HUMPBACK WHALE (*Megaptera novaeangliae*): Gulf of Maine Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

In the western North Atlantic, humpback whales feed during spring, summer and fall over a geographic range encompassing the eastern coast of the United States (including the Gulf of Maine), the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland (Katona and Beard 1990). Other North Atlantic feeding grounds occur off Iceland and in the Norwegian Sea, including off northern Norway, Bear Island, Jan Mayen, and Franz Josef Land (Christensen *et al.* 1992; Palsbøll *et al.* 1997). These six regions represent relatively discrete subpopulations, fidelity to which is determined matrilineally (Clapham and Mayo 1987), which is supported by studies of the mitochondrial genome (Palsbøll *et al.* 1995; Palsbøll *et al.* 2001) and individual animal movements (Stevick *et al*. 2006). During the 2002 Comprehensive Assessment of North Atlantic humpback whales, the International Whaling Commission acknowledged the evidence for treating the Gulf of Maine as a separate management unit (IWC 2002).

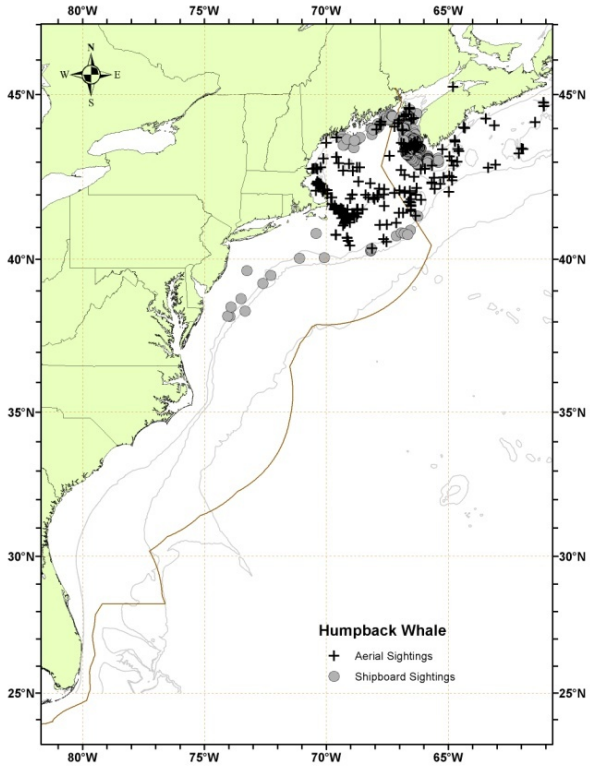

Figure 1. Distribution of humpback whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1995, 1998, 1999, 2002, 2004, 2006, 2007, 2008, 2010 and 2011. Isobaths are the 100-m, 1000-m and 4000-m depth contours.

During the summers of 1998 and 1999, the Northeast Fisheries Science Center conducted surveys for humpback whales on the Scotian Shelf to establish the occurrence and population identity of the animals found in this region, which lies between the well-studied populations of the Gulf of Maine and Newfoundland. Photographs from both surveys were compared to both the overall North Atlantic Humpback Whale Catalog and a large regional catalog from the Gulf of Maine (maintained by the College of the Atlantic and the Center for Coastal Studies, respectively); this work is summarized in Clapham *et al.* (2003). The match rate between the Scotian Shelf and the Gulf of Maine was 27% (14 of 52 Scotian Shelf individuals from both years). Comparable rates of exchange were obtained from the southern (28%, n=10 of 36 whales) and northern (27%, *n*=4 of 15 whales) ends of the Scotian Shelf (one whale was observed in both areas). In contrast, all of the 36 humpback whales identified by the same NMFS surveys elsewhere in the Gulf of Maine (including Georges Bank, southwestern Nova Scotia, and the Bay of Fundy) had been previously observed in the Gulf of Maine region. The sighting histories of the 14 Scotian Shelf whales matched to the Gulf of Maine suggested that many of them were transient through the latter area. There were no matches between the Scotian Shelf and any other North Atlantic feeding ground, except the Gulf of Maine; however, instructive comparisons are compromised by the often low sampling effort in other regions in recent years. Overall, it appears that the northern range of many members of the Gulf of Maine stock does not extend onto the Scotian Shelf.

