Stock Assessment Report (SAR)

WEST INDIAN MANATEE *(Trichechus manatus)*

FLORIDA STOCK
(Florida subspecies, *Trichechus manatus latirostris*)

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STOCK DEFINITION AND GEOGRAPHIC RANGE

The West Indian manatee (*Trichechus manatus*) is found in coastal and riverine areas of North America, Central America, and South America and islands in the Caribbean basin. Two subspecies are recognized. Hatt (1934) identified an Antillean and a Florida subspecies, *Trichechus manatus manatus* and *Trichechus manatus latirostris*, respectively, and Domning and Hayek (1986) subsequently reported that the two subspecies could be individually identified based on cranial characteristics. They suggested that this subspeciation could reflect reproductive isolation brought on by the intemperate northern coast of the Gulf of Mexico and characteristically strong currents found in the Straits of Florida (Domning and Hayek 1986). More recently, Barros *et al*. (2016), using landmark-based 3D geometric morphometrics of cranial size and shape diversification, suggested the two subspecies taxonomic classification may not be accurate, especially in relation to the Antillean subspecies in and around Brazil. Within the jurisdictional waters of the United States (U.S.), Florida manatees are found throughout the southeastern U.S., and Antillean manatees are found in Puerto Rico and on rare occasions, in the U.S. Virgin Islands (Figure 1; Lefebvre *et al.* 2001).

Genetic differences between the Antillean and Florida subspecies have been identified (García-Rodríguez *et al*. 1998, Vianna *et al.* 2006, Tucker *et al*. 2012). García-Rodríguez *et al.* (1998) compared mitochondrial DNA (mtDNA) from eight locations and identified three geographic clusters: 1) Florida and the West Indies; 2) the Gulf of Mexico to the Caribbean rivers of South America; and 3) the northeast Atlantic coast of South America. Vianna *et al.* (2006) assessed relatedness between the Florida and Puerto Rico populations and identified a gene flow barrier. This was further confirmed by Hunter *et al.* (2012), who used microsatellite Bayesian cluster analyses to detect two populations (K = 2) and noted no admixture or recent migrants between Florida (q = 0.99) and Puerto Rico (q = 0.98).

Florida manatees are generally restricted to the inland and coastal waters of peninsular Florida during the winter where they shelter in or near warm-water springs and spring complexes, heated industrial effluents, and other warm-water sites such as passive thermal basins (Hartman 1979, Lefebvre *et al.* 2001, Laist and Reynolds 2005, Stith *et al.* 2006, Laist *et al.* 2013, Valade *et al*. 2020). In warmer months, manatees leave these sites and can disperse great distances (Figure 1). Individuals have been sighted as far north as Massachusetts, as far west as Texas, and in all states in between (Rathbun *et al.* 1982, Powell and Rathbun 1984, Rathbun *et al*. 1990, Schwartz 1995, Fertl *et al.* 2005, Cummings *et al.* 2014, Slone *et al.* 2017). On rare occasions, known Florida manatees have been sighted in Cuba, the Bahamas, and along the Yucatan Peninsula, Mexico (Alvarez-Alemán *et al.* 2010, Alvarez-Alemán *et al*. 2018, Castelblanco-Martinez et al. 2021, Melillo-Sweeting *et al.* 2011, Rood *et al.* 2020). In November 2016, a manatee rescued from Massachusetts and then later released on the east coast of Florida was tagged and tracked by satellite, making the crossing to the Bahamas (M. Ross pers. comm. 2019). A known female manatee from southwest Florida also swam to Cuba where it was photo-identified in 2017 close to Havana and then was seen again near Ocean Springs, Mississippi, in January 2020 (Rood *et al*. 2020). Warm-season sightings are most common in Florida, coastal Georgia, South Carolina, and Alabama (Rathbun *et al.* 1982, Powell and Rathbun 1984, Rathbun *et al.* 1990, Schwartz 1995, Fertl *et al.* 2005, Pabody *et al.* 2009, M. Ross pers. comm. 2019), and manatee movements outside of Florida appear to be increasing (Hieb *et al*. 2017; Slone *et al.* 2017).

Figure 1. Range of the West Indian manatee (USFWS, unpublished)

Previous studies of the Florida manatee identified four, relatively distinct, regional management units (formerly referred to as subpopulations): an Atlantic Coast unit that occupies the east coast of Florida, including the Florida Keys and the lower St. Johns River north of Palatka; an Upper St. Johns River unit that occurs in the river south of

Palatka; a Northwest unit that occupies the Florida Panhandle south to Hernando County; and a Southwest unit that occurs from Pasco County south to Whitewater Bay in Monroe County (Figure 2; USFWS 2001 and 2007).

