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BOTTLENOSE DOLPHIN (*Tursiops truncatus*)
Indian River Lagoon 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 bays, sounds and estuaries. Except for animals residing within the Southern North Carolina and Northern North Carolina Estuarine Systems (e.g., Waring *et al.* 2007), estuarine dolphins along the U.S. east coast have not previously been included in stock assessment reports. 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 2007), 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 biopsies collected from bottlenose dolphins along the coast and those collected within the estuarine systems at the same latitude (NMFS unpublished data). Similar results have been reported for the west coast of Florida (Sellas *et al.* 2005).

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, 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.

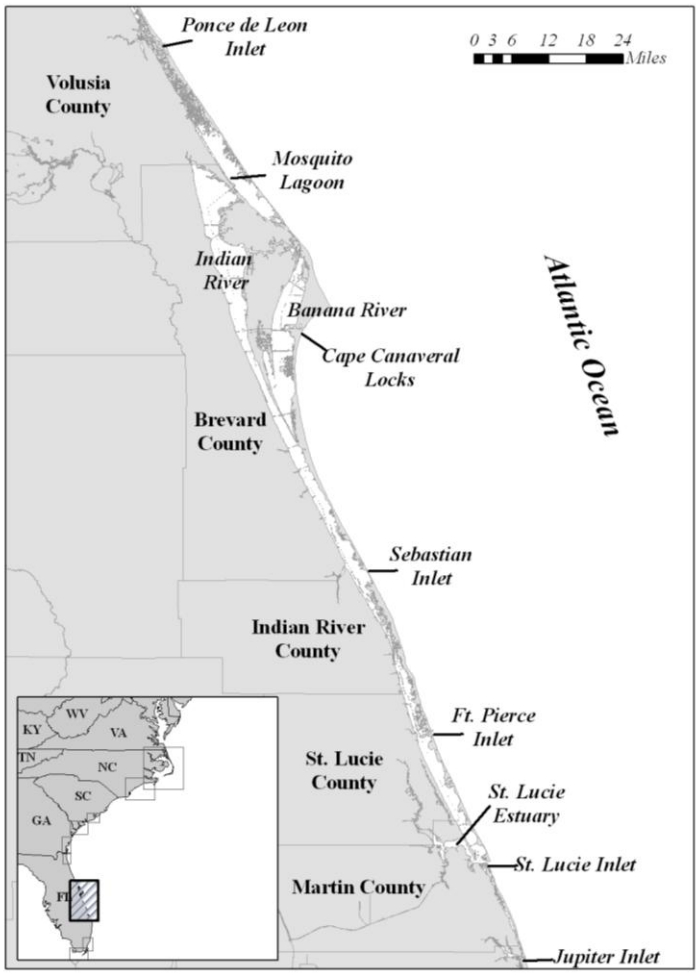

Figure 1. *Geographic extent of the Indian River Lagoon Estuarine System (IRLES) stock.*

Multiple studies utilizing varying methods such as freeze-branding, photo-ID and radio telemetry support the designation of bottlenose dolphins in the IRLES as a distinct stock. Odell and Asper (1990) reported that none of the 133 freeze-branded dolphins from the IRLES 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 IRLES that was rehabilitated, freeze-branded and released into the IRLES was recaptured 14 years later in the IRLES during a health assessment project (Mazzoil *et al.* 2008b). Photo-ID studies have provided evidence that some dolphins in the IRLES 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 IRLES, 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 IRLES based on analyses of photo-ID data. Radio-tracking of 2 rehabilitated dolphins stranded in the IRLES indicated that neither dolphin left the IRLES from the time of release until their deaths in 100 days and 7days, respectively (Mazzoil *et al.* 2008b).

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 2003-2007, there were 16 stranded bottlenose dolphins in the region north of the IRLES in enclosed waters. Evidence of human interaction was detected for 4 of these strandings, including 2 fishery interactions with crab pots (1 of these was a live animal that was disentangled) and 2 boat strikes (1 fresh prop marks and 1 healed prop marks). There were 3 estuarine strandings south of the IRLES. One of these had signs human of interaction from a boat strike and another was identified as belonging to the offshore morphotype.

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 (Table 1) were made in the 1970's and 1980's in response to bottlenose dolphin live-capture fisheries where 68 dolphins were permanently removed between 1973 and 1988 for captive display in marine parks (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, pers. comm.). 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). While mortality of some of these 615 identified dolphins certainly occurred during the 3 years, there were also dolphins with indistinct dorsal fins that were not included in the count. This number of dolphins is also 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. Analyses of recently collected aerial survey data and capture-recapture analyses from the photo-ID studies are currently underway that should yield updated abundance estimates (Noke-Durden, pers. comm.; Mazzoil, pers. comm.).

