COMMON BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*) Mississippi Sound, Lake Borgne, Bay Boudreau Stock

NOTE – NMFS is in the process of writing individual stock assessment reports for each of the 31 bay, sound and estuary stocks of common bottlenose dolphins in the Gulf of Mexico. Until this effort is completed and 31 individual reports are available, some of the basic information presented in this report will also be included in the report: "Northern Gulf of Mexico Bay, Sound and Estuary Stocks".

STOCK DEFINITION AND GEOGRAPHIC RANGE

Common bottlenose dolphins are distributed throughout the bays, sounds, and estuaries of the northern Gulf of Mexico (Mullin 1988). Long-term (year-round, multi-year) residency by at least some individuals has been reported from nearly every site where photographic identification (photo-ID) or tagging studies have been conducted in the Gulf of Mexico (e.g., Irvine and Wells 1972; Shane 1977; Gruber 1981; Irvine *et al.* 1981; Wells 1986; Wells *et al.* 1987; Scott *et al.* 1990; Shane 1990; Wells 1991; Bräger 1993; Bräger *et al.* 1994; Fertl 1994; Wells *et al.* 1996a,b; Wells *et al.* 1997; Weller 1998; Maze and Würsig 1999; Lynn and Würsig 2002; Wells 2003; Hubard *et al.* 2004; Irwin and Würsig 2004; Shane 2004; Balmer *et al.* 2008; Urian *et al.* 2009; Bassos-Hull *et al.* 2013). In many cases, residents occur predominantly within estuarine waters, with limited movements through passes to the Gulf of Mexico (Shane 1977; Shane 1990; Gruber 1981; Irvine *et al.* 1981; Shane 1990; Maze and Würsig 1999; Lynn and Würsig 2002; Fazioli *et al.* 2006; Bassos-Hull *et al.* 2013; Wells *et al.* 2017). Genetic data also support the concept of relatively discrete, demographically independent bay, sound and estuary (BSE) stocks (Duffield and Wells 2002; Sellas *et al.* 2005). Sellas *et al.* (2005) examined population subdivision among Sarasota Bay, Tampa Bay, and Charlotte Harbor, Florida; Matagorda Bay, Texas; and the coastal Gulf of Mexico (1–12 km offshore) from just outside Tampa Bay to the south end of Lemon Bay, and found evidence of significant population structure among all areas on the basis of both mitochondrial DNA control region sequence data and nine nuclear microsatellite loci. The Sellas *et al.* (2005) findings support the identification of BSE populations distinct from those occurring in adjacent Gulf coastal waters. Differences in reproductive seasonality from site to site also suggest genetic-based distinctions among areas (Urian *et al.* 1996). Photo-ID and genetic data from several inshore areas of the southeastern United States also support the existence of resident estuarine animals and a differentiation between animals biopsied along the Atlantic coast and those biopsied within estuarine systems at the same latitude (Caldwell 2001; Gubbins 2002; Zolman 2002; Mazzoil *et al.* 2005; Litz 2007; Rosel *et al.* 2009).

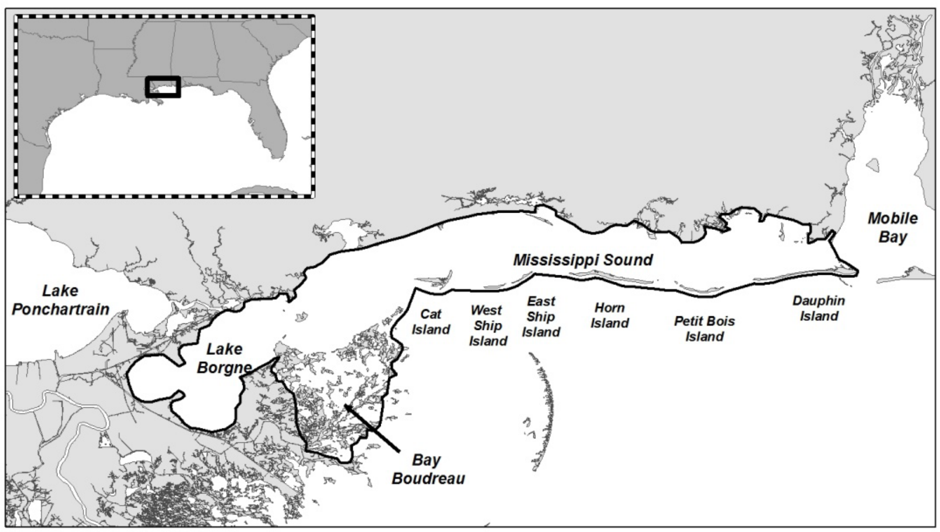

Figure 1. *Geographic extent of the Mississippi Sound, Lake Borgne, Bay Boudreau Stock, located on the coasts of Alabama, Mississippi and Louisiana.*

The Mississippi Sound, Lake Borgne, Bay Boudreau Stock was delimited in the first stock assessment reports published in 1995 (Blaylock *et al.* 1995). The stock area (Figure 1) is complex with an estimated surface area of