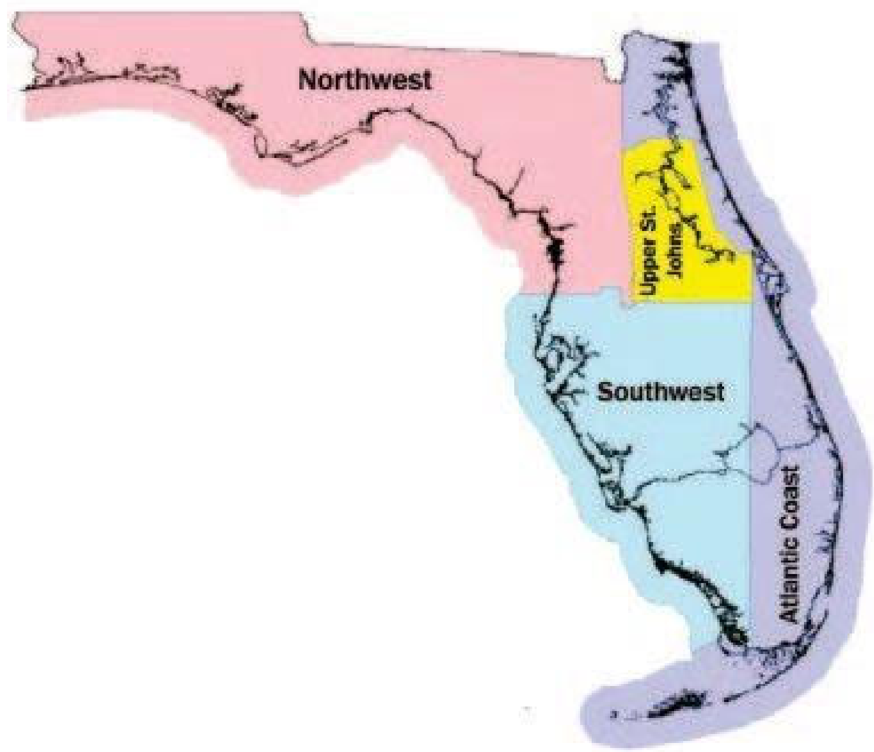

Figure 2. Florida manatee distribution within the four designated regional management units in Florida. Valade *et al.* (2020).

Manatees in each of these management units tend to return to the same warm-water sites each winter and have similar non-winter distribution patterns. The exchange of individuals between these units is generally limited during the winter months, based on data from telemetry studies (Rathbun *et al*. 1990, Reid *et al.* 1991, Weigle *et al*. 2001, Deutsch *et al*. 1998 and 2003) and photo-identification studies (Rathbun *et al*. 1990, Higgs, pers. comm. 2007a, b). During non-winter months, movements occur between the Northwest and Southwest units and between the Upper St. Johns River and Atlantic Coast units (Laist *et al.* 2013). Movements between Florida's Atlantic Coast and Gulf Coast are uncommon but have occurred in recent years as confirmed through photo identification and satellite-telemetry studies (Laist *et al.* 2013, Manatee Individual Photo-Identification System (MIPS) data, Florida Fish and Wildlife Conservation Commission (FWC)/Mote Marine Laboratory (MML)/U.S. Geological Survey (USGS)). Low levels of genetic diversity and little sub-structuring exist among the four management units in Florida with over 95% of the genetic variance documented within management units (Bonde 2009, Tucker *et al*. 2012).

While there are unique issues among the individual management units, the Service manages the Florida manatee as a single stock. As described above, the management unit delineations were originally based on studies of regional manatee wintering sites. The management units are a useful construct for assessing unit-specific population trends and threats; the Service and its collaborators evaluate these parameters for each unit using a core biological model (CBM) developed by Runge *et al.* (2004, 2017). Consistent with the requirements of the Endangered Species Act of 1973 (ESA), as amended, threats are then appropriately addressed at the federal level primarily through the ESA's implementing regulations and related guidance documents, including the Service's recovery plan, and at the state level primarily through the State of Florida's Manatee Management Plan (FWC 2007), the Florida Manatee Sanctuary Act (379.2431(2), Florida Statutes), and implementing regulations.

POPULATION SIZE

In 2015, Martin *et al.* published the first statistically robust estimate of total population size for the Florida manatee stock. The estimate, which relied upon innovative aerial survey techniques and multiple sources of information, estimated a Florida manatee population of 6,350 animals (95% CI, 5,310-7,390 individuals) based on surveys conducted in 2011-12. Hostetler *et al.* (2018) used improved methodologies and aerial survey data collected in 2015-2016 to provide an updated statewide abundance assessment of 8,810 manatees (95% CI, 7,520-10,280 individuals; statewide CV = 0.080) as well as a revised estimate of 6,810 (95% CI, 5,680-8,110 individuals; statewide CV = 0.092) for the surveys flown in 2011-12. Efforts are underway to produce an updated abundance estimate. Researchers at the Florida Fish and Wildlife Conservation Commission (FWC) flew surveys of the West Coast of Florida in December 2021 and of the East Coast in December 2022 and a new abundance estimate is expected in 2023 or 2024.

Previous and ongoing efforts to assess population size for this stock include an annual, legislatively mandated State of Florida winter count of manatees at warm-water sites throughout Florida. The FWC has conducted these counts (known as synoptic surveys) since 1991 as survey conditions permit. The counts provide a minimum estimate of the Florida manatee population during the time period when the survey was conducted. Not all Florida waters are included in the surveys and the number of manatees missed during the surveys is not known so these counts cannot be used to produce a population estimate (FWC FWRI 2020).

The most recent synoptic survey occurred on January 28 - February 2, 2019, and documented a minimum population estimate of 5,733 Florida manatees, including counts of 2,394 on the East Coast and 3,339 on the West Coast. This type of count, conducted during cold periods in winter, provides an assessment of manatee distribution at warm water sites such as power plants and natural springs. However, these counts can be highly variable due to weather and other environmental conditions. The highest count to date was 6,620 documented during the 2017 synoptic count (FWC FWRI 2020). However, these synoptic counts are not used to quantitatively describe population trends (Lefebvre *et al.* 2009, Laist *et al*. 2013).

