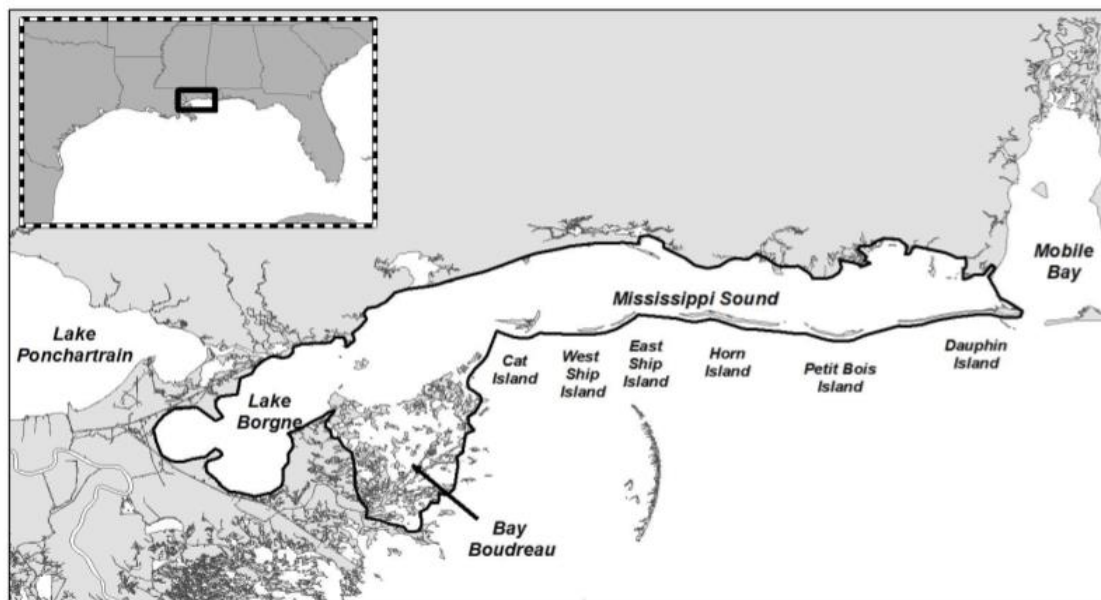


## COMMON BOTTLENOSE DOLPHIN (*Tursiops truncatus truncatus*): Mississippi Sound, Lake Borgne, Bay Boudreau Stock

**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, 1996b; 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



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

discrete, demographically independent bay, sound and estuary (BSE) populations (Duffield and Wells 2002; Sellas *et al.* 2005; Rosel *et al.* 2017). 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 genetic population structure among all areas. The Sellas *et al.* (2005) findings support the identification of BSE populations distinct from those occurring in adjacent Gulf coastal waters. Rosel *et al.* (2017) also identified significant population differentiation between estuarine residents of Barataria Bay and the adjacent coastal stock. 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; Mazzeo *et al.* 2005; Litz 2007; Rosel *et al.* 2009).

The Mississippi Sound, Lake Borgne, Bay Boudreau Stock was designated 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<sup>2</sup> (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<sup>2</sup> (Eleuterius 1978a, 1978b) 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 common bottlenose dolphins (Scott 1990). Mississippi Sound was once the site of the largest live-capture fishery of common bottlenose dolphins in North America (Reeves and Leatherwood 1984). Between 1973 and 1988, of the 533 common 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 common 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 common 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 common 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 common bottlenose dolphins were captured from Mississippi Sound, freeze-branded and released during 1982–1983 (Solangi and Dukes 1983; Lohoefer *et al.* 1990). Re-sighting efforts for these dolphins conducted from 1982–1985 by Lohoefer *et al.* (1990) 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 for 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.

In 2013, 19 dolphins (11 males and 8 females) were satellite tagged in Mississippi Sound with most (17) tagged near the mainland off eastern Mississippi and two tagged off the barrier islands (Mullin *et al.* 2017). Tag life averaged about 200 days. Dolphins tagged near the coast had a variety of ranges but generally remained in the region where they were tagged along the coast to mid-Mississippi Sound. One ranged into extreme eastern Mobile Bay and one other briefly into the Gulf of Mexico, but the others did not range outside of Mississippi Sound. Those tagged near the barrier islands ranged wider east to west but always in a very narrow corridor along both sides of the islands. While more work is needed, these tagging data indicate the potential for at least two dolphin communities, mainland and island, in the MS Sound Region.