3,711 km^2 (Scott *et al*. 1989), including adjacent Gulf coastal waters extending 1 km from Mississippi Sound barrier islands and passes. Mississippi Sound itself has a surface area of about 2,100 km^2 (Eleuterius 1978a,b) and is bounded by Mobile Bay in the east, Lake Borgne in the west, and the opening to Bay Boudreau in the southwest. It is bordered to the north by the mainlands of Louisiana, Mississippi and Alabama and to the south by six barrier islands: Cat, West Ship, East Ship, Horn, Petit Bois and Dauphin islands (Eleuterius 1978b), and in the extreme west, by Louisiana marshes. Mississippi Sound is an open embayment with large passes between the barrier islands allowing broad access to the Gulf of Mexico, including two dredged shipping channels. Average depth at mean low water is 2.98 m, and tides are diurnal with an average range of 0.57 m (Eleuterius 1978b). Sea surface temperature ranges seasonally from 9˚C to 32˚C (Christmas 1973). Salinity patterns are complex, varying seasonally with managed outputs from the Mississippi River, and there are multiple sharp salinity fronts; however, measurements of 20–35 ppt are typical (Kjerfve 1986). The bottom type is soft substrate consisting of mud and/or sand (Moncreiff 2007). Lake Borgne and Bay Boudreau are part of the Pontchartrain Basin and are remnants of the Saint Bernard lobe of the Mississippi River Delta that existed until about 2000 years ago when the Mississippi River changed course (Roberts 1997; Penland *et al.* 2013). Lake Borgne has an average depth of 3 m and an average salinity of 7 ppt (USEPA 1999). Bay Boudreau is a large shallow complex in the Saint Bernard marshes and consists of marshes, bayou, shallow bays, and points (Penland *et al*. 2013).

The Mississippi Sound, Lake Borgne, Bay Boudreau Stock area ("MS Sound Region") configuration is, in part, a result of the management of the live-capture fishery for bottlenose dolphins (Scott 1990). Mississippi Sound was once the site of the largest live-capture fishery of bottlenose dolphins in North America (Reeves and Leatherwood 1984). Between 1973 and 1988, of the 533 bottlenose dolphins removed from southeastern U.S. waters, 202 were removed from Mississippi Sound and adjacent waters (Scott 1990). In 1989, the Alliance of Marine Mammal Parks and Aquariums declared a self-imposed moratorium on the capture of bottlenose dolphins in the Gulf of Mexico (Corkeron 2009). Passage of the Marine Mammal Protection Act in 1972 and the concomitant need to manage the live-capture fishery for bottlenose dolphins was the impetus for much of the earliest bottlenose dolphin research in the MS Sound Region. This work focused on estimating the abundance of bottlenose dolphins (see below) and, to a lesser extent, on stock structure research primarily to provide live-capture quota recommendations (Scott 1990). To gather baseline biological data and study dolphin ranging patterns, 57 bottlenose dolphins were captured from Mississippi Sound, freeze-branded and released during 1982–1983 (Solangi and Dukes 1983; Lohoefener *et al*. 1990*a*). Re-sighting efforts for these dolphins conducted from 1982–1985 by Lohoefener *et al.* (1990a) suggested at least some individual dolphins exhibited fidelity for specific areas within Mississippi Sound.

The first dedicated photo-ID effort in the area undertaken by Hubard *et al.* (2004) during 1995–1996 suggested that some individual dolphins, seen multiple times, displayed spatial and temporal patterns of site fidelity, and some dolphins showed preferences to different habitats, particularly barrier islands, channels, or mainland coasts. Some individuals were seen in the same seasons both years, while others were seen in multiple seasons with a gap during winter months (Hubard *et al.* 2004). Also, two dolphins freeze branded during the live capture performed by Solangi and Dukes (1983) were re-sighted by Hubard *et al.* (2004).

During 2004–2007, Mackey (2010) followed dolphins in a portion of Mississippi Sound near and on both the Gulf and sound sides of the barrier islands and along the Gulfport Shipping Channel, and identified three different residency patterns. Of the 687 dolphins identified in those surveys, 71 (10%) were classified as year-round residents, 109 (16%) as seasonal residents, and 498 (73.5%) as transients. These patterns may not be representative of the entire MS Sound Region. Dolphins sighted near the barrier islands adjacent to or within the range of the Northern Coastal Stock of bottlenose dolphins may have a higher probability of being transient. Outside of the ship channel, a small proportion of the dolphins sighted by Mackey (2010) were from the interior two-thirds of Mississippi Sound (adjacent to the mainland) where dolphins may have quite different residency patterns. Mackey (2010) also identified two animals that were freeze-branded during the live captures 20 years earlier (Solangi and Dukes 1983).

Sinclair (2016) conducted photo-ID surveys in four zones within central Mississippi Sound during 2002–2005 to examine group sizes and movement patterns. The zones included one inner-sound zone near the mainland coast, two outer-sound zones near two barrier islands, and one coastal Gulf zone adjacent to the barrier island. Mean group sizes were significantly larger in summer, in outer-sound zones, and when a calf was present within the group. Limited movements were detected between the inner sound and other zones; however, movements between the outer sound and coastal waters were common.

Sinclair (2016), Mackey (2010), and Hubard *et al.* (2004) all noted low re-sighting rates of dolphins with a high percentage of dolphins seen only on one occasion. Both Mackey (2010) and Hubard *et al.* (2004) suggested dolphins move out of the Sound into deeper Gulf of Mexico waters during winter months, whereas Sinclair (2016) suggested that as dolphins are present year-round, it is the reverse and dolphins are moving into the sound in warm months, coinciding with the active seasons of the menhaden and shrimp fisheries.

Establishing residency patterns in the MS Sound Region using photo-ID studies that cover large study areas will be difficult because of the large number of dolphins that inhabit the area and its open geography. Nevertheless, studies to date indicate that, similar to other Gulf of Mexico BSE areas, some individuals are long-term inhabitants of the MS Sound Region. In addition, photo-ID data indicate distinct ranging and habitat usage patterns, suggesting that the stock may contain multiple demographically independent populations. The stock boundaries are subject to change upon further study of dolphin residency patterns in estuarine waters of Alabama, Mississippi, and Louisiana.

