon (IRL) as a distinct stock. Odell and Asper (1990) reported that none of the 133 freeze-branded dolphins from the IRL were observed outside of the system during their 4-year monitoring period from 1979 to 1982 and suggested that there may be an additional discrete group of dolphins in the southern end of the system. A stranded dolphin from the IRL that was rehabilitated, freeze-branded and released into the IRL was recaptured 14 years later in the IRL during a health assessment project (Mazzoil *et al.* 2008b). Photo-ID studies have provided evidence that some dolphins in the IRL exhibit both short-term and long-term site fidelity (Mazzoil *et al.* 2005; Mazzoil *et al.* 2008a). During a 5-year study (1996-2001) in the IRL, 67 individual dolphins were sighted 8 or more times, which included 11 dolphins freeze-branded from the Odell and Asper (1990) study that were sighted at least once (Mazzoil *et al.* 2005). In addition, Mazzoil *et al.* (2008a) suggested that at least 3 different dolphin communities exist within the IRL based on analyses of photo-ID data. Radio-tracking of 2 rehabilitated dolphins stranded in the IRL indicated that neither dolphin left the IRL from the time of release until their deaths in 100 days and 7days, respectively (Mazzoil *et al.* 2008b). A photo-ID study conducted from 2006-2008 provided evidence for spatial separation and minimal

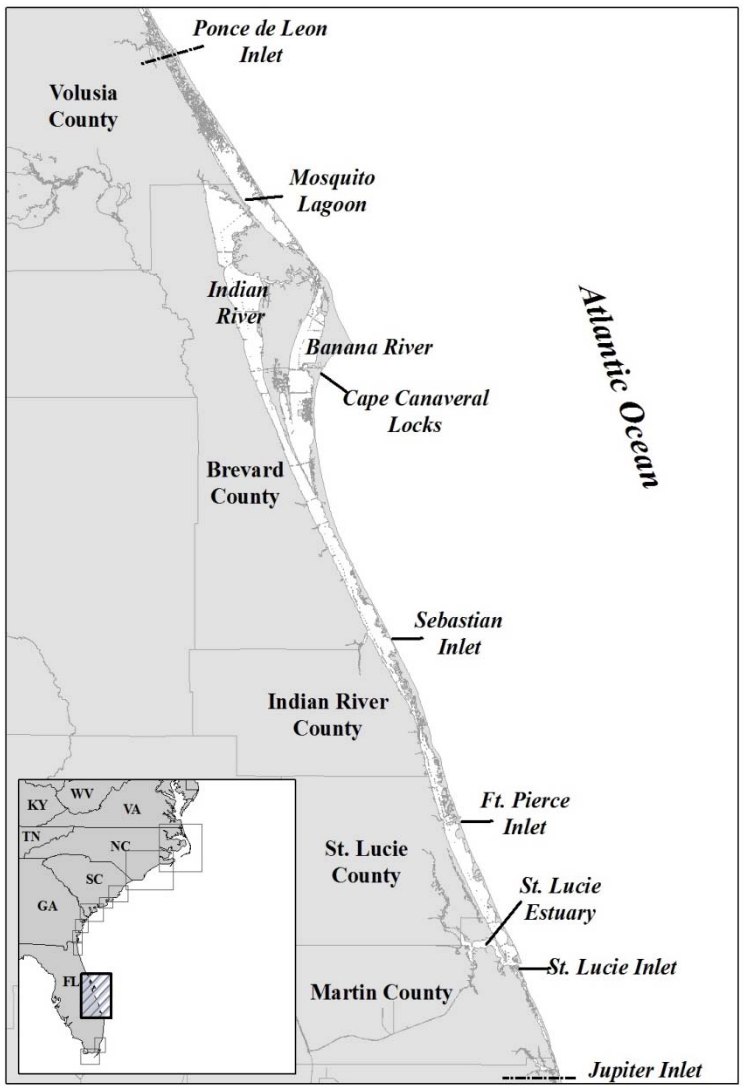

Figure 1. *Geographic extent of the Indian River Lagoon Estuarine System (IRLES) Stock. Dashed lines denote the boundaries.*

degree of movement between dolphins in the IRL and those occurring in the nearshore coastal waters of the Atlantic Ocean between Sebastian and St. Lucie Inlets (Mazzoil *et al.* 2008a). However, results from aerial surveys to estimate abundance during 2002-2004 (Durden *et al.* 2011, described under "Population Size" below) seem to contradict an exclusively resident population, and rather suggest movements of IRL dolphins between adjacent estuarine and/or coastal waters. There is still a need to better understand movement patterns between the IRL and adjacent coastal and estuarine waters. The boundaries of this stock are subject to change upon further study.

