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

STOCK DEFINITION AND GEOGRAPHIC RANGE

The coastal morphotype of common bottlenose dolphins 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. 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coast (Rosel *et al.* 2009), and between those biopsied in coastal and estuarine waters at the same latitude (NMFS unpublished data).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 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 2007-2011, there were 36 stranded bottlenose dolphins in the region north of the IRLES in enclosed waters. Evidence of human interactions was detected for 11 of these stranded dolphins, 3 of which involved fishery interactions with hook and line gear, including an animal disentangled from recreational gear and released alive without serious injury (Maze-Foley and Garrison in prep.). Seven of the 11 human interactions involved boat collisions, and the remaining human interaction was a stranding with signs of mutilation. There was 1 estuarine

stranding south of the IRLES. It could not be determined if there was evidence of human interactions for this stranded animal (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 13 September 2012). In addition to animals included in the stranding database, in estuarine waters north of the IRLES in 2010 there was an at-sea observation of a dolphin entangled in hook and line gear, and during 2011, there was an at-sea observation of a dolphin entangled in crab pot gear, which the animal later shed on its own. Both dolphins were considered not seriously injured (Maze-Foley and Garrison in prep.).

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 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 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 2007-2011 is unknown. Interactions were documented with crab pot gear and hook and line gear; however, it is not possible to estimate the total number of interactions or mortalities associated with crab pots or hook and line fisheries since there are no systematic observer programs. A 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.

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

There is a potential for the IRLES Stock to interact with the Category II Southeastern U.S. Atlantic, Gulf of Mexico stone crab trap/pot and Atlantic blue crab trap/pot fisheries. The IRLES Stock may also interact with the Category III Atlantic commercial passenger fishing vessel (hook and line) fishery (Appendix III).

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).

Between 2007 and 2011, 6 bottlenose dolphins documented 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 13 September 2012). Two of the animals were mortalities. Three animals were disentangled from crab pot gear (identified as commercial blue crab pot gear in two cases) and released alive without serious injury (Maze-Foley and Garrison in prep.). One dolphin had no external signs of entanglement but an escape ring from a blue crab pot was found in its stomach upon necropsy. 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.

Hook and Line Fisheries

Stranding data from 1997 through 2009 were used to investigate hook and line gear interactions with 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 2007 and 2011, there were 27 documented strandings with evidence of hook and line fishery interaction (see Other Mortality below).

Other Mortality

A total of 218 bottlenose dolphin strandings were documented within the IRLES from 2007 through 2011 (Table 2; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 13 September 2012). Evidence of human interactions (e.g., fishing gear or debris entanglement or ingestion, mutilation, boat collision) was detected for 44 strandings; no evidence of human interactions was found for 37 animals, and for the remaining 137 animals, it could not be determined if there was evidence of human interactions. Thirty-six of the

44 strandings for which evidence of human interactions was detected involved fisheries interactions, including the 6 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; Stolen *et al.* 2012). One dolphin stranded dead entangled in trammel net gear (in 2008). Twenty-seven 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.), 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 these 2 identified dolphins, there were also other live strandings entangled in hook and line gear, crab pot gear, or debris, and 1 was considered to be seriously injured (see Maze-Foley and Garrison in prep.).

In addition to animals included in the stranding database, in 2008 and 2010, 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.).

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 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 2001, there was a record high number of strandings in the IRLES (n=61) (Stolen *et al.* 2007). An Unusual Mortality Event (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.

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 100m 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.

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.

Table 2. Bottlenose dolphin strandings by county within the Indian River Lagoon System from 2007 to 2011, 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 13 September 2012). Please note human interaction does not necessarily mean the interaction caused the animal's death.

COUNTY		2007	2008	2009	2010	2011	TOTAL
Volusia	**Total Stranded**	**5[a]**	**6[b]**	**2**	**1**	**6**	**20**
	Human Interaction						
	---Yes	1	3	1	1	2	8
	---No	3	0	0	0	1	4
	---CBD	1	3	1	0	3	8
Brevard	**Total Stranded**	**41**	**61[c]**	**25**	**32**	**18**	**177**
	Human Interaction						
	---Yes	7	13	3	5	1	29
	---No	5	10	4	6	3	28
	---CBD	29	38	18	21	14	120
Indian River	**Total Stranded**	**3**	**0**	**1**	**2**	**1**	**7**
	Human Interaction						
	---Yes	1	0	0	0	0	1
	---No	0	0	0	0	0	0

	---CBD	2	0	1	2	1	6
St. Lucie	**Total Stranded**	**2**	**2**	**1**	**0**	**5**	**10**
	Human Interaction						
	---Yes	1	1	0	0	4	6
	---No	1	1	1	0	1	4
	---CBD	0	0	0	0	0	0
Martin	**Total Stranded**	**0**	**0**	**1**	**1**	**2**	**4**
	Human Interaction						
	---Yes	0	0	0	0	0	0
	---No	0	0	0	0	1	1
	---CBD	0	0	1	1	1	3
TOTAL	Total Stranded	**51**	**69**	**30**	**36**	**32**	**218**
	Human Interaction						
	---Yes	10	17	4	6	7	44
	---No	9	11	5	6	6	37
	---CBD	32	41	21	24	19	137

[a] Includes a mass stranding of 2 animals in December 2007
[b] Includes 3 animals that were considered part of the 2008 UME event
[c] Includes 44 animals that were considered part of the 2008 UME event

STATUS OF STOCK

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 annual average human-caused mortality for this stock for 2007 – 2011 is unknown. 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 (2 since 2001) 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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