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 and satellite tag 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 1,265 (CV=0.35; Table 1; Garrison *et al.* 2021). This estimate is from an aerial survey conducted during winter 2018.

### **Earlier Abundance Estimates (>8 years old)**

Please see Appendix IV and Hayes *et al.* (2018) for a summary of abundance estimates, including earlier estimates and survey descriptions from NMFS surveys. In addition to NMFS surveys, 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 were 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<sup>2</sup> (CV=0.31) in spring 2013 to 1.12 dolphins/km<sup>2</sup> (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.

### **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 summer (June–August) 2017 and fall (October–November) 2018, and from Tampa, Florida, to Port O'Connor, Texas, during winter (January–March) 2018. The surveys were conducted along tracklines oriented perpendicular to the shoreline and spaced 20 km apart. The total survey effort varied during each survey due to weather conditions, but ranged between

8,046 and 14,590 km. The Mississippi Sound, Lake Borgne, Bay Boudreau Stock boundaries were surveyed completely in each season, and tracklines were spaced 5 km apart. Survey effort within the stock boundaries ranged between 487 and 750 km of effort (Garrison *et al.* 2021). 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). Abundance was calculated using mark-recapture distance sampling implemented in package mrds (version 2.21; Laake *et al.* 2020) in the R statistical programming language. This approach estimates both the probability of detection on the trackline and within the surveyed strip accounting for the effects of sighting conditions (e.g., sea state, glare, turbidity, and cloud cover). A different detection probability model was used for each seasonal survey (Garrison *et al.* 2021). The abundance estimates for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock of bottlenose dolphins were based upon tracklines and sightings in waters along the Alabama, Mississippi, and Louisiana coasts inside of the barrier islands. The seasonal abundance estimates for this stock were: summer – 2,146 (CV=0.34), winter – 1,265 (CV=0.35), and fall – 4,337 (CV=0.16). In order to assure that the abundance estimate for the stock reflects primarily resident animals, the lowest seasonal estimate (winter) was used to determine  $N_{est}$  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 1,265 (CV=0.35; Table 1).

### 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 1,265 (CV=0.35). The minimum population estimate for the stock is 947 common bottlenose dolphins (Table 1).

### Current Population Trend

The statistical power to detect a trend in abundance for this stock is poor due to the relatively imprecise abundance estimates and long intervals between surveys. For example, the power to detect a precipitous decline in abundance (i.e., 50% decrease in 15 years) with estimates of low precision (e.g., CV>0.30) remains below 80% ( $\alpha=0.30$ ) unless surveys are conducted on an annual basis (Taylor *et al.* 2007). Point estimates of common bottlenose dolphin abundance have been made based on aerial data from surveys during 2011–2012 and 2017–2018 (Garrison *et al.* 2021). Each of these surveys had a similar design and was conducted using the same aircraft and observer configuration. The resulting abundance estimates for winter seasonal surveys were: 2011–2012 – 1,104 (CV=0.59) and 2017–2018 – 1,265 (CV=0.35). A trends analysis is not possible because there are only two abundance estimates available. For further information on comparisons of old and current abundance estimates for this stock see Garrison *et al.* (2021).

### 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 *Deepwater Horizon* (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 947. The maximum productivity rate is 0.04, the default value for cetaceans. The recovery factor is 0.45 because the CV of the shrimp trawl mortality estimate for Mississippi and Alabama BSE stocks is greater than 0.6 (Wade and Angliss 1997). PBR for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock of bottlenose dolphins is 8.5 (Table 1).