The Indian River Lagoon Estuarine System (IRLES) Stock on the Atlantic coast of Florida extends from Ponce de Leon Inlet in the north to Jupiter Inlet in the south and encompasses all estuarine waters in between (Figure 1), including but not limited to the Intracoastal Waterway, Mosquito Lagoon, Indian River, Banana River and the St. Lucie Estuary. Five inlets and the Cape Canaveral Locks connect the IRLES to the Atlantic Ocean. This definition of the IRLES has been used by a number of researchers (e.g., Kent *et al.* 2008) and is the most expansive definition. Some researchers truncate the southern border at the St. Lucie Inlet.

Dolphins residing within estuaries north and south of this stock are currently not included in any Stock Assessment Report. There are insufficient data to determine whether animals south of the IRLES exhibit affiliation to the Biscayne Bay Stock or are simply transient animals associated with coastal stocks. Similarly, there are insufficient data to determine whether animals in estuarine waters north of the IRLES exhibit affiliation to the IRLES Stock or to the Jacksonville Estuarine System Stock to the north or are simply transients. There is relatively limited estuarine habitat along the coastline south of the IRLES but some potentially suitable habitat north of the IRLES. Further research is needed to establish affinities of dolphins in these regions. It should be noted that during 2009–2013, there were 32 stranded bottlenose dolphins in the region north of the IRLES in enclosed waters, including 3 interactions with hook and line fishing gear (1 mortality, 1 serious injury, 1 live release without serious injury) and 2 entanglements in blue crab trap/pot gear (1 mortality and 1 live release without serious injury) (Maze-Foley and Garrison in prep a,b). During 2009–2013 there were 3 estuarine stranding south of the IRLES. In addition to animals included in the stranding database, in estuarine waters north of the IRLES there were 3 at-sea observations of dolphins entangled in hook and line gear, crab trap/pot gear and thick line. All 3 dolphins were considered not seriously injured (Maze-Foley and Garrison in prep a,b).

POPULATION SIZE

Population size estimates for this stock are greater than 8 years old and therefore the current population size for the stock is considered unknown (Wade and Angliss 1997). Abundance estimates ranging from 206 to 816 dolphins (Leatherwood 1979; Thompson 1981; Leatherwood 1982; Burn *et al.* 1987; Mullin *et al.* 1990) were made in the 1970's and 1980's in response to common bottlenose dolphin live-capture fisheries where 68 dolphins were permanently removed between 1973 and 1988 for display in marine parks and use by the military (Scott 1990). No dolphins have been removed from the IRLES since 1989. Abundances based on aerial and small boat-based strip- or line-transect surveys were estimated to establish capture quotas or to assess the impact of the removals (Scott 1990). Scott (1990) suggested that a large number of bottlenose dolphins moved into the IRLES during the summer from the adjacent Atlantic Ocean. However, preliminary analyses of extensive photo-ID data collected throughout the IRLES and the adjacent Atlantic from 2002 to 2008 do not support this hypothesis and indicate very few bottlenose dolphins move between the IRLES and the Atlantic Ocean (Mazzoil *et al.* 2011). During photo-ID studies conducted in the IRLES for 3 years from 2002 to 2005, 615 bottlenose dolphins with distinct dorsal fins were identified (Mazzoil *et al.* 2008a). This number of dolphins is comparable to the larger abundances previously estimated (506-816 dolphins) which were based on small boat surveys (Mullin *et al.* 1990) and a mark-recapture study (Burn *et al.* 1987) and were probably less negatively biased compared to the aerial surveys. Seasonal aerial surveys were conducted from summer 2002 through spring 2004 (Durden *et al.* 2011). Abundance estimates were lowest in summer and highest in winter, ranging from 362 (CV=0.29) for summer 2003 to 1316 (CV=0.24) for winter 2002-2003 with an overall mean abundance of 662 (CV=0.09). These results also do not support Scott (1990) regarding dolphin movements into the IRLES during summer. The pattern of larger winter estimates occurred in both years of the Durden *et al.* (2011) study and was pronounced in two areas, Mosquito Lagoon and southern Indian River.