POPULATION SIZE

The best available abundance estimate for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock of common bottlenose dolphins is 3,046 (95% CI: 2,702–3,293; CV=0.06), based on a January 2012 vessel-based capture-recapture photo-ID survey (Mullin *et al.* 2017).

Earlier abundance estimates (>8 years old)

Aerial and small boat surveys conducted in the MS Sound Region covered different portions of the region and yielded a wide range of abundance estimates for bottlenose dolphins. Because of the differences in techniques and areas surveyed, it is very difficult to compare results. Early aerial surveys were conducted from single-engine high-winged aircraft that were not designed to estimate abundance for the Mississippi Sound or the MS Sound Region (Leatherwood *et al.* 1978; Thompson 1982). The studies also produced negatively biased results because the strip of transect directly under the aircraft was not observed. Scott *et al.* (1989) attempted to correct this bias by utilizing an aircraft with a glass bubble nose and placing an observer in it to observe the trackline at all times. Their estimates for the MS Sound Region ranged from 205 in winter to 858 in summer. (Abundances for Mississippi Sound only ranged from 136 dolphins in winter to 719 dolphins in summer). Boat-based mark-recapture surveys using dolphins freeze-branded during a previous live-capture study were performed by Lohoefener *et al.* (1990a) to assess the impacts of removing 30 dolphins from the population for captivity. The pre-removal estimate was 2,392 dolphins, and the post-removal estimate was 7,052 dolphins (Lohoefener *et al.* 1990a), but these were probably not accurate estimates, as too many assumptions of mark-recapture analysis were likely violated in this study (Lohoefener *et al.* 1990a). Boat-based line-transect abundance surveys of Mississippi Sound (about 55% of the MS Sound Region) were carried out by Lohoefener *et al*. (1990b) in 1984 and 1985, yielding much higher abundance estimates than aerial strip- or line-transect surveys and suggesting a seasonal shift in bottlenose dolphin abundance. For the entire Sound, abundance estimates were 2,400 and 500 dolphins for summer and winter, respectively. Another series of line-transect aerial surveys were performed in fall of 1992 by Blaylock and Hoggard (1994), where the abundance was reported as 1,401 for the MS Sound Region. Two additional abundance estimates from Mississippi Sound were boat-based line-transect surveys and only covered a portion of Mississippi Sound. Hubard *et al.* (2004) surveyed an area that was roughly one-quarter the size of the entire Sound. Again, abundances were found to fluctuate seasonally with higher abundances observed in summer months in 1995 (584 dolphins) and 1996 (555 dolphins) versus winter 1995–1996 months (268 dolphins). Miller *et al.* (2013) reported abundance estimates for a study area in eastern Mississippi Sound roughly 2,104 km^2 in size that included areas up to 15 km south of the barrier islands. Abundance estimates were 2,255 dolphins in summer 2007 and 1,413 dolphins in winter 2007–2008 (Miller *et al.* 2013).

Recent surveys and abundance estimates

The Southeast Fisheries Science Center conducted aerial surveys of continental shelf waters (shoreline to 200 m depth) along the U.S. Gulf of Mexico coast from the Florida Keys to the Texas/Mexico border during spring (March–April) 2011, summer (July–August) 2011, fall (October–November) 2011, and winter (January–February) 2012 (see Garrison 2017 for survey design and abundance estimation method). Each of these surveys was conducted using a two-team approach to develop estimates of visibility bias using the independent observer approach with Distance analysis (Laake and Borchers 2004). A model for the probability of detection on the trackline as a function of sighting conditions (sea state, glare, water color, etc.) was developed using data across all four surveys (Garrison 2017). The abundance estimates for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock of bottlenose dolphins were based upon trackline and sightings in waters along the Alabama, Mississippi, and Louisiana coasts inside of the barrier islands. The surveys did not include trackline in Lake Borgne, but the estimated density was extrapolated to include the entire stock area. The seasonal abundance estimates for this stock were: spring – 2,395 (CV=0.42), summer – 1,709 (CV=0.59), fall – 1,140 (CV=0.41), and winter – 900 (CV=0.63). As with other BSE stocks, it is possible that there is movement of animals from coastal waters into the MS Sound Region on a seasonal basis. In order to assure that the abundance estimate for the stock reflects primarily resident animals, the lowest seasonal estimate (winter) was used to determine N_{best} for this stock. The resulting best estimate of abundance for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock of common bottlenose dolphins from these aerial surveys was 900 (CV=0.63).

Pitchford *et al.* (2016) conducted vessel-based line-transect surveys from December 2011 to November 2013 in Lake Borgne and Mississippi Sound, excluding the far eastern waters of Mississippi Sound within Alabama. Density and population size was estimated for each season (winter, December–February; spring, March–May; summer, June–August; and fall, September–November) across the two years. Density estimates varied by stratum and season from 0.27 dolphins/km^2 (CV%=31.3) in spring 2013 to 1.12 dolphins/km^2 (CV%=21.6) in spring 2012 (Pitchford *et al.* 2016). The population estimates ranged from 738 (95% CI: 397–1369) in spring 2013 to 3,236 (95% CI: 1927–4627) in spring 2012 (Pitchford *et al.* 2016). According to Pitchford *et al.* (2016) differences in density estimates among central and eastern Mississippi Sound strata compared to the westernmost Mississippi Sound stratum and Lake Borgne stratum suggested animals use the westernmost portions of the study area during the warmer seasons of summer and fall, and also suggested the Mississippi Sound region is dynamic with respect to environmental variables that affect dolphin distribution and occurrence. The population size estimates of Pitchford *et al.* (2016) were negatively biased for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock because estimates did not include the easternmost waters of Mississippi Sound nor the waters of Bay Boudreau.