**Table 1. Best and minimum abundance estimates for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock of common bottlenose dolphins with Maximum Productivity Rate ( $R_{max}$ ), Recovery Factor ( $F_r$ ) and PBR.**

Nest	Nest CV	Nmin	$F_r$	$R_{max}$	PBR
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1,265	0.35	947	0.45	0.04	8.5
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## 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 2015–2019 is unknown. Across Mississippi/Alabama BSE stocks (from Mississippi River Delta east to Mobile Bay, Bonsecour Bay), the total annual estimated mortality for the shrimp trawl fishery was 33 (CV=0.70), but the portion of this attributed to the Mississippi Sound, Lake Borgne, Bay Boudreau Stock is unknown (see Shrimp Trawl section). The mean annual fishery-related mortality and serious injury during 2015–2019 for strandings and at-sea observations identified as fishery-related was 2.0. Additional mean annual mortality and serious injury during 2015–2019 due to other human-caused sources (fishery research, gunshot wounds, and DWH oil spill) was 57. The minimum total mean annual human-caused mortality and serious injury for this stock during 2015–2019 was therefore 59 (Table 2). This is considered a minimum 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 five commercial fisheries that interact, or potentially could interact, with this stock. These include three Category II fisheries (Southeastern U.S. Atlantic, Gulf of Mexico shrimp trawl; Gulf of Mexico gillnet; Gulf of Mexico menhaden purse seine) and two Category III fisheries (Gulf of Mexico blue crab trap/pot; Atlantic Ocean, Gulf of Mexico, Caribbean commercial passenger fishing vessel (hook and line)). Detailed fishery information is presented in Appendix III.

*Note: Animals reported in the sections to follow were ascribed to a stock or stocks of origin following methods described in Maze-Foley et al. (2019). These include strandings, observed takes (through an observer program), fisherman self-reported takes (through the Marine Mammal Authorization Program), research takes, and opportunistic at-sea observations.*

### Shrimp Trawl

During 2015–2019, based on limited observer coverage in Louisiana BSE waters under the NMFS MARFIN program, there was one observed mortality and no observed serious injuries of common bottlenose dolphins from Gulf of Mexico BSE stocks by commercial shrimp trawls. Between 1997 and 2019, 13 common bottlenose dolphins and nine 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 observed trips of the commercial shrimp trawl fishery in the Gulf of Mexico (Soldevilla *et al.* 2021). 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, 2021) provided mortality estimates calculated from analysis of shrimp fishery effort data and NMFS’s Observer Program bycatch data. Limited observer program coverage of Louisiana BSE waters started in 2015, but has not yet reached sufficient levels for estimating BSE bycatch rates; therefore time-area stratified bycatch rates were extrapolated into inshore waters to estimate the most recent five-year unweighted mean mortality estimate for 2015–2019 based on inshore fishing effort (Soldevilla *et al.* 2021). Because the spatial resolution at which fishery effort is modeled is aggregated into four state areas (e.g., Nance *et al.* 2008), the mortality estimate covers all inshore waters of Mississippi, Alabama, and eastern Louisiana and thus all their respective BSE stocks, not just the Mississippi Sound, Lake Borgne, Bay Boudreau Stock. The mean annual mortality estimate for Mississippi/Alabama BSE stocks (from Mississippi River Delta east to Mobile Bay, Bonsecour Bay) was 33 (CV=0.70) dolphins per year. If all of the mortality occurred in the Mississippi Sound, Lake Borgne, Bay Boudreau Stock, the mortality estimate would exceed 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 38% of shrimp fishery effort in eastern Louisiana,

Mississippi, and Alabama 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, 2021).

### **Gillnet**

No marine mammal mortalities associated with gillnet fisheries have been reported or observed for the Mississippi Sound, Lake Borgne, Bay Boudreau Stock. There is no observer coverage of gillnet fisheries within the estuarine waters of the Mississippi Sound, Lake Borgne, or Bay Boudreau. There is limited observer coverage of gillnet fisheries in federal waters (e.g., Mathers *et al.* 2020), but none currently in state waters, although during 2012–2018 NMFS placed observers on commercial vessels (state permitted gillnet vessels) in the coastal state waters of Alabama, Mississippi, and Louisiana (Mathers *et al.* 2016). No takes were observed in state coastal waters during that time. However, stranding data suggest that gillnet and marine mammal interactions do occur (Read and Murray 2000), causing mortality and serious injury. During 2015–2019, two stranded common bottlenose dolphins were recovered with markings indicative of interaction with gillnet gear, but no gillnet gear was attached to the carcasses and it is unknown whether the interactions with the gear contributed to the death of these animals. One case was ascribed to the Mississippi Sound, Lake Borgne, Bay Boudreau Stock (2015; was entangled in hook and line gear and is also discussed in the Hook and Line section below), and one case was ascribed to both the Mississippi Sound, Lake Borgne, Bay Boudreau and the Northern Coastal stocks (2016). Because there is no observer program within this stock's boundaries, it is not possible to estimate the total number of mortalities or serious injuries associated with gillnet gear.