Table 1. Abundance estimates for the Indian River Lagoon System.

Study	Type	Year & Month	N_{best}	CV
Leatherwood (1979)	Aerial - transect	1977 August	438	0.15
Thompson (1981)	Aerial - transect	1980 May	206	0.42
	Aerial - transect	1980 August	435	0.19
	Aerial - transect	1980 November	202	0.26
Leatherwood (1982)	Aerial - transect	1979 November	222	0.08
	Aerial - transect	1980 January	214	0.10
Burn *et al.* (1987)	Mark - recapture	1982	553	~ 0.05
Mullin *et al.* (1990)	Boat - transect	1985 July	816	0.15
	Boat - transect	1986 March	506	0.21
Griffin and Patton (1990)	Aerial - transect	1987-1990	143[a]	0.09

[a] Average of seasonal surveys

Minimum Population Estimate

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

Current Population Trend

There are insufficient data to determine the population trends for this stock. It would be difficult to use historical abundance estimates for meaningful trend analysis due to differences in the survey and analytical methods, and specific areas surveyed.

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 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 IRLES stock of bottlenose dolphins is unknown.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The total annual human-caused mortality and serious injury for this stock during 2003-2007 is unknown.

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

Fishery Information

Crab Pots

Interactions between 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).

Table 2. Bottlenose dolphin strandings by county within the Indian River Lagoon System from 2003 to 2007, 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 10 November 2008). Please note human interaction does not necessarily mean the interaction caused the animal's death.

COUNTY		2003	2004	2005	2006	2007	TOTAL
Volusia							
	Total Stranded	**3**	**0**	**6**	**2**	**5[a]**	**16**
	Human Interaction						
	---Fishery Interaction	1	0	1	0	0	2
	---Other	0	0	0	2	1	3
	No Human Interaction	1	0	1	0	3	5
	CBD	1	0	4	0	1	6
Brevard							
	Total Stranded	**23**	**29**	**21**	**32**	**41**	**146**
	Human Interaction						
	---Fishery Interaction	3	6	3	8	5	25
	---Other	0	1	0	2	2	5
	No Human Interaction	5	6	2	4	4	21

	CBD	15	16	16	18	30	95
Indian River							
	Total Stranded	**5**	**2**	**3**	**0**	**3**	**13**
	Human Interaction						
	---Fishery Interaction	1	0	0	0	1	2
	---Other	0	1	1	0	0	2
	No Human Interaction	2	1	1	0	0	4
	CBD	2	0	1	0	2	5
St. Lucie							
	Total Stranded	**2**	**1**	**1**	**1**	**2**	**7**
	Human Interaction						
	---Fishery Interaction	0	0	0	0	1	1
	---Other	0	0	0	1	0	1
	No Human Interaction	1	1	0	0	1	3
	CBD	1	0	1	0	0	2
Martin							
	Total Stranded	**3**	**0**	**4**	**3**	**0**	**10**
	Human Interaction						
	---Fishery Interaction	2	0	0	0	0	2
	---Other	0	0	0	0	0	0
	No Human Interaction	0	0	0	2	0	2
	CBD	1	0	4	1	0	6
TOTAL							
	Total Stranded	**36**	**32**	**35**	**38**	**51**	**192**
	Human Interaction						
	---Fishery Interaction	7	6	4	8	7	32
	---Other	0	2	1	5	3	11
	No Human Interaction	9	8	4	6	8	35
	CBD	20	16	26	19	33	114

[a] Includes a mass stranding of 2 animals in December 2007

Between 2003 and 2007, 5 bottlenose dolphins recovered by the Stranding Network within the IRLES displayed evidence of interaction with a trap/pot fishery (i.e., rope and/or pots attached) (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 10 November 2008). Four of the dolphins had been entangled in pots (0.8 dolphins per year on average). Two of the 4 entangled dolphins were recovered dead (one of which also had multiple sections of blubber removed, possibly post-mortem), 1 was released from the pot alive and 1 dolphin was recovered alive, disentangled from a pot, and was placed into rehabilitation. This dolphin, a calf, eventually lost her fluke due to severe tissue damage from the pot line and is in permanent care at Clearwater Marine Aquarium in Clearwater, Florida. The fifth dolphin had no signs of entanglement but an escape ring from a crab pot was found in its stomach upon necropsy. An additional 2 dolphins were reported by the public as entangled in pots or rope with buoys attached (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 10 November 2008). In both of these cases, the dolphins were sighted alive and then could not be relocated. It is unclear whether these animals freed themselves or died and sank. 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, interaction with the crab fishery does occur and results in mortalities of bottlenose dolphins in the IRLES.