In March 2021, an Unusual Mortality Event (UME) was declared along the Atlantic coast of Florida. The UME, which began in December 2020 and is ongoing, is associated with phytoplankton blooms and seagrass loss in the Indian River Lagoon. Seagrass is the primary forage for manatees in this area. Preliminary data indicate 1,337 deaths were recorded in the UME area from all causes between December 1, 2020, and December 31, 2022. While all carcasses are verified and documented, necropsies are performed using a standard surveillance protocol; thus, detailed necropsies are not performed on all carcasses. When a full necropsy is not performed, the death is listed as "Verified; Not Necropsied" (VNN). There were 836 VNN deaths within the UME area through December 31, 2022. A subset of these VNN cases received a partial evaluation and 88% had findings consistent with malnutrition (FWC FWRI 2022a).

The UME is primarily affecting one of the four management units (the Atlantic Coast unit). The number of manatees within this unit has likely declined substantially since the UME began, given the number of deaths represents over 35% of the abundance point estimate for this unit and over 45% of the lower end of the 95% credible interval reported in Hostetler *et al*. (2018); however, population size and trends are related to births, immigration, and emigration in addition to deaths. The 2018 best available estimate of abundance is based on aerial surveys flown in 2015-16, so current abundance has been affected by any population changes that occurred during four years before the UME began (2017-2020) and the 2+ years with the UME (late 2020 to present). Prior to the UME, this unit was exhibiting stable or slow positive population growth, while the other three units were (and still are) exhibiting stronger positive growth than the Atlantic Coast unit. For these reasons, the effect of the UME on overall population size and other important metrics, including adult survival and reproductive rates, is not known at this time. This will be assessed in the future based on the new abundance estimates discussed above and additional population modeling. Additional information on the UME is provided in the HABITAT ISSUES section.

Minimum Population Estimate

The minimum population estimate (N_{min}) for the Florida manatee stock is calculated using the equation for Minimum Population Estimate provided in NMFS (2016): $N_{min} = N/\exp(0.842 \times [\ln(1+[CV(N)]^2)]^{½})$. Using the best available abundance estimate discussed above (Hostetler *et al*. 2018), N_{min} is 8,237 given a population estimate of 8,810 and a CV of 0.08.

Current Population Trends

Demographic analyses previously indicated that the Florida stock of manatees was increasing or stable throughout much of Florida (Runge *et al.* 2004, 2007, 2017). The analyses rely on photo-ID based mark-recapture analyses using iterations of a manatee-specific core biological model. The most recent adult-survival-rate analysis for the

Florida manatee identifies mean adult survival rates of over 97% and reproductive rates of over 30% throughout the range (Runge *et al.* 2017; see Table 1). The fastest growing segment of this stock was found in the Upper St. Johns River, with a growth rate of 6.2% (Runge *et al.* 2004). As noted in POPULATION SIZE above, the effect of the ongoing UME on population size and trend is unknown at this time but will be assessed in the future based on the new abundance estimates discussed above and additional population modeling. Additional information on the UME is provided in the HABITAT ISSUES section.

Table 1. Baseline Florida manatee mean adult survival and reproductive rates for four regions in Florida, 1982-2015. From Runge *et al*. 2017.

Region	Mean rate	SE	Data included	Years estimable
Adult survival rates				
Atlantic	0.9729	0.0029	1987 - 2014	1987 - 2010
Upper St Johns	0.9790	0.0031	1987 - 2014	1987 - 2011
Northwest	0.9780	0.0026	1982 - 2014	1982 - 2009
Southwest	0.9759	0.0023	1996 - 2015	1997 - 2012
Reproductive rates				
Atlantic	0.307	0.023	1987 - 2014	1987 - 2010
Upper St Johns	0.384	0.022	1997 - 2014	1997 - 2013
Northwest	0.368	0.027	1987 - 2014	1982 - 2010
Southwest	0.307	0.020	1996 - 2015	1998 - 2014

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates have not been determined for the Florida manatee. In the absence of maximum net productivity rates for this stock, the maximum growth rate for the Upper St. Johns River segment (6.2%) of this stock, which incorporates both reproductive and adult survival rates, is identified as $R_{max.}$ This rate describes a maximum rate of increase and reflects both additions and losses to this population, including losses due to both natural and human causes. The rate for the Upper St. Johns River segment was used as the maximum rate because the rate in this segment was higher than any of the other segments and, therefore, represents a reasonable upper limit for the maximum growth rate the other segments might be able to achieve. As previously noted, the effects of the ongoing UME are not yet known but will be assessed when information is available.

POTENTIAL BIOLOGICAL REMOVAL (PBR)

PBR is the product of three elements: the minimum population estimate (N_{min}), half of the maximum net productivity rate (0.5 R_{max}), and a recovery factor (F_r). Recovery factor values range between 0.1 and 1.0. Population-simulation studies demonstrate that a default value of 0.5 should be used for species or stocks that are listed as threatened under the Endangered Species Act (ESA) (NMFS 2016). The West Indian manatee is listed as threatened throughout its range (81 FR 1000) under the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), as amended. Thus, by default, the recovery factor for the Florida stock is 0.5. We are using the N_{min} and highest calculated growth rate as reported above. Based on these values, PBR for the Florida manatee is 127 (Table 2).

Table 2. Best and minimum abundance estimates for Florida manatees (*Trichechus manatus latirostris*) with Coefficient of Variation (CV), Recovery Factor (F_r), Maximum Productivity Rate (R_{max}), and Potential Biological Removal (PBR).