### **Menhaden Purse Seine**

During 2015–2019, there were four mortalities documented through the Marine Mammal Authorization Program (MMAP) within waters of the MS Sound Region that involved the menhaden purse seine fishery (Table 2). Two incidents involving two dolphins each were reported as entangled within a single purse seine, both occurring during 2018. There is, however, currently no observer program for the Gulf of Mexico menhaden purse seine fishery. 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 2015–2019, there were three mortalities and one serious injury (Maze-Foley and Garrison 2021) of common bottlenose dolphins for which blue crab trap/pot gear entanglement were documented within the stranding data. Two of the cases were confirmed to involve commercial gear, and for the remaining two, it could not be determined whether the gear was commercial or recreational. Three cases were ascribed to the Mississippi Sound, Lake Borgne, Bay Boudreau Stock, and one case was ascribed to both the Mississippi Sound, Lake Borgne, Bay Boudreau and the Northern Coastal stocks. The mortalities occurred during 2016, 2018, and 2019, and the serious injury occurred in 2017. The mortalities and serious injury were all included in the stranding database (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 25 August 2020) and in the totals presented in Table 3, as well as in the annual human-caused mortality and serious injury total for this stock (Table 2). There is no 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 2015–2019, there were four mortalities of common bottlenose dolphins for which hook and line gear entanglement or ingestion were documented within the stranding data. One mortality occurred in 2015 and three occurred in 2019. For two of these mortalities (2015, 2019), available evidence from the stranding records suggested the hook and line gear interactions contributed to the cause of death (the 2015 mortality also had markings indicative of interaction with gillnet gear and is also discussed in the Gillnet section above). For one mortality (2019), available evidence suggested the hook and line gear interaction was not a contributing factor to cause of death. For one mortality (2019), based on available evidence, it could not be determined if the hook and line gear interaction contributed to the cause of death. Three cases were ascribed to the Mississippi Sound, Lake Borgne, Bay Boudreau Stock, and one case was ascribed to the Mississippi Sound, Lake Borgne, Bay Boudreau and the Mobile Bay, Bonsecour Bay stocks. These mortalities were included in the stranding database (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 25 August 2020) and in the totals presented in Table 3. The two mortalities

(2015, 2019) for which evidence suggested the gear contributed to the cause of death were included in the annual human-caused mortality and serious injury total for this stock (Table 2).

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 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 2015–2019, the model projected 282 mortalities (Table 2). The observed differences in abundance estimates from 2011–2012 and 2017–2018 are not consistent with this predicted change in population size. 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).

One mortality was documented in 2016 in the MS Sound Region as a result of an entanglement in a fishery research gillnet. This interaction was included in the stranding database (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 25 August 2020) and in the totals presented in Table 3, and it was also included in the annual human-caused mortality and serious injury total for this stock (Table 2).

During 2019, one stranded common bottlenose dolphin was recovered with markings indicative of twisted twine net gear, but no gear was attached to the carcasses and it is unknown whether the interactions with the gear contributed to the death of this animal. The case was ascribed to both the Mississippi Sound, Lake Borgne, Bay Boudreau and Northern Coastal stocks. This interaction was included in the stranding database (NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 25 August 2020) and in the totals presented in Table 3, but it was not included in the annual human-caused mortality and serious injury total for this stock (Table 2).

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 2015–2019, two mortalities were attributed to a shooting in 2018, and in 2019 gunshot pellets were found in a carcass during necropsy. For the 2018 case, a pregnant dolphin was found to have died from the gunshot wound, and her unborn calf died as a result of her death. For the 2019 case, the gunshot was not believed to be the cause of death (included in Table 3; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, accessed 25 August 2020). The two gunshot mortalities from 2018 were included in the annual human-caused mortality and serious injury total for this stock (Table 2). 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 of fishing catch and/or bait 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). Such conditioning increases risks of subsequent injury and mortality (Christiansen *et al.* 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 2.