Minimum Population Estimate

Present data are insufficient to calculate a minimum population estimate for the IRLES Stock of common bottlenose dolphins.

Current Population Trend

There are insufficient data to determine the population trends for this stock because of significant methodological differences in the surveys over time.

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 IRLES Stock of common bottlenose dolphins is unknown. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor is 0.5 because this stock is of unknown status. PBR for the IRLES Stock of common bottlenose dolphins is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The total annual human-caused mortality and serious injury for the IRLES Stock during 2009–2013 is unknown because this stock is known to interact with unobserved fisheries (see below). The mean annual fishery-related mortality and serious injury for strandings and at-sea observations identified as fishery-caused was 4.4. No additional mortality or serious injury was documented from other human-caused actions. The minimum total mean annual human-caused mortality and serious injury for this stock during 2009–2013 was 4.4.

Fishery Information

The commercial fisheries that interact, or that potentially could interact, with this stock are the Category II Atlantic blue crab trap/pot; and Southeastern U.S. Atlantic, Gulf of Mexico stone crab trap/pot fisheries; and the Category III Atlantic Ocean, Gulf of Mexico, Caribbean commercial passenger fishing vessel (hook and line) fishery (Appendix III).

Crab Trap/Pot

Interactions between common bottlenose dolphins and the blue crab fishery in the IRLES have been documented. Noke and Odell (2002) observed behaviors that included dolphins closely approaching crab boats, begging, feeding on discarded bait and crab pot tipping to remove bait from the pot. Of the dolphins sighted during this 1-year study, 16.6% interacted with crab boats and these interactions peaked during summer months. Also during the 1-year study, in March 1998 a dolphin was found dead, entangled in float lines with 3 crab pots attached (Noke and Odell 2002).

Between 2009 and 2013, 3 bottlenose dolphins were documented entangled in commercial blue crab trap/pot gear (i.e., rope and/or pots attached), and disentanglement efforts were made for each. All 3 were released alive without serious injuries (Maze-Foley and Garrison in prep a,b). The 3 cases were included in the stranding database (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 11 June 2014). Since there is no systematic observer program, it is not possible to estimate the total number of interactions or mortalities associated with crab trap/pot gear.

Hook and Line

Stranding data from 1997 through 2009 were used to investigate hook and line gear interactions with common bottlenose dolphins in the IRLES (Stolen *et al.* 2012). During the 13-year study, 57 dolphins (16% of dolphins examined) were found with evidence of fishing gear (single or multi-strand line, fishing hooks, metal sinkers, swivels, and/or lures). Forty-five dolphins ingested gear, 10 dolphins had gear externally wrapped or embedded, and in 2 instances gear was present both externally and internally. In total, 18 interactions (32%) with gear were considered fatal (gear was cause of death) and 23 (40%) were considered incidental (gear did not cause significant tissue or functional damage). While ingested gear was more common than external gear interactions, in most cases it was considered not fatal. However, interactions involving ingested line wrapped around the base of the larynx were always fatal. Occurrence of gear entanglements was less frequent than ingestion of gear but was almost always considered severe and often fatal. Stolen *et al.* (2012) noted that the nature of this study resulted in a conservative estimate of the effects of hook and line fishing for several reasons, including: nonlethal effects of gear interactions could not be determined; carcasses with gear interactions may not always be found by stranding personnel; and animals decompose rapidly in Florida making entanglement difficult to document.

Between 2009 and 2013, there were 25 documented strandings with evidence of hook and line fishery interaction (see Other Mortality below). Nineteen of the 25 were mortalities, 1 was released alive with serious injuries, and 5 were released alive without serious injuries (Maze-Foley and Garrison in prep a,b,c). It should be noted that, in general, it cannot be determined if hook and line gear originated from a commercial (i.e., charter boat and headboat) or recreational angler because the gear type used by both sources is typically the same. Also, it is not possible to estimate the total number of interactions with hook and line gear because there is no systematic observer program.

Other Mortality

A common bottlenose dolphin live-capture fishery operating between 1973 and 1988 in the IRLES permanently removed 68 bottlenose dolphins for display in marine parks and for use by the military (Scott 1990). No dolphins have been removed from the IRLES since 1989.