N_{best}	95% Credible Interval	CV	N_{min}	F_r	R_{max}	PBR
8,810	7,520 – 10,280	0.080	8,237	0.5	0.062	127.67

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Data on manatee mortality in the southeastern United States have been collected since 1974 through a manatee carcass salvage and necropsy program (Bonde *et al.* 1983). Based on these data, the primary sources of human-caused injury and death include watercraft-related strikes (direct impact and/or propeller), entrapment and/or crushing in water-control structures (gates, locks, etc.), entanglement in fishing gear, and ingestion of marine debris (O'Shea *et al*. 1985, Ackerman *et al*. 1995, Wright *et al*. 1995, Pitchford *et al.* 2005, Lightsey *et al*. 2006, Rommel *et al*. 2007, Reinert *et al*. 2017, Bassett *et al*. 2020, FWC FWRI Manatee Mortality Statistics 2021, USFWS Manatee Rescue, Rehabilitation, and Release Program Reports 2020). Natural factors that affect significant numbers of this stock include exposure to cold and red tides. Mortality and morbidity associated with natural factors, including cold stress syndrome and brevetoxicosis, are discussed under Other Mortality.

Cause of death for many salvaged carcasses cannot be determined. These "undetermined" causes can be the result of a carcass that is too decomposed to diagnose or when no specific factor or set of factors can be identified as a cause of death. Carcasses that are verified but do not have a detailed necropsy performed are listed as "Verified; Not Necropsied" (VNN). In addition, small manatees (less than or equal to 150 cm in length) that die at or near the time of birth and whose deaths cannot be attributed to one of the known human-related causes are described as "perinatal" deaths, an undetermined cause (FWC FWRI 2022a). No estimate of the true number of manatee deaths exists because the number of carcasses not found or unreported is unknown.

The Service and its manatee recovery partners maintain an extensive manatee rescue and rehabilitation network to treat distressed manatees (including seriously injured manatees) and return them to the wild. This program, in existence since at least the 1950s, responds to public reports of distressed manatees (Zeiller 1992; USFWS 2020). These reports are verified and, if warranted, manatees are rescued and rehabilitated by members of the Manatee Rescue and Rehabilitation Partnership (MRP), which includes FWC, USFWS, and USGS. In some cases, rescued manatees are transported to a critical care facility for treatment and where appropriate, they may be treated and released in the field. Currently, there are over 20 conservation partners involved with this rescue and rehabilitation program, and five facilities authorized to serve as critical care facilities under USFWS Marine Mammal Enhancement Permits for rescue and rehabilitation activities. The MRP also includes some secondary holding facilities, many of which provide space for stable manatees until they are medically cleared for release back to the wild.

Rescued manatees are distressed due to both human-related and natural causes. Sources of distress include watercraft, marine debris, entrapment associated with water-control structures or due to tidal situations, exposure to brevetoxin and cold, disease, calf abandonment, and others. Not all distressed animals are physically injured.

Examples of distressed animals without physical injuries include orphaned calves, animals exposed to cold and red tides, diseased animals, entrapped animals (stranded due to high tides, caught behind water-control structures, etc.) and others. Some examples of distressed animals with serious injuries include animals cut by watercraft propellers, animals with broken bones due to watercraft collisions, animals with cuts from embedded marine debris, etc. For the purposes of this report, a manatee is deemed to have experienced a human-related "serious injury" if the injury is considered life-threatening. Generally, this necessitates the manatee being brought into a facility for treatment. Some injuries are superficial and non-life threatening. For example, some marine debris-entangled animals may be minimally affected with only minor injuries that do not necessitate being taken into captivity.

Upon rescue, responders determine the condition of the distressed animal. Manatees with non-life-threatening injuries and distressed animals without injuries may be addressed in the field and released on-site. When responders conclude that, in the absence of medical treatment, a distressed manatee may suffer or die, the animal is taken to a critical care facility for treatment.

Data summarized in Tables 3-5 below and discussed in this report are based on confirmed mortality data. Preliminary data are not included because these data are subject to change as to cause of death and other attributes. In discussions of the ongoing UME contained in other sections of this report, the reported total number of deaths does include preliminary data (to provide context on the scale of the event) but no assessments of these data have been made as to cause of death. The mortality and rescue data summarized in this report include data through 2018, the last full year for which confirmed mortality data were available from the FWC at the time this report was prepared and submitted to the Atlantic Scientific Review Group for peer review. After peer review, FWC provided confirmed mortality data covering all of 2019 and 2020. Because of when these data became available and changes FWC made to their data collection protocols, these data are discussed in this report but are not included in the tables.

Starting in 2020, FWC made significant revisions to their data collection protocols, partly due to pandemic-related restrictions but mostly as a planned transition to a new sampling and surveillance approach that was needed due to increases in the number of reported carcasses and it no longer being practicable to try and recover and necropsy them all. The transition involved the creation of a new category (Verified, Not Necropsied, VNN) that includes all deaths that are verified but which do not receive a full necropsy that allows a cause of death to be assigned. Whereas there have always been (and continue to be) deaths that are categorized as Undetermined, this category includes only carcasses for which a cause of death could not be determined following a necropsy and carcasses that were too decomposed for a thorough evaluation. The predecessor of the VNN category was an Unrecovered category. There was typically a relatively small number of deaths (<30) in the Unrecovered category each year, unless there was a large-scale mortality event (such as red tide or extreme cold weather) that resulted in many carcasses that could not be investigated. The new VNN category will likely include a much larger number of deaths (>200) per year even when no large-scale event occurs; it also will likely include at least some carcasses for which it would have been possible to assign a cause of death had the carcass been necropsied. For these reasons, for 2020 and going forward, it will be necessary to develop new modeling or analyses to estimate the number of VNN deaths that could have been in each of the other categories. This also will be necessary for years prior to 2020 if they are included in the data range reported in the stock assessment report so that all years are treated in a similar manner. The new methodology has not yet been finalized but is expected in or before 2024.