Vessel-based capture-recapture (C-R) photo-ID surveys were conducted from June 2010 to May 2012 to estimate density and abundance of bottlenose dolphins within Mississippi Sound during and after the *Deepwater Horizon* (DWH) oil spill (Mullin *et al.* 2017). The study area included waters of Mississippi Sound between the mainland and Horn and Petit Bois islands, as well as nearshore coastal waters south of Horn and Petit Bois islands (see Mullin *et al.* 2017). Density estimates and abundance were adjusted for the proportion of the population that had distinctive fins. Similar to McDonald *et al.* (2017), a spatial covariate, consisting of Island and Inshore strata, was used to estimate separate densities for these two strata. Abundance estimates were extrapolated by multiplying the total area of each stratum by the stratum density. Only a small part of Lake Borgne west of Half Moon Island was included in the extrapolation area as the remainder of Lake Borgne was presumed to be poor dolphin habitat (based on average low salinity). None of Bay Boudreau was included in the extrapolation. Resulting abundance estimates ranged from 4610 (95% CI: 4,271−4,865) during July 2011 to 3046 (95% CI: 2,702–3,293) during January 2012, for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock. While abundances for the stock were generally similar across the primary periods, previous studies consistently showed cold and warm seasons with low and high abundances, respectively. In order to assure that the abundance estimate for the stock reflects primarily resident animals, the lowest seasonal estimate (January 2012), 3,046 (CV=0.06), was used to determine N_{best} for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock of common bottlenose dolphins. This estimate is negatively biased because it does not include an estimate for most of Lake Borgne nor any of Bay Boudreau. Key uncertainties in this abundance estimate include use of extrapolation from the surveyed area to a total stock abundance based on a preferred habitat model (McDonald *et al.* 2017; Hornsby *et al.* 2017). Also, this abundance estimate was made during the DWH oil spill event and may not accurately represent the post oil-spill abundance as it does not account for mortality due to the spill that occurred after 2012.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distributed abundance estimate as specified by Wade and Angliss (1997). The best estimate of abundance for this stock of common bottlenose dolphins is 3,046 (CV=0.06). The minimum population estimate for the stock is 2,896 common bottlenose dolphins.

Current Population Trend

There are insufficient data to determine the population trends for this stock. While not a trend analysis, it should be noted it was projected that there was up to a 62% decline in population size resulting from the DWH oil spill (see Habitat Issues section).

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 likely do not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995). The current productivity rate may be compromised by the DWH oil spill as Kellar *et al.* (2017) reported negative reproductive impacts from the spill (see Habitat Issues section).

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; Wade 1998). The minimum population size of common bottlenose dolphins in the MS Sound Region is 2,896. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor is 0.4 because the CV of the shrimp trawl mortality estimate for Mississippi and Alabama BSE stocks is greater than 0.8 (Wade and Angliss 1997). PBR for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock of bottlenose dolphins is 23.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

The total annual human-caused mortality and serious injury for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock during 2011–2015 is unknown. The mean annual fishery-related mortality and serious injury during 2011–2015 for strandings and at-sea observations identified as fishery-related was 1.0 (see Shrimp Trawl section for additional fishery-related mortality). Additional mean annual mortality and serious injury during 2011–2015 due to other human-caused sources (fishery research, sea turtle relocation trawling, gunshot wounds, and DWH oil spill) was 309. The minimum total mean annual human-caused mortality and serious injury for this stock during 2011–2015 was therefore 310 (Table 1). This is likely a biased estimate because 1) not all fisheries that could interact with this stock are observed and/or observer coverage is very low, 2) stranding data are used as an indicator of fishery-related interactions and not all dead animals are recovered by the stranding network (Peltier *et al*. 2012; Wells *et al*. 2015), 3) cause of death is not (or cannot be) routinely determined for stranded carcasses, 4) the estimate of fishery-related interactions includes an actual count of verified fishery-caused deaths and serious injuries and should be considered a minimum (NMFS 2016), 5) the estimate does not include shrimp trawl bycatch (see Shrimp Trawl section), and 6) various assumptions were made in the population model used to estimate population decline for the northern Gulf of Mexico BSE stocks impacted by the DWH oil spill.

Fishery Information

There are four commercial fisheries that interact, or that potentially could interact, with this stock. These include two Category II fisheries (Southeastern U.S. Atlantic, Gulf of Mexico shrimp trawl, and Gulf of Mexico menhaden purse seine fisheries) and two Category III fisheries (Gulf of Mexico blue crab trap/pot and Atlantic Ocean, Gulf of Mexico, Caribbean commercial passenger fishing vessel (hook and line) fisheries). Detailed fishery information is presented in Appendix III.