A total of 227 common bottlenose dolphin strandings were documented within the IRLES from 2009 through 2013 (Table 2; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 11 June 2014). Evidence of human interactions (e.g., fishing gear or debris entanglement or ingestion, mutilation, boat collision) was detected for 36 strandings; no evidence of human interactions was found for 42 animals, and for the remaining 149 animals, it could not be determined if there was evidence of human interactions. Thirty of the 36 strandings for which evidence of human interactions was detected involved fisheries interactions, including the 3 crab trap/pot interactions discussed above. Bottlenose dolphins are known to become entangled in, or ingest recreational and commercial fishing gear (Wells and Scott 1994; Gorzelany 1998; Wells *et al.* 1998; Wells *et al.* 2008; Stolen *et al.* 2012). Twenty-five strandings showed evidence of interaction with hook and line fishing gear, including entanglement in or ingestion of monofilament line, hooks or lures. These interactions may or may not have been the cause of the animal's death, and in some cases the relationship between the gear and cause of death could not be determined.

Two identified dolphins from the IRLES were disentangled from fishing gear multiple times. One dolphin was disentangled and released alive on 3 separate occasions (Maze-Foley and Garrison in prep a), and subsequently stranded dead entangled in fishing gear. The second dolphin stranded dead as a result of tail fluke entanglement in fishing gear following 3 prior disentanglement and live release interventions.

In addition to animals included in the stranding database, in 2010 and 2012, there were at-sea observations in the IRLES area of a dolphin entangled in fishing gear (wrapped around body parts). Both dolphins were considered seriously injured (Maze-Foley and Garrison in prep a,b).

There are a number of difficulties associated with the interpretation of stranding data. It is possible that some of the stranded dolphins may have been from a nearby coastal stock, although the proportion of stranded dolphins belonging to another stock cannot be determined because it is often unclear from where the stranded carcasses originated. However, preliminary analyses of photo-ID data suggest that many of the stranded dolphins with distinct dorsal fins found within the IRLES had been photographed within the estuary previously, and furthermore, many of them were found within their known photo-ID home ranges (Mazzoil *et al.*, in preparation). Stranding data probably underestimate the extent of human and fishery-related mortality and serious injury because not all of the dolphins that die or are seriously injured in human interactions wash ashore, or, if they do, they are not all recovered (Peltier *et al*. 2012; Wells *et al*. 2015). Additionally, not all carcasses will show evidence of human interaction, entanglement or other fishery-related interaction due to decomposition, scavenger damage, etc. (Byrd *et al.* 2014). Finally, the level of technical expertise among stranding network personnel varies widely as does the ability to recognize signs of human interaction.

Bottlenose dolphin stranding data from 1977 to 2005 were analyzed by Stolen *et al.* (2007) to examine spatio-temporal aspects of strandings, age/sex specific mortality patterns and human-related mortality in the IRLES. Stolen *et al.* (2007) reported that 834 total dolphins stranded during the time frame of the study, which ranged from a low of 11 animals in 1985 to a high of 61 animals in 2001. Significant findings were: more strandings occurred in spring and summer; more of the strandings were males; and juveniles stranded more frequently, followed by adults, then calves (Stolen *et al.* 2007). Human interaction (HI) (e.g., gear and debris entanglement or ingestion, mutilation, boat collision) was reported in 10.2% (n=85) of strandings. Significantly more males showed evidence of HI than females. Most strandings with HI evidence were reported in spring and summer and found in Brevard County (n=64). Ingestion of or entanglement in recreational fishing gear accounted for 54.1% (n=46), and commercial fishing interaction accounted for 23.5% (n=20) of strandings where HI was recorded (Stolen *et al.* 2007).