From 1974 through 2018 (a 45-year period), 12,548 manatee carcasses were salvaged in the southeastern United States. Of these carcasses, 3,107 (25%) were animals that died from human causes. Eighty-four percent (2,596) of the manatees that died from human causes were killed by watercraft. Water-control structures (including floodgates and navigation locks) killed 240 manatees, and the deaths of the remaining 271 manatees were attributed to other human causes, including entanglement in and ingestion of fishing gear and other marine debris (FWC FWRI 2021a and 2021b).

For the period 2014-2018, the average annual documented human-caused mortality and serious injury to Florida manatees in the southeastern U.S. was 144.8 (Table 3). Each category of mortality and injury is discussed in more detail below. Table 4 summarizes total mortality by cause and includes both human-related and natural factors. Table 5 provides information on the number of rescues over the same period and how many manatees taken into captivity for treatment were later released back to the wild.

Table 3. Average annual documented human-caused mortality and serious injury for the Florida manatee (*Trichechus manatus latirostris*) Source: FWC FWRI 2021a and 2021b, USFWS 2020.

Years	Source	Mortality	Serious Injury	Annual Average
2014-2018	Watercraft	101.0	23.2	124.2
2014-2018	Structures: Crushing/Impingement	4.0	0	4.0
2014-2018	Structures: Entrapment	4.0	1.4	5.4
2014-2018	Fishery: Entanglement	0	1.6	1.6
2014-2018	Fishery: Other	1.2	0.4	1.6
2014-2018	Other Human Causes	7.6	0.4	8.0
TOTAL	All Human-Caused Sources	117.8	27.0	144.8

Table 4. All documented manatee deaths (number of deaths, percent of annual total), 2014 through 2018. (Source: FWC FWRI 2021a and 2021b). Numbers include reported, dead manatees that were salvaged and confirmed/verified carcasses that were not salvaged (included in "Other").

Year	Human-caused Deaths	Perinatal	Cold Stress	Natural, Other*	Other**	Total
2014	82 (22%)	100 (26%)	30 (8%)	29 (8%)	140 (37%)	381
2015	103 (25%)	91 (22%)	22 (5%)	45 (11%)	153 (37%)	414
2016	115 (22%)	113 (21%)	24 (5%)	86 (16%)	191 (36%)	529
2017	132 (24%)	117 (21%)	31 (6%)	93 (17%)	175 (32%)	548
2018	157 (19%)	113 (13%)	90 (11%)	232 (28%)	251 (30%)	843
TOTAL	589 (22%)	534 (20%)	197 (7%)	485 (18%)	910 (33%)	2,715
5-Year Avg.	117.8	106.8	39.4	97.0	182.0	543

***includes confirmed red tide; **includes suspected red tide**

Table 5. All manatee rescue responses (total number of responses and number of distressed manatees taken into critical care facilities for treatment, 2014-2018. (Source: USFWS 2020)

YEAR	No. of Rescue Responses	Manatees Taken to Critical Care Facilities	Manatees Released from Captivity	Human-caused Serious Injuries		
				Watercraft	Entanglement	Other
2014	68	52	26	16	2	1
2015	93	50	30	19	0	2
2016	125	85	50	30	2	3
2017	113	59	40	26	2	3
2018	133	83	53	25	2	2
TOTAL	532	329	199	116	8	11
5-Year Avg.	106.4	65.8	39.8	23.2	1.6	2.2

Watercraft-related Mortality and Serious Injury

For the period 2014-2018, the average annual documented mortality and serious injury to Florida manatees in the southeastern U.S. related to watercraft was 124.2 (Table 3). Without accounting for the new sampling protocols, 140 and 92 watercraft-related deaths were documented in 2019 and 2020, respectively. When watercraft-related collisions occur, manatees may suffer injuries or death by propeller cuts, damage from other parts of the vessel as well as by blunt-force trauma (Lightsey *et al*. 2006, Rommel *et al*. 2007). Watercraft-related impacts may also lead to the orphaning of dependent calves whose mothers are struck by watercraft and do not survive or are unable to be released back to the wild. Orphaned calves may not survive unless they are rescued and raised in captivity until they are healthy and meet benchmark criteria for release (generally minimum requirements of 200 cm total straight-line length and 600 pounds total body weight) (USFWS 2010). Meeting these targets can sometimes require several years or more in captivity. Manatee calves gain important knowledge from their mothers, such as learning locations for warm-water availability, foraging habitat, and freshwater, so these young, orphaned manatees present challenges for the MRP (Adimey *et al.* 2016). For most orphaned calves, the reason for their separation from their mother is not known. For the period 2014-18, 68 calves were rescued and brought into captivity, 10 of which were brought into captivity because the mother was known to have been struck by watercraft.

Runge *et al.* (2017) observed that increases in watercraft-related mortality had the potential to substantially increase the risk of quasi-extinction at the statewide or coastal level. Specifically, they noted that, "if the rate of watercraft-related mortality were to double, the risk of quasi-extinction would increase more than 10 fold." Their analysis assumes that current protection and mitigation programs (for example, boat speed zones, rescue and rehabilitation of injured manatees, etc.) remain in place indefinitely (Runge *et al.* 2017).

Structure-related Mortality and Serious Injury

For the period 2014-2018, the average annual documented mortality and serious injury to Florida manatees in the southeastern U.S. due to structure-related causes was 9.4 (Table 3). This average includes 4.0 manatees injured or killed by crushing or impingement in water-control structures or navigation locks as well as 5.4 manatees injured or killed due to being entrapped in or behind various man-made structures, such as culverts, pipes, and weirs. Without accounting for the new sampling protocols, 5 and 12 structure-related deaths were documented in 2019 and 2020, respectively.