**Table 2. 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, 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 strandings, at-sea counts, and fisherman self-reported takes, the number reported is a minimum because not all strandings, at-sea cases, or gear interactions are detected. See the Annual Human-Caused Mortality and Serious Injury section for biases and limitations of mortality estimates, and the Strandings section for limitations of stranding data. NA = not applicable.**

<b>Fishery</b>	<b>Years</b>	<b>Data Type</b>	<b>Mean Annual Estimated Mortality and Serious Injury Based on Observer Data</b>	<b>5-year Minimum Count Based on Stranding, At-Sea, and/or MMAP Data</b>
Shrimp Trawl	2015–2019	Observer Data	Undetermined for this stock but may be non-zero (see Shrimp Trawl section)	NA
Menhaden Purse Seine	2015–2019	MMAP fisherman self-reported takes	NA	4
Atlantic Blue Crab Trap/Pot	2015–2019	Stranding Data	NA	4
Hook and Line	2015–2019	Stranding Data	NA	2
<b>Mean Annual Mortality due to commercial fisheries (2015–2019)</b>			<b>2.0</b>	
Research Takes (5-year Count)			1	
Other Takes (gunshot wounds; 5-year Count)			2	
Mortality due to DWH (5-year Projection)			282	
<b>Mean Annual Mortality due to research takes, other takes, and DWH (2015–2019)</b>			<b>57</b>	
<b>Minimum Total Mean Annual Human-Caused Mortality and Serious Injury (2015–2019)</b>			<b>59</b>	

### Strandings

During 2015–2019, 405 common bottlenose dolphins were reported stranded within the Mississippi Sound, Lake Borgne, Bay Boudreau Stock area (Table 3; NOAA National Marine Mammal Health and Stranding Response Database unpublished data, 25 August 2020). Of those 405, three 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. There was evidence of human interaction (HI) for 25 of the strandings. No evidence of human interaction was detected for

13 strandings, and for the remaining 367 strandings, it could not be determined if there was evidence of human interaction. Human interactions were from numerous sources, including four entanglements with hook and line gear, four entanglements with crab trap/pot gear, one incidental take in a research gillnet, one mortality with markings indicative of interaction with twisted twine net gear, two mortalities with markings indicative of interactions with gillnet gear, two mortalities with evidence of gunshot wounds, and three animals with evidence of a vessel strike (Table 3). It should be noted that evidence of human interaction does not necessarily mean the interaction caused the animal's stranding or death.

The assignment of animals to a single stock is impossible in some regions where stocks overlap, especially in nearshore coastal waters (Maze-Foley *et al.* 2019). Of the 405 strandings ascribed to the Mississippi Sound, Lake Borgne, Bay Boudreau Stock, 356 were ascribed solely to this stock. It is likely, therefore, that the counts in Table 3 include some animals from the Western Coastal Stock and possibly the Mobile Bay, Bonsecour Bay Stock, and thereby overestimate the number of strandings for the stock; those strandings that could not be definitively ascribed to the Mississippi Sound, Lake Borgne, Bay Boudreau Stock were also included in the counts for the Western Coastal Stock or Mobile Bay, Bonsecour Bay Stock as appropriate. Stranded carcasses are not routinely identified to either the offshore or coastal morphotype of common bottlenose dolphin, therefore it is possible that some of the reported strandings were of the offshore form, though that number is likely to be low (Byrd *et al.* 2014).

There are a number of other difficulties associated with the interpretation of stranding data. Stranding data 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; Carretta *et al.* 2016). 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 four common bottlenose dolphin die-offs or Unusual Mortality Events (UMEs). 1) From January through May 1990, a total of 344 common 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). 2) In 1996 a UME was declared for common bottlenose dolphins in Mississippi when 31 common 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). 3) 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](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 section 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. 4) During 1 February 2019 to 30 November 2019, a UME was declared for the area from the eastern border of Taylor County, Florida, west through Alabama, Mississippi, and Louisiana ([http://www.nmfs.noaa.gov/pr/health/mmume/cetacean\\_gulfofmexico.htm](http://www.nmfs.noaa.gov/pr/health/mmume/cetacean_gulfofmexico.htm), accessed 5 November 2020). A total of 337 common bottlenose dolphins stranded during this event, with 166 of them being from the Mississippi Sound, Lake Borgne, Bay Boudreau Stock. The largest number of mortalities occurred in eastern Louisiana and Mississippi. An investigation concluded the event was caused by exposure to low salinity waters as a result of extreme freshwater discharge from rivers. The unprecedented amount of freshwater discharge during 2019 (e.g., Gasparini and Yuill 2020) resulted in low salinity levels across the region.