Shrimp Trawl

Between 1997 and 2014, seven common bottlenose dolphins and seven unidentified dolphins, which could have been either common bottlenose dolphins or Atlantic spotted dolphins, became entangled in the net, lazy line, turtle excluder device, or tickler chain gear in the commercial shrimp trawl fishery in the Gulf of Mexico (Soldevilla *et al.* 2016). All dolphin bycatch interactions resulted in mortalities except for one unidentified dolphin that was released alive without serious injury in 2009 (Maze-Foley and Garrison 2016). Soldevilla *et al.* (2015; 2016) provided mortality estimates calculated from analysis of shrimp fishery effort data and NMFS's Observer Program bycatch data. Observer program coverage does not extend into BSE waters, therefore time-area stratified bycatch rates were extrapolated into inshore waters to estimate the most recent five-year unweighted mean mortality estimate for 2010–2014 based on inshore fishing effort (Soldevila *et al*. 2016). Because the spatial resolution at which fishery effort is modeled is aggregated at the state level (e.g., Nance *et al.* 2008), the mortality estimate covers all inshore waters of both Mississippi and Alabama and thus all their respective BSE stocks, not just the Mississippi Sound, Lake Borgne, Bay Boudreau Stock. The mortality estimate for Mississippi/Alabama BSE stocks (from Mississippi River Delta east to Mobile Bay, Bonsecour Bay) was 27 (CV=1.1) dolphins per year. If all of the mortality occurred in the Mississippi Sound, Lake Borgne, Bay Boudreau Stock, the mortality estimate would nearly equal PBR for this stock; however, because bycatch for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock alone cannot be quantified at this time, the mortality estimate is not included in the annual human-caused mortality and serious injury total for this stock. It should also be noted that this mortality estimate does not include skimmer trawl effort, which accounts for >48% of shrimp fishery effort in Louisiana, Alabama, and Mississippi inshore waters, because Observer Program coverage of skimmer trawls is limited. Limitations and biases of annual bycatch mortality estimates are described in detail in Soldevilla *et al.* (2015; 2016).

Menhaden Purse Seine

During 2011–2015, there were two mortalities (2012) and one animal released alive without serious injury (2011) documented within waters of the MS Sound Region that involved the menhaden purse seine fishery. The two mortalities were included in the annual human-caused mortality and serious injury total for this stock (Table 1).

There is currently no observer program for the Gulf of Mexico menhaden purse seine fishery; however, incidental takes during 2011–2015 have been reported via two sources. First, during 2011, a pilot observer program operated from May through September and observers documented three dolphins trapped within purse seine nets. All three were released alive without serious injury (Maze-Foley and Garrison 2017). Two of the three dolphins were trapped within a single purse seine within waters of the Western Coastal Stock, and the third animal was trapped in waters of the MS Sound Region. Second, through the Marine Mammal Authorization Program (MMAP), there have been 13 self-reported incidental takes (all mortalities) of common bottlenose dolphins in northern Gulf of Mexico coastal and estuarine waters by the menhaden purse seine fishery during 2000–2015. These takes likely affected the following stocks: Western Coastal Stock; Northern Coastal Stock; Mississippi Sound, Lake Borgne, Bay Boudreau Stock; and Mississippi River Delta Stock. Specific self-reported takes under the MMAP likely involving the MS Sound Region are as follows: two dolphins were reported taken in a single purse seine during 2012 in waters of Mississippi Sound; one take of a single unidentified dolphin was reported during 2002 in waters of Mississippi Sound; and during 2000, three bottlenose dolphins were reported taken in a single purse seine in waters of Mississippi Sound.

Without an ongoing observer program, it is not possible to obtain statistically reliable information for this fishery on the number of sets annually, the incidental take and mortality rates, and the stocks from which bottlenose dolphins are being taken. The documented interactions in this commercial gear represent a minimum known count of interactions in the last five years.

Blue Crab Trap/Pot

During 2011–2015, there were two mortalities of common bottlenose dolphins for which commercial blue crab trap/pot gear entanglement were documented within the stranding data. One mortality occurred during 2011 and another in 2014. Both mortalities were included in the stranding database (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 18 May 2016) and in the totals presented in Table 2, as well as in the annual human-caused mortality and serious injury total for this stock (Table 1). There is no systematic observer coverage of crab trap/pot fisheries, so it is not possible to quantify total mortality. The documented interactions in this gear represent a minimum known count of interactions in the last five years.

Hook and Line (Rod and Reel)

During 2011–2015, there were six mortalities of common bottlenose dolphins for which hook and line gear entanglement or ingestion were documented within the stranding data. Three mortalities occurred in 2011, one in 2012, one in 2013 (in Lake Pontchartrain), and one in 2015. For one of these mortalities (2015), available evidence from the stranding record suggested the hook and line gear interaction contributed to the cause of death. For two mortalities (both 2011), available evidence suggested the hook and line gear interaction was not a contributing factor to cause of death. For three mortalities (2011, 2012, 2013), based on available evidence, it could not be determined if the hook and line gear interaction contributed to cause of death. These mortalities were included in the stranding database (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 18 May 2016) and in the totals presented in Table 2. The 2015 mortality for which evidence suggested the gear contributed to the cause of death was included in the annual human-caused mortality and serious injury total for this stock (Table 1).

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. The documented interactions in this gear represent a minimum known count of interactions in the last five years.

Other Mortality

A population model was developed to estimate the injury in lost cetacean years and time to recovery for stocks affected by the DWH oil spill (see Habitat Issues section), taking into account long-term effects resulting from mortality, reproductive failure, and reduced survival rates (DWH MMIQT 2015; Schwacke *et al.* 2017). For the Mississippi Sound, Lake Borgne, Bay Boudreau Stock, this model predicted the stock will have experienced a 62% (95% CI: 43–83) maximum reduction in population size (DWH MMIQT 2015; Schwacke *et al.* 2017), and for the years 2011–2015, the model projected 1539 mortalities (Table 1). This population model has a number of sources of uncertainty. The baseline population size was estimated from studies initiated after initial exposure to DWH oil occurred. Therefore, it is possible that the pre-spill population size was larger than this baseline level and some mortality occurring early in the event was not quantified. The duration of elevated mortality and reduced reproductive success after exposure is unknown, and expert opinion was used to predict the rate at which these parameters would return to baseline levels. Where possible, uncertainty in model parameters was included in the estimates of excess mortality by re-sampling from statistical distributions of the parameters (DWH MMIQT 2015; DWH NRDAT 2016; Schwacke *et al.* 2017).