Few manatees are rescued from crushing and impingement impacts because the discovery of the carcass is often the first indication that an incident has occurred. Most water-control structures that are known to have caused deaths and/or are determined to represent a significant risk have been built or retrofitted with manatee-protection devices to prevent or at least reduce the potential for manatees to be affected. Risks at other structures, including navigation locks, have been reduced by implementing standard operating procedures to ensure efforts are made to locate manatees before structure gates are operated. As a result of these efforts, crushing and impingement deaths are less common now than they were in the past (FWC FWRI 2021a and 2021b).

Entrapment in or behind a man-made structure can result directly in injury or death (e.g., the manatee is trapped under water and unable to breathe) or it can indirectly result in death or distress if the animal is not discovered in time to be rescued and either released or brought into captivity for treatment. Impacts causing distress that can require treatment include, but are not limited to, emaciation, exposure to cold, and severe abrasions.

Fisheries-related Mortality and Serious Injury

For the period 2014-2018, the average annual documented mortality and serious injury to Florida manatees in the southeastern U.S. due to fishery-related causes was 3.2 (Table 3). This average includes 1.6 manatees injured or killed due to entanglement in commercial or recreational fishing gear as well as 1.6 manatees injured or killed due to other fishery-related causes. Without accounting for the new sampling protocols, 1 and 0 fisheries-related deaths were documented in 2019 and 2020, respectively. The total U.S. fishery-related mortality and serious injury for this stock derived from available data was less than 10% of the calculated PBR, and therefore could be considered insignificant and approaching a zero mortality and serious injury rate.

Entanglement in blue crab traps (traps and/or associated buoys and lines) is typically the most frequent source of fishery-related impacts, but manatees are known to entangle in and/or ingest many types of fishing gear used in commercial and recreational fisheries (Nill 1998, Smith 1998, Reinert *et al*. 2017, FWC FWRI 2021a and 2021b, USFWS 2020). Fishing gear used by commercial fishers known to entangle or be ingested by manatees includes shrimp trawls, shrimp nets, crab traps, seines, shiner nets, hoop nets, trot lines, and monofilament fishing line and associated tackle. Similarly, recreational fishery gear known to either entangle or be ingested by manatees includes monofilament fishing line and/or associated tackle, cast nets, and crab traps. Manatees are struck and killed or injured by a variety of watercraft, including watercraft of a size and type comparable to those used by commercial and recreational fishers (Beck and Barros 1991, Pitchford *et al.* 2005, Lightsey *et al.* 2006, Rommel *et al.* 2007).

The National Marine Fisheries Services' (NMFS) 2020 List of Fisheries (NMFS 2020) identifies two commercial fisheries known to take Florida manatees: the Atlantic blue crab trap/pot fishery and the Gulf of Mexico blue crab trap/pot fishery. The Southeastern U.S. Atlantic/Gulf of Mexico shrimp trawl fishery was listed in prior years but was removed in 2020. NMFS (2020) estimates 6,679 vessels/persons participate in the Atlantic blue crab trap/pot fishery and 4,113 vessels/persons participate in the Gulf of Mexico blue crab trap/pot fishery.

From 2014 to 2018, there were 43 manatee–crab-fishery interactions, including three seriously injured manatees. All three of the seriously injured manatees entangled in crab-fishery gear were successfully treated and returned to the wild (USFWS 2020). Because both commercial and recreational crab-pot fisheries use the same types of gear, it is difficult to attribute specific crab-trap-entanglement events to commercial crab fisheries. There was one documented mortality in a shrimp trawl (in Florida in 2017), but it is not known if the trawl was being used for commercial or recreational purposes.

Efforts have been made to reduce the incidence of lethal and non-lethal entanglements in and ingestion of marine debris, including fishing gear (Spellman 1999, Spellman *et al.* 2003, Reinert *et al*. 2017). Manatees entangled in or ingesting marine debris are rescued each year by the MRP, and manatee mortalities and serious injuries are reduced as a result of this activity (Nill 1998, Smith 1998, FWC FWRI 2021a and 2021b, USFWS 2020). The Service has funded studies to assess manatee behavior in the presence of fishing gear and to identify "manatee-safe" crab-fishing gear that, if used, will minimize the number of crab-trap entanglements (Bowles 2000, Bowles *et al.* 2003). Derelict-crab-trap removals and monofilament removal and recycling programs are helping to reduce the likelihood of manatee interactions with this gear (Koelsch *et al.* 2003). In February 2009, FWC adopted regional blue crab harvest closures across the state; derelict crab traps are removed during the closures, further reducing the likelihood of crab-trap-gear entanglements (FWC 2009).

Other Human-caused Mortality and Serious Injury

For the period 2014-2018, the average annual documented mortality and serious injury to Florida manatees in the southeastern U.S. due to other human-related causes was 8.0 (Table 3). This category includes all other human causes not covered by the watercraft, structures, or fishery categories, including poaching, vandalism, and entanglement in or ingestion of materials not associated with fishing gear. The majority of cases in this category typically involve ingestion of unidentified or non-fishery materials or cases where the origin of the human-caused injury could not be conclusively determined, such as between a watercraft and a structure. Without accounting for the new sampling protocols, 8 and 15 Other Human-caused deaths were documented in 2019 and 2020, respectively.

Manatees occasionally entangle in gear associated with fisheries, marine-mammal, and sea-turtle research projects (Reinert *et al*. 2017, USFWS 2020). Prior incidents have involved shrimp and other trawls, seines, hoop nets, as well as collisions with research vessels. These activities did not result in any deaths or serious injuries between 2014 and 2018.