The IRLES Stock has experienced several Unusual Mortality Events (UMEs). In 2001, there was a record high number of strandings in the IRLES (n=61) (Stolen *et al.* 2007). A UME was declared when 34 of these dolphins stranded in a relatively short time period (7 May – 25 August 2001) and were confined to a relatively small geographic area in central Brevard County (Stolen *et al.* 2007). The cause of this UME was undetermined; however, saxitoxin, a biotoxin produced by the algae *Pyrodinium bahamense*, was suspected to be a factor. The IRLES experienced another UME in 2008. From May to August a total of 47 bottlenose dolphins were recovered from the northern IRLES. One dolphin from the Central Florida Coastal Stock was also considered part of this UME (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 13 September 2012). Infectious disease is suspected as a possible cause of this event. During January to December 2013, another UME occurred within the IRLES. Elevated strandings occurred in the northern and central IRLES in Brevard County. The investigation and analyses are ongoing. Finally, a UME was declared in the summer of 2013 for the mid-Atlantic coast from New York to Brevard County, Florida. Beginning in July 2013, bottlenose dolphins have been stranding at elevated rates. The total number of stranded bottlenose dolphins from New York through North Florida (Brevard County) as of mid-October 2014 (1 July 2013 - 19 October 2014) was ~1546. Morbillivirus has been determined to be the cause of the event. Most strandings and morbillivirus positive animals have been recovered from the ocean side beaches rather than from within the estuaries, suggesting that at least so far coastal stocks have been more impacted by this UME than estuarine stocks. However, several confirmed morbillivirus positive animals have been recovered from within the IRLES Stock area. The UME is still ongoing as of December 2014 when this report was drafted, and work continues to determine the effect of this event on all bottlenose dolphin stocks in the Atlantic.

Feeding or provisioning of wild bottlenose dolphins has been documented in Florida, particularly in areas of the Indian River Lagoon. Feeding wild dolphins is defined under the MMPA's implementing regulations as a form of "take" because it can alter the dolphins' natural behavior and increase their risk of injury or death. There are emerging questions regarding potential linkages between provisioning wild dolphins, dolphin depredation of recreational fishing gear, and associated entanglement and ingestions of gear, which is increasing through much of Florida.

Impacts of motorized vessels on bottlenose dolphins in the IRLES were investigated using photo-ID data collected from September 1996 to October 2006 (Bechdel *et al.* 2009). Six percent of distinctly marked individuals had injuries associated with vessel impact. Two counties, Martin and St. Lucie Counties, had the highest rate (9.9%) of boat-injured dolphins as well as the largest number of registered boaters per km^2 (237 boats/km^2). During sightings with less than 5 vessels within 100 m of the dolphin group, changes in the frequency of feeding decreased and traveling increased. Resting behavior was the least observed activity (< 1% of observations) during the 10-year study. Bechdel *et al.* (2009) suggest that continual vessel avoidance, lack of rest, and projected increases in anthropogenic impacts may result in chronic stress for dolphins inhabiting the IRLES.

Table 2. Bottlenose dolphin strandings by county within the Indian River Lagoon System from 2009 to 2013, as well as number of strandings for which evidence of human interaction was detected and number of strandings for which it could not be determined (CBD) if there was evidence of human interaction. Data are from the NOAA National Marine Mammal Health and Stranding Response Database (accessed 11 June 2014). Please note human interaction does not necessarily mean the interaction caused the animal's death.

COUNTY		**2009**	**2010**	**2011**	**2012**	**2013**	**TOTAL**
Volusia	**Total Stranded**	**2**	**1**	**6**	**5**	**8**	**22**
	Human Interaction						
	---Yes	1	1	2	1	1	6
	---No	0	0	1	0	1	2
	---CBD	1	0	3	4	6	14
Seminole	**Total Stranded**	**1**	**0**	**0**	**0**	**0**	**1**
	Human Interaction						
	---Yes	1	0	0	0	0	1
	---No	0	0	0	0	0	0
	---CBD	0	0	0	0	0	0
Brevard	**Total Stranded**	**25**	**32**	**18**	**38**	**70**	**183**
	Human Interaction						
	---Yes	3	5	1	8	7	24
	---No	4	6	3	9	13	35
	---CBD	18	21	14	21	50	124
Indian							

River	**Total Stranded**	**1**	**2**	**1**	**3**	**4**	**11**
	Human Interaction						
	---Yes	0	0	0	1	0	1
	---No	0	0	0	0	2	2
	---CBD	1	2	1	2	2	8
St. Lucie	**Total Stranded**	**1**	**0**	**5**	**0**	**0**	**6**
	Human Interaction						
	---Yes	0	0	4	0	0	4
	---No	1	0	1	0	0	2
	---CBD	0	0	0	0	0	0
Martin	**Total Stranded**	**1**	**1**	**2**	**0**	**0**	**4**
	Human Interaction						
	---Yes	0	0	0	0	0	0
	---No	0	0	1	0	0	1
	---CBD	1	1	1	0	0	3
TOTAL	Total Stranded	**31**	**36**	**32**	**46**	**82**	**227**
	Human Interaction						
	---Yes	5	6	7	10	8	36
	---No	5	6	6	9	16	42
	---CBD	21	24	19	27	58	149