In both 2013 and 2014, single dolphins were entrapped during research skimmer trawl operations within the MS Sound Region. The 2014 interaction resulted in a mortality, and for the 2013 interaction, the animal was released alive, and it could not be determined if the animal was seriously injured (Maze-Foley and Garrison 2017). An additional mortality was documented in 2011 in the MS Sound Region as a result of an entanglement in a fishery research gillnet. All of these interactions were included in the stranding database (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 18 May 2016) and in the totals presented in Table 2. The two mortalities were included in the annual human-caused mortality and serious injury total for this stock (Table 1).

As part of its annual coastal dredging program, the Army Corps of Engineers conducts sea turtle relocation trawling during hopper dredging as a protective measure for marine turtles. During 2011–2015, one bottlenose dolphin mortality was documented during 2011 in the MS Sound Region incidental to relocation trawling activities. This mortality was included in the stranding database (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 18 May 2016) and in the totals presented in Table 2, as well as in the annual human-caused mortality and serious injury total for this stock (Table 1).

NOAA's Office of Law Enforcement has been investigating increasing numbers of reports from the northern Gulf of Mexico coast of violence against bottlenose dolphins, including shootings using guns and bows and arrows, throwing pipe bombs and cherry bombs, and stabbings (Vail 2016). During 2011–2015, three mortalities were attributed to shootings. In the summer of 2012, a shrimp fisherman knowingly shot a dolphin with a shotgun while shrimping and was subsequently convicted under the MMPA. In addition, two carcasses recovered in 2012 by the stranding network had gunshot wounds that caused the deaths of these animals (included in Table 2; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 18 May 2016). All three gunshot mortalities were included in the annual human-caused mortality and serious injury total for this stock (Table 1). From recent cases that have been prosecuted, it has been shown that fishermen became frustrated and retaliated against dolphins for removing bait or catch from (depredating) their fishing gear (Vail 2016).

Depredation is a growing problem in the Gulf of Mexico and globally, and can lead to serious injury or mortality via ingestion of or entanglement in gear (e.g., Zollett and Read 2006; Read 2008; Powell and Wells 2011; Vail 2016), as well as changes to the dolphin's activity patterns, such as decreases in natural foraging (Powell and Wells 2011). It has been suggested that provisioning, or the illegal feeding, of wild bottlenose dolphins, may encourage depredation because provisioning conditions dolphins to approach humans and vessels, where they then may prey on bait and catches (Vail 2016). Provisioning has been documented in Florida and Texas (Bryant 1994; Samuels and Bejder 2004; Cunningham-Smith *et al.* 2006; Powell and Wells 2011). To date there are no reports within the literature of provisioning in the Mississippi Sound region.

All mortalities and serious injuries from known sources for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock are summarized in Table 1.

Table 1. Summary of the incidental mortality and serious injury of common bottlenose dolphins (*Tursiops truncatus*) of the Mississippi Sound, Lake Borgne, Bay Boudreau Stock. For the shrimp trawl fishery, the bycatch mortality for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock alone cannot be quantified at this time and the mortality estimate for Mississippi and Alabama has not been included in the annual human-caused mortality and serious injury total for this stock (see Shrimp Trawl section). The remaining fisheries do not have an ongoing, systematic, federal observer program, so counts of mortality and serious injury were based on stranding data, at-sea observations, or fisherman self-reported takes via the Marine Mammal Authorization Program (MMAP). For stranding and at-sea counts, the number reported is a minimum because not all strandings or at-sea cases are detected. See the Annual Human-Caused Mortality and Serious Injury section for biases and limitations of mortality estimates. NA = not applicable.

Fishery	Years	Data Type	Mean Annual Estimated Mortality and Serious Injury Based on Observer Data	5-year Minimum Count Based on Stranding, At-Sea, and/or MMAP Data

Shrimp Trawl	2010–2014	Observer Data	Undetermined for this stock (see Shrimp Trawl section)	NA
Menhaden Purse Seine	2011–2015	Pilot Observer Program (2011); MMAP fisherman self-reported takes	NA	2
Atlantic Blue Crab Trap/Pot	2011–2015	Stranding Data	NA	2
Hook and Line	2011–2015	Stranding Data and At-Sea Observations	NA	1
Mean Annual Mortality due to commercial fisheries (2011–2015)			**1.0**	
Research Takes (5-year Count)			2	
Other Takes (sea turtle relocation trawling, gunshot wounds; 5-year Count)			4	
Mortality due to DWH (5-year Projection)			1539	
Mean Annual Mortality due to research takes, other takes, and DWH (2011–2015)			**309**	
Minimum Total Mean Annual Human-Caused Mortality and Serious Injury (2011–2015)			**310**	

Strandings

During 2011–2015, 306 common bottlenose dolphins were reported stranded within the Mississippi Sound, Lake Borgne, Bay Boudreau Stock area (Table 2; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, 18 May 2016). Of those 306, 21 dolphins stranded within Lake Pontchartrain, which is connected to Lake Borgne. It is likely the stranded animals in Lake Pontchartrain were members of this stock. It could not be determined if there was evidence of human interaction for 281 of these strandings. For eight dolphins, no evidence of human interaction was detected. Evidence of human interactions was detected for 17 stranded dolphins. Human interactions were from numerous sources, including six entanglements with hook and line gear (described above), two entanglements with commercial blue crab trap/pot gear (described above), one incidental take in a research gillnet, one incidental take during turtle relocation trawling, and two incidental takes during research skimmer trawling, three mortalities with evidence of gunshot wounds, and one animal with evidence of a boat strike (Table 2). 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.