Other Mortality

As noted above, human causes have accounted for approximately 25% of all documented mortality since 1974. For the period 2014-2018, the percentage attributed to human causes was 22% (Table 4), which means deaths not attributed to human causes accounted for 78% of the total. The largest portion of the deaths (33% of all mortality) was from cases where the cause of death could not be determined (due to decomposition or no identifiable cause) or the carcass was not recovered or not necropsied. This subset also includes deaths where brevetoxicosis (i.e., red tide) was suspected but not confirmed. Some of the undetermined deaths *could* have been human-related (e.g., a manatee killed by watercraft, but the carcass was not recovered). Runge *et al*. (2017) used a fractions-of-mortality analysis to apportion these deaths to known causes in order to model the effects of different threat scenarios on population viability; however, none of these deaths are considered human-related in this report. In addition, and as mentioned previously, there is an ongoing Unusual Mortality Event (UME) along the Atlantic coast of Florida that began in December 2020 associated with phytoplankton blooms and seagrass loss in the Indian River Lagoon. Information on the UME is provided in the HABITAT ISSUES section below.

For the period 2014-2018, the average annual documented mortality to Florida manatees in the southeastern U.S. due to confirmed or suspected red tide was 89 (FWC FWRI 2021a). The highest annual total during this period was 288 (in 2018) and the lowest was 2 (in 2014). Without accounting for the new sampling protocols, 92 and 9 red tide-related deaths were documented in 2019 and 2020, respectively. When there are red-tide outbreaks, the MRP may rescue affected manatees, and they will remain in captivity until they are declared medically cleared and red-tide cell counts have lowered to acceptable levels in the area where they were rescued or if during winter, the closest warm-water site.

For the period 2014-2018, the average annual documented mortality to Florida manatees in the southeastern U.S. due to cold stress was 39.4 (Table 4). The highest annual total during this period was 90 (in 2018) and the lowest was 22 (in 2015). Without accounting for the new sampling protocols, 69 and 50 cold-related deaths were documented in 2019 and 2020, respectively. None of these deaths are considered human-related unless the manatee was entrapped by a man-made obstacle and unable to migrate to warmer water.

If such cases occur, the mortality or serious injury would be included in the Structures: Entrapment category.

It has been suggested that some cold-stress mortality or serious injury should be considered human-related if the manatee was lured to or enticed to stay at a manmade warm-water site north of the manatee's historical winter range. Although this certainly does occur periodically (particularly in coastal Georgia and South Carolina), manatee movements far north and west of Florida have been documented dating back to at least the early 1900s (Moore 1951). Thus, it is unknown to what extent present-day manatee movements are influenced by manmade warm-water sources in Florida or beyond. For this reason, the Service does not include those cases as human-related in this report due to the inherently subjective nature of the assessment that would need to be made in each case. However, for the period 2014-2018, the average annual documented mortality to Florida manatees in the southeastern U.S. north or west of Florida due to cold stress was 2.8, with an additional 5.2 rescues on average per year (FWC FWRI 2021a and 2021b, USFWS 2020). Most of the rescued manatees were captured in early winter before serious cold-stress symptoms were present. These manatees were then transported back to Florida and released without needing to be taken into captivity for treatment. Only four manatees rescued from South Carolina or Georgia (1 in 2017 and 3 in 2018) required short-term rehabilitation due to cold stress.

HABITAT ISSUES

Florida manatee survival depends on the future availability of both freshwater and saltwater habitats for reliable warm water, feeding, drinking, and mating, as well as travel (or migratory) corridors and sheltered areas for resting and calving (Husar 1977; USFWS 2016). Of these, the most significant are warm water and winter foraging habitat availability (USFWS 2016). At present, there are at least 67 known primary and secondary warm-water sites, including 10 power plants, 23 springs and spring complexes, and 34 passive thermal basins that provide warm water for the Florida manatee (Valade *et al.* 2020). Given the importance of long-term warm-water availability to the Florida manatee stock, the USFWS and FWC have been working cooperatively with partners and in 2020 finalized a Warm Water Habitat Action Plan. This key plan will provide the framework for the development of regional warm-water networks as some industrial sources transition offline in the years to come (Valade *et al.* 2020). While this is a critical issue for the future, one carrying-capacity study of eleven selected warm-water sites found that warm water did not present a current constraint for most sites, and under present scenarios vegetation within proximity was more limiting than spatial concerns (Provancha *et al.* 2012). Addressing the manatee's reliance on these industrial and natural spring sites and the allocation of warm water for manatees for future generations will be one of the key tasks for wildlife researchers, managers, and industry partners for many years to come.

Harmful algal blooms continue to affect the Florida manatee, particularly red-tide blooms, which usually occur on the west coast of Florida between Pinellas County and Collier County, but occasionally span into the Atlantic coast of Florida. Red-tide blooms tend to affect manatees primarily through the ingestion of food such as seagrass, and less through inhalation of brevetoxin or through consumption from seawater (Flewelling *et al*. 2005; Walsh *et al*. 2015). Red-tide blooms are more prevalent during the fall and winter but can persist throughout the year. Duration ranges from a few weeks to over a year. The most recent red-tide bloom in Southwest Florida occurred in 2021 and preliminary data indicate at least 60 manatees were affected (more than 50 red-tide-related carcasses and 10 rescues). The highest annual red-tide-related mortality event occurred in 2018 and resulted in the loss of at least 288 manatees (FWC FWRI 2022b). While blue-green algae blooms have also been well documented in Florida, and specifically around Lake Okeechobee, the impacts of cyanotoxins on manatee health have not been determined with certainty; to date no deaths have been attributed to these toxins. FWC is continuing investigations through the manatee necropsy program, but currently the effects to water clarity, light penetration, and shading of the native submerged aquatic vegetation seem to be the most critical aspects of blue-green algae blooms.