HABITAT ISSUES

The IRLES is a shallow water estuary with little tidal influx, which limits water exchange with the Atlantic Ocean. This allows for accumulation of land-based effluents and contaminants in the estuary, as well as fresh-water dilution from run-off and rivers. A large portion of Florida's agriculture also drains into the IRLES, including all of the sugarcane, approximately 38% of citrus and 42% of other vegetable crops (Miles and Pleuffer 1997). Dolphins in the IRLES were found to have concentrations of contaminants at levels of possible toxicological concern. Hansen *et al.* (2004) suggested that polychlorinated biphenyl (PCBs) concentrations in blubber samples collected from remote biopsy of IRLES dolphins were sufficiently high to warrant additional sampling. Fair *et al.* (2010) found potentially harmful levels of several different chemical contaminants, including some that may act as endocrine disruptors. However, there have been no reports of mortalities in the IRLES resulting solely from contaminant concentrations.

Durden *et al.* (2007) found mean mercury concentrations in IRLES dolphins were positively correlated with age and length and tended to be slightly higher than dolphins from the Gulf of Mexico and South Carolina coasts. In the same study, 5 animals were found to have mercury concentrations exceeding 100ppm, which may be associated with toxic effects in marine mammals (Durden *et al.* 2007). Stavros *et al.* (2007, 2008) reported that blood and skin samples obtained from IRLES dolphins had concentrations of total mercury among the highest reported in free-living marine mammals worldwide and approximately 4 to 5 times the concentrations found in dolphins from Charleston, South Carolina. Concentrations of total mercury in IRLES dolphins were associated with lower levels of total thyroxine, triiodothyronine, lymphocytes, eosinophils and platelets and increases in blood urea nitrogen and gamma-glutamyl transferase (Schaefer *et al.* 2011). A further study of IRLES dolphins indicated that 33% of the stranded and 15% of the free-ranging dolphins from Florida exceeded the minimum 100 lg g_1 wet weight (ww) Hg threshold for hepatic damage previously published for marine mammals (Stavros *et al.* 2011).

Recent studies of IRLES dolphins have shown evidence of infection with the cetacean morbillivirus. Positive morbillivirus titers were found in 12 of 122 (9.8%) IRLES dolphins sampled between 2003 and 2007 (Bossart *et al.* 2010). In addition, approximately 10% of bottlenose dolphins had lacaziosis (lobomycosis), a chronic mycotic disease of the skin caused by *Lacazia loboi* (Reif *et al.* 2006). The prevalence of lacaziosis was also studied through examination of photo-ID data between 1996 and 2006 and was estimated to be 6.8% (Murdoch *et al.* 2008). There are no published reports of mortalities resulting solely from this disease.

STATUS OF STOCK

Common bottlenose dolphins in the western North Atlantic are not listed as threatened or endangered under the

Endangered Species Act. However, because the abundance of the IRLES Stock is currently unknown, but likely small, and relatively few mortalities and serious injuries would exceed PBR, NMFS considers this to be a strategic stock under the Marine Mammal Protection Act. The documented mean annual human-caused mortality for this stock for 2009 – 2013 was 4.4. However, there are several commercial fisheries operating within this stock's boundaries and these fisheries have little to no observer coverage. In particular, the impact of crab trap/pot fisheries on estuarine bottlenose dolphins is currently unknown, but has been shown previously to be considerable in the similar Charleston Estuarine System Stock area (Burdett and McFee 2004). Therefore, any documented mortalities must be considered minimum estimates of total fishery-related mortality. There is insufficient information 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 the population trends for this stock.

Documented human-caused mortalities from hook and line gear and crab pot gear entanglements as well as repeated UMEs reinforce concern for this stock. The removal of dolphins in live-capture fisheries in the 1970's and 1980's is also cause for concern; however, the effects of the permanent removals and the mortality events on stock abundance have not yet been completely determined. Stolen and Barlow (2003) concluded that the population's growth rate was stable or increasing from a model life table that was based on stranding data collected from 1978 to 1997 and incorporated the live capture removals. The limited ranging behavior of potentially 3 or more discrete dolphin communities and the geographic localization of previous UMEs suggest that mortality impacts may be more significant when analyzed on a smaller spatial scale.

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