The Mississippi Sound, Lake Borgne, Bay Boudreau Stock has been affected by three bottlenose dolphin die-offs or Unusual Mortality Events (UMEs). From January through May 1990, a total of 344 bottlenose dolphins stranded in the northern Gulf of Mexico including Mississippi. Overall this represented a two-fold increase in the prior maximum recorded number of strandings for the same period, but in some locations (i.e., Alabama) strandings were 10 times the average number. The cause of the 1990 mortality event could not be determined (Hansen 1992), however, morbillivirus may have contributed to this event (Litz *et al.* 2014). In 1996 a UME was declared for bottlenose dolphins in Mississippi when 31 bottlenose dolphins stranded during November and December. The cause was not determined, but a *Karenia brevis* (red tide) bloom was suspected to be responsible (Litz *et al.* 2014). A UME was declared for cetaceans in the northern Gulf of Mexico beginning 1 March 2010 and ending 31 July 2014 (Litz *et al.* 2014; http://www.nmfs.noaa.gov/pr/health/mmume/cetacean_gulfofmexico.htm, accessed 1 June 2016). It includes cetaceans that stranded prior to the DWH oil spill (see "Habitat Issues" below), during the spill, and after. Exposure to the DWH oil spill was determined to be the primary underlying cause of the elevated stranding numbers in the northern Gulf of Mexico after the spill (e.g., Schwacke *et al.* 2014; Venn-Watson *et al.* 2015a; Colegrove *et al.* 2016; DWH NRDAT 2016). During 2011–2014, nearly all stranded dolphins from this stock were considered to be part of the UME (see Table 2).

Table 2. Common bottlenose dolphin strandings occurring in the Mississippi Sound, Lake Borgne, Bay Boudreau Stock area from 2011 to 2015, including the 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 (HI). Data are from the NOAA National Marine Mammal Health and Stranding Response Database (unpublished data, accessed 18 May 2016). Please note HI does not necessarily mean the interaction caused the animal's death.

Stock	Category	2011	2012	2013	2014	2015	Total
Mississippi Sound, Lake Borgne, Bay Boudreau Stock	Total Stranded	114[a]	47[a]	62[a]	53[b]	30	306
	Human Interaction						
	---Yes	8[c]	3[d]	3[e]	2[f]	1[g]	17
	---No	6	2	0	0	0	8
	---CBD	100	42	59	51	29	281

[a] All strandings were part of the UME event in the northern Gulf of Mexico.
[b] 46 strandings were part of the UME event in the northern Gulf of Mexico.
[c] Includes 3 entanglement interactions (mortalities) with hook and line fishing gear, 1 entanglement interaction (mortality) with commercial blue crab trap/pot gear, 1 mortality incidental to sea turtle relocation trawling, 1 entanglement interaction (mortality) with a research gillnet, and 1 mortality with evidence of a boat strike.
[d] Includes 1entanglement interaction (mortality) with hook and line fishing gear and 2 mortalities with evidence of gunshot wounds.
[e] Includes 1 entanglement interaction (mortality, Lake Pontchartrain) with hook and line fishing gear, 1 interaction with a research skimmer trawl (CBD if seriously injured), and 1 mortality with evidence of a gunshot wound.
[f] Includes 1 entanglement interaction with commercial blue crab trap/pot gear (mortality) and 1 entanglement interaction with a research skimmer trawl (mortality).
[g] An entanglement interaction with hook and line fishing gear (mortality).

HABITAT ISSUES

Issues Related to the DWH Oil Spill

The DWH MC252 drilling platform, located approximately 80 km southeast of the Mississippi River Delta in waters about 1500 m deep, exploded on 20 April 2010. The rig sank, and over 87 days up to ~3.2 million barrels of oil were discharged from the wellhead until it was capped on 15 July 2010 (DWH NRDAT 2016). Within the region occupied by the Mississippi Sound, Lake Borgne, Bay Boudreau Stock of common bottlenose dolphins, light to trace oil was reported along the majority of Mississippi's mainland coast, and heavy to light oiling occurred on Mississippi's barrier islands (Michel *et al.* 2013). Shortly after the oil spill, the Natural Resource Damage Assessment (NRDA) process was initiated under the Oil Pollution Act of 1990. A variety of NRDA research studies were conducted to determine potential impacts of the spill on marine mammals.

Stranding rates in the northern Gulf of Mexico rose significantly in the years of and following the DWH oil spill to levels higher than previously recorded (Litz *et al.* 2014; Venn-Watson *et al.* 2015b) and a UME was declared for cetaceans in the northern Gulf of Mexico beginning 1 March 2010 and ending 31 July 2014 (Litz *et al.* 2014; http://www.nmfs.noaa.gov/pr/health/mmume/cetacean_gulfofmexico.htm, accessed 1 June 2016). The primary cause for the UME was attributed to exposure to the DWH oil spill (Venn-Watson *et al.* 2015a; Colegrove *et al.*

2016; DWH NRDAT 2016) as other possible causes (e.g., morbillivirus infection, brucellosis, and biotoxins) were ruled out (Venn-Watson *et al.* 2015a).

A suite of research efforts indicated the DWH oil spill negatively affected the Mississippi Sound, Lake Borgne, Bay Boudreau Stock of common bottlenose dolphins (Schwacke *et al.* 2014; Venn-Watson *et al.* 2015a; Colegrove *et al.* 2016). Capture-release health assessments and analysis of stranded dolphins during the oil spill both found evidence of moderate to severe lung disease and compromised adrenal function (Schwacke *et al.* 2014; Venn-Watson *et al.* 2015a). In addition, low serum cortisol levels were found in Mississippi Sound dolphins (Smith *et al.* 2017). Compared to animals from Sarasota Bay, Florida, the percentage of the population with a guarded or worse health prognosis was 24% higher in Mississippi Sound (DWH MMIQT 2015; Smith *et al.* 2017). In addition, De Guise *et al.* (2017) suggested immune systems were weakened due to the DWH oil exposure.