Loss of foraging habitat associated with human activities such as coastal development, dredging, anchoring, fishing, eutrophication, and siltation is well documented and managed, to the extent practicable, through state and federal regulatory agencies. Where possible, the USFWS works with state, industry, and other resource and conservation partners to encourage best practices and habitat restoration efforts. Coastal development is addressed through a suite of state and federal regulatory review processes along with countywide manatee protection plans (MPPs) in 16 Florida counties, which include comprehensive boat-facility siting strategies to help balance manatee protection and waterfront development needs. Habitat protection and avoidance and minimization measures are included in these MPPs.

Florida's Indian River Lagoon (generally southern Mosquito Lagoon south to near the Fort Pierce Inlet) has been experiencing significant losses of seagrass and drift algae since 2009. The amount of available seagrass remained relatively consistent between 1994 and 2009. Since 2011, approximately 58% of the seagrass acreage has been lost and the density of seagrass in the remaining areas has decreased from an average of about 20% to about 4% due primarily to reduced light penetration as a result of protracted and intense phytoplankton blooms (Morris *et al*. 2022). The causes of this decline are complex and include both natural and human-related factors. The primary natural factors include extremely low water temperatures in the winters of 2009-10 and 2010-11, high salinity caused by drought conditions, weather events at other times that resulted in heavy runoff from adjacent uplands, as well as a shift in the character and dynamics of the phytoplankton blooms that have followed (Philips *et al*. 2021; Philips *et al*. 2014). The primary human-related factor contributing to the blooms is excess nutrients (mainly nitrogen and phosphorous) entering the lagoon from agricultural and residential land, stormwater runoff, and leaking septic tanks or sewage treatment facilities (St. Johns River Water Management District 2022). Manatees have been affected by the loss of seagrass and other changes in the lagoon in several ways.

Soon after the seagrass losses began, there was a spike in manatee deaths that led to a UME designation in 2013. At least 199 manatee deaths fit the case definition for the

UME between 2012 and 2019, although most of the deaths (111) occurred in 2013. Carcasses were in good nutritional condition but had wet lungs consistent with drowning without trauma. Necropsies revealed multiple species of macroalga had been consumed. The results from eight years of sampling and testing ultimately indicated the cause of death was associated with clostridial infection associated with the change in diet from seagrass to predominantly macroalgae (Landsberg *et al*. 2022).

In contrast to the 2013 UME, deaths associated with the ongoing UME that began in December 2020 are being caused by starvation due to lack of forage. There is likely a cumulative toll on manatee health, especially in those manatees that continue to be exposed to suboptimal nutrition during summer and fall. These animals enter winter in already compromised condition and the added stressor of suboptimal temperatures causes elevated mortality, as has been observed over the winters of 2020-2021 and 2021-2022 (FWC FWRI 2022c). The UME investigation is ongoing and with time will provide answers on future health effects of chronic malnutrition. As previously mentioned in the POPULATION SIZE section, preliminary data indicate 1.337 deaths were recorded in the UME area from all causes between December 1, 2020, and December 31, 2022. While all carcasses are verified and documented, detailed necropsies of select carcasses are targeted to support health research and inform the UME investigation. For carcasses that are necropsied and the cause of death is determined to be associated with the starvation UME, FWC categorizes the deaths in the “Natural; Other” category. This is also how deaths from the 2013 clostridial UME were categorized. When a full necropsy is not performed, the death is listed as “Verified; Not Necropsied” (VNN). There were 836 VNN deaths within the UME area from December 1, 2020, through March 31, 2022. A subset of these VNN cases received a partial evaluation and 88% had findings consistent with malnutrition (FWC FWRI 2022c).

While human-related factors are partly responsible for the habitat losses, the Service has not characterized the deaths from the 2013 UME or the ongoing UME as human-caused. This is because there are multiple natural and human-related factors contributing to the phytoplankton blooms and other habitat changes leading to lack of forage and ultimately, to manatees in compromised health condition due to suboptimal nutrition. Colder weather during winter then exacerbates the situation given the generally poor health condition of many manatees and the added stress of colder temperatures. The Service implemented a Joint Incident Command with FWC in November 2021 to enhance and supplement existing efforts and partnerships and coordinate other response activities intended to reduce manatee deaths and mitigate the effects on the overall ecosystem. Furthermore, the Service is working with federal, state, local, and private conservation partners to monitor habitat status and assist with efforts to address the underlying nutrient issues and pursue habitat-restoration projects when and where they are appropriate. Investigations into the UME as well as the complex factors affecting the lagoon are ongoing and efforts are underway (and have been for years) to develop projects that will reduce nutrient loading (e.g., conversion of septic systems to sewer) as well as remove excess nutrients that are already present (e.g., dredging of organic muck).

STATUS OF STOCK

The Florida manatee is protected by the State of Florida under the Florida Manatee Sanctuary Act of 1978, as amended (§ 379.2431(2), FS). Federally, Florida manatees were originally listed as an endangered species in 1967 under the Endangered Species Preservation Act of 1966. The original listing was subsequently adopted under the Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq*.), as amended. The West Indian manatee was reclassified in 2017 as a threatened species. As a threatened species under the Endangered Species Act, manatees are considered a "strategic stock" and "depleted" under the Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361 *et seq*.).

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