**Table 3. Common bottlenose dolphin strandings occurring in the Mississippi Sound, Lake Borgne, Bay Boudreau Stock area from 2015 to 2019, including the number of strandings for which evidence of human interaction (HI) was detected and number of strandings for which it could not be determined (CBD) if there was evidence of HI. Data are from the NOAA National Marine Mammal Health and Stranding Response Database (unpublished data, accessed 25 August 2020). Please note HI does not necessarily mean the interaction caused the animal's death.**

Stock	Category	2015	2016	2017	2018	2019	Total
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Mississippi Sound, Lake Borgne, Bay Boudreau Stock	Total Stranded	39	88	55	50	173 <sup>e</sup>	405
	Human Interaction						
	---Yes	4 <sup>a</sup>	5 <sup>b</sup>	3 <sup>c</sup>	5 <sup>d</sup>	8 <sup>f</sup>	25
	---No	0	1	2	3	7	13
	---CBD	35	82	50	42	158	367

a. Includes 2 mortalities with evidence of a vessel strike and 2 fisheries interactions (FI), 1 of which was an entanglement interaction (mortality) with hook and line fishing gear.

b. Includes 1 entanglement interaction in research gillnet gear (mortality), and 4 FIs, including 1 with markings indicative of interaction with gillnet gear and 1 entanglement interaction with trap/pot gear (mortality).

c. Includes 1 entanglement interaction with trap/pot gear (released alive seriously injured).

d. Includes 1 mortality with a gunshot wound, 1 mortality with evidence of a vessel strike, and 2 fisheries interactions (FI), 1 of which was an entanglement interaction (mortality) with commercial blue crab trap/pot gear.

e. 166 strandings were part of the UME event in the northern Gulf of Mexico.

f. Includes 1 mortality with evidence of a gunshot wound and 5 FIs, including 3 entanglement interactions (mortalities) with hook and line fishing gear, 1 entanglement interaction (mortality) with commercial blue crab trap/pot gear, and 1 animal with markings indicative of interaction with twisted twine net gear.

## 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](http://www.nmfs.noaa.gov/pr/health/mmume/cetacean_gulfofmexico.htm), accessed 1 June 2016). 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).

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 common 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 common 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 common 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; PCBs, chlordanes, mirex, DDTs, HCB and dieldrin) 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. A subsequent study by Balmer *et al.* (2018), using both blubber and blood samples collected during health assessments in 2011, 2013, and 2014, examined POP concentrations, also suggested that POPs were unlikely the cause of the adverse health and high stranding rates in Mississippi Sound.

### Other Habitat Issues

Prior to the DWH oil spill, environmental contaminants have been an issue of concern for bottlenose dolphins throughout the southeastern U.S., including Mississippi Sound. Kucklick *et al.* (2011) examined POPs and polybrominated diphenyl ether (PBDE) concentrations from common bottlenose dolphin blubber and found that 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 other locations. However, as noted, Balmer *et al.* (2015) found lower levels of POPs in Mississippi Sound when compared to the results of Kucklick *et al.* (2011). Balmer *et al.* 2018 found that dolphins from Mississippi Sound had higher overall contaminant levels, based on blood samples, than those in Barataria Bay and Sarasota Bay, levels nearly 1.5 times higher than those detected in dolphins from the Sarasota Bay reference site. The authors suggested higher levels of several contaminants in Mississippi Sound dolphins are due to the established ship-building industry operating in the area.

The presence of vessels may impact common bottlenose dolphin behavior in bays, sounds, and estuaries. Miller *et al.* (2008) investigated the immediate responses of common 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 minimum estimate of human-caused mortality and serious injury exceeds PBR, the Mississippi Sound, Lake Borgne, Bay Boudreau Stock is a strategic stock under the MMPA. The documented mean annual human-caused mortality for this stock for 2015–2019 was 59. 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 section), 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 section). It is likely that this stock is below its optimum sustainable population (NMFS 2016) due to mortalities related to the DWH oil spill and two recent UMEs. Total fishery-related mortality and serious injury for this stock is unknown, but at a minimum is greater than 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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