Other Mortality

A total of 192 bottlenose dolphins were found stranded within the IRLES from 2003 through 2007 (Table 2; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 10 November 2008). Evidence of human interactions (HI; e.g., gear and debris entanglement or ingestion, mutilation, boat collision) was detected for 43 strandings, including the 7 crab 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). Twenty-five animals showed evidence of interaction

with 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. Four of the 25 animals stranded alive. Two of these died shortly after stranding, 1 animal could not be relocated after the initial report, and 1 was disentangled from monofilament line and released. Two animals were entangled in monofilament line and had also ingested marine debris, which was found during the necropsy.

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.

The remaining 10 cases of HI were not related to interactions with fishing gear. Of these, 6 animals had evidence of boat strike, some of which were old healed wounds, others were recent. One animal was found alive entangled in marine debris and was disentangled and released. Upon necropsy, 2 other animals were found to have ingested marine debris (bringing ingestion of marine debris to a total of 5 animals overall). One animal was found with a 13cm square of blubber cut from the peduncle, possibly postmortem (bringing the total cases of carcass mutilation to 2 including the crab pot animal with blubber removed, discussed above). Another case of HI involved a person who tried to tow a live stranded dolphin back out to sea before reporting it and may have inadvertently injured it in the process. As with HI involving fishing gear, HI in the other cases may or may not have been the cause for stranding or death of the animal.

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 in the IRLES had been photographed within the estuary previously, and furthermore, many of them were found within their known photo-ID home ranges (Mazzoil, Stolen and Noke, in preparation). Stranding data probably underestimate the extent of mortality and serious injury resulting from HI because not all of the dolphins that die or are seriously injured in HI wash ashore, nor will all of those that do wash ashore necessarily show signs of HI. Finally, ability to recognize HI varies widely due to many factors including the condition of the carcass (for instance, later stages of decomposition and carcass scavenging).

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).

In 1992, with the enactment of the Marine Mammal Health and Stranding Response Act, the Working Group on Marine Mammal Unusual Mortality Events was created to determine when an unusual mortality event (UME) is occurring, and then to provide guidance for responses to such events. 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 48 bottlenose dolphins were recovered from the northern IRLES (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 10 November 2008). Infectious disease is being considered as a possible cause of this event.

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) speculated that polychlorinated biphenyl (PCBs) concentrations in blubber samples collected from remote biopsy of IRLES dolphins were sufficiently high to warrant additional sampling. 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). Blubber samples from surgical biopsies taken from bottlenose dolphins in the IRLES were analyzed by Fair *et al.* (2007) for polybrominated diphenyl ethers (PBDEs), establishing baseline levels for this current use compound. There are no reports of mortalities in the IRLES resulting solely from contaminant concentrations.

Bottlenose dolphins captured in the IRLES during the Health and Risk Assessment (HERA) project had lobomycosis, a chronic mycotic disease of the skin caused by *Lacazia loboi* (Reif *et al.* 2006) and orogenital papillomatosis (Bossart *et al.* 2005). Results indicated that of the 89 dolphins captured in the IRLES, 9 (10.1%) had lobomycosis and 10 (11.2%) had orogenital papillomatosis (Reif *et al.* 2008). All 9 dolphins with lobomycosis were from the southern portion of the IRLES (Reif *et al.* 2006). Afflicted dolphins showed no significant difference in prevalence of the disease between sexes and were significantly older than non-afflicted dolphins (Reif *et al.* 2006). Basis for presence and localization of lobomycosis to the southern portion of the IRLES is currently unknown, but may be related to immunosupression and environmental factors such as freshwater influx and exposure to contaminants (Reif *et al.* 2006). There are no reports of mortalities resulting solely from infection of either disease.

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 IRLES stock relative to OSP is unknown. This species is not listed as threatened or endangered under the Endangered Species Act and there are insufficient data to determine population trends for this stock. The removal of dolphins in live-capture fisheries in the 1970's and 1980's and the occurrence of 2 UMEs of bottlenose dolphins in the IRLES since 2001 (NMFS unpublished data) is cause for concern; however, the effects of the permanent removals and the mortality events on stock abundance have not yet been determined. 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.

Total human-caused mortality and serious injury for this stock is not known and 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. Documented human-caused mortalities in recreational fishing gear entanglement and repeated UMEs reinforce concern for this stock. Because the stock size is currently unknown, but likely small and relatively few mortalities and serious injuries would exceed PBR, the NMFS considers this stock to be a strategic stock.

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