Reproductive success also was compromised after the oil spill. Kellar *et al.* (2017) estimated the reproductive success rate of bottlenose dolphins in Mississippi Sound during and following the DWH oil spill at 0.222, meaning only about one in five detected pregnancies resulted in a viable calf. This rate was much lower than the expected rate, 0.647, based on previous work in non-oiled reference areas (Kellar *et al.* 2017). The elevated reproductive failure rate determined for Mississippi Sound following the DWH spill is consistent with previous research on mammals demonstrating a connection between petroleum exposure and reproductive impairments, and was not thought to be caused by other possible agents, namely persistent organic pollutants, *Brucella* spp., or biotoxins (Kellar *et al.* 2017). The reproductive failure rates are also consistent with findings of Colegrove *et al.* (2016) who examined perinate strandings in Louisiana, Mississippi, and Alabama during 2010–2013 and found that bottlenose dolphins were prone to late-term failed pregnancies and *in utero* infections, including pneumonia and brucellosis.

Congruent with evidence for compromised health and poor reproductive success, low survival rates were reported for bottlenose dolphins in Mississippi Sound following the DWH oil spill based on C-R photo-ID surveys (DWH MMIQT 2015; DWH NRDAT 2016). The estimated survival rate in the first year after the spill (July 2010–July 2011) was 0.73 and the rate for the second period (July 2011–January 2012) was 0.78. These survival rates are much lower than those reported previously for other southeastern U.S. estuarine areas, such as Charleston, South Carolina (0.95; Speakman *et al.* 2010), or Sarasota Bay, Florida (0.96; Wells and Scott 1990).

Finally, Balmer *et al.* (2015) indicated it is unlikely that persistent organic pollutants (POPs) significantly contributed to the unusually high stranding rates following the DWH oil spill. POP concentrations in dolphins sampled between 2010 and 2012 at six northern Gulf sites that experienced DWH oiling were comparable to or lower than those previously measured by Kucklick *et al.* (2011) from southeastern U.S. sites; however, the authors cautioned that potential synergistic effects of oil exposure and POPs should be considered as the extra stress from oil exposure added to the background POP levels could have intensified toxicological effects.

Other Habitat Issues

Environmental contaminants have been an issue of concern for bottlenose dolphins throughout the southeastern U.S., including Mississippi Sound, prior to the DWH oil spill. As mentioned above, Kucklick *et al.*(2011) examined POPs (PCBs, chlordanes, mirex, DDTs, HCB and dieldrin) and polybrominated diphenyl ether (PBDE) concentrations from bottlenose dolphin blubber samples collected during 2000–2007 from 14 locations, including Mississippi Sound, along the U.S. Atlantic and Gulf coasts and Bermuda. Dolphins from both rural and urban estuarine and coastal waters were sampled. Dolphins sampled from Mississippi Sound had relatively high concentrations of some pollutants, like PBDEs, HCB, mirex and DDTs, and more intermediate concentrations of dieldrin, PCBs and chlordanes, when compared to dolphins sampled from the other 13 locations (Kucklick *et al.* 2011). The more recent work of Balmer *et al.* (2015) (discussed above) found lower levels of POPs in Mississippi Sound when compared to the results of Kucklick *et al.* (2011); however, future research is necessary to identify which stock(s) were sampled in this region to fully assess changes in POPs over time.

The presence of vessels may impact bottlenose dolphin behavior in bays, sounds, and estuaries. Miller *et al.* (2008) investigated the immediate responses of bottlenose dolphins to “high-speed personal watercraft” (i.e., boats) in Mississippi Sound. They found an immediate impact on dolphin behavior demonstrated by an increase in traveling behavior and dive duration, and a decrease in feeding behavior for non-traveling groups. The findings suggested dolphins attempted to avoid high-speed personal watercraft. It is unclear whether repeated short-term effects will result in long-term consequences like reduced health and viability of dolphins. Further studies are needed to determine the impacts throughout the Gulf of Mexico.

STATUS OF STOCK

Common bottlenose dolphins are not listed as threatened or endangered under the Endangered Species Act.

Because the estimate of human-caused mortality and serious injury exceeds PBR, this is a strategic stock under the MMPA. The documented mean annual human-caused mortality for this stock for 2011–2015 was 310. However, it is likely the estimate of annual fishery-caused mortality and serious injury is biased low as indicated above (see Annual Human-Caused Mortality and Serious Injury), and there are uncertainties in the population model used to estimate population decline due to the DWH oil spill, also indicated above (see Habitat Issues). Because a UME of unprecedented size and duration (1 March 2010 through 31 July 2014) has impacted the northern Gulf of Mexico, including the Mississippi Sound, Lake Borgne, Bay Boudreau Stock, NMFS finds cause for concern about this stock. The DWH damage assessment projected that the stock will have experienced a 62% (95% CI: 43–83) maximum reduction in population size due to the oil spill (DWH MMIQT 2015; Schwacke *et al.* 2017). It is therefore likely that this stock is below its optimum sustainable population (NMFS 2016). In the absence of any additional non-natural mortality or restoration efforts, the DWH damage assessment estimated this stock will take 46 years to recover to pre-spill population size (DWH MMIQT 2015). It is plausible that this stock contains multiple demographically independent populations. Total fishery-related mortality and serious injury for this stock is not known, but at a minimum is greater than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant and approaching zero mortality and serious injury rate. There are insufficient data to determine population trends for this stock.

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