During winter, whales from most North Atlantic feeding areas (including the Gulf of Maine) mate and calve in the West Indies, where spatial and genetic mixing among feeding groups occurs (Katona and Beard 1990; Clapham *et al.* 1993; Palsbøll *et al.* 1997; Stevick *et al.* 1998). Some whales using eastern North Atlantic feeding areas

migrate to the Cape Verde Islands (Reiner *et al.* 1996; Wenzel *et al.* 2009; Stevick *et al.* 2016), and some individuals have been recorded in both the Cape Verde Islands and the Caribbean (Stevick e*t al*. 2016). In the West Indies, the majority of whales are found in the waters of the Dominican Republic, notably on Silver Bank and Navidad Bank, and in Samana Bay (Balcomb and Nichols 1982; Whitehead and Moore 1982; Mattila *et al.* 1989, 1994). Humpback whales also are found at much lower densities throughout the remainder of the Antillean arc (Winn *et al.* 1975; Levenson and Leapley 1978; Price 1985; Mattila and Clapham 1989). Although recognition of 2 breeding areas for North Atlantic humpbacks is the prevailing model, our knowledge of breeding season distribution is far from complete (see Smith and Pike 2009; Stevick *et al.* 2016).

Not all whales from this stock migrate to the West Indies every winter, because significant numbers of animals are found in mid- and high-latitude regions at this time (Clapham *et al.* 1993; Swingle *et al.* 1993) and some individuals have been sighted repeatedly within the same winter season (Clapham *et al.* 1993; Robbins 2007). Acoustic recordings made within the Massachusetts Bay area detected some level of humpback song and non-song sounds in almost all months, with two prominent periods, March through May and September through December (Clark and Clapham 2004; Vu *et al*. 2012; Murray *et al*. 2013). This pattern of acoustic occurrence, especially for song, confirms the presence of male humpback whales in the area (a mid-latitude feeding ground) during periods that bracket male occurrence in the Caribbean region, where singing is highest during winter months. A complementary pattern of humpback singer occurrence was observed during the January–May period in deep-ocean regions north and west of the Caribbean and to the east of Bermuda during April (Clark and Gagnon 2002). These acoustic observations from both coastal and deep-ocean regions support the conclusion that at least male humpbacks are seasonally distributed throughout broad regions of the western North Atlantic. In addition, photographic records from Newfoundland have shown a number of adult humpbacks remain there year-round, particularly on the island's north coast. In collaboration with colleagues in the French islands of St. Pierre and Miquelon, a new photographic catalogue and concurrent matching effort is being undertaken for this region (J. Lawson, DFO, pers. comm.).

Within the U.S. Atlantic EEZ, humpback whales have been sighted well away from the Gulf of Maine. Sightings of humpback whales in the vicinity of the Chesapeake and Delaware Bays occurred in 1992 (Swingle *et al.* 1993). Wiley *et al.* (1995) reported that 38 humpback whale strandings occurred during 1985–1992 in the U.S. mid-Atlantic and southeastern states. Humpback whale strandings increased, particularly along the Virginia and North Carolina coasts, and most stranded animals were sexually immature; in addition, the small size of many of these whales strongly suggested that they had only recently separated from their mothers. Wiley *et al.* (1995) concluded that these areas were becoming an increasingly important habitat for juvenile humpback whales and that anthropogenic factors may negatively impact whales in this area. For the period 2011–2015, there are records of 43 humpback whale strandings between New York and Florida in the Marine Mammal Health and Stranding Response database (accessed 17 May 2017). There have also been a number of wintertime humpback sightings in coastal waters of the southeastern U.S. Whether the increased numbers of sightings represent a distributional change, or are simply due to an increase in sighting effort and/or whale abundance, is unknown. Other sightings of note include 46 sightings of humpbacks in the New York-New Jersey Harbor Estuary documented between 2011 and 2016 (Brown et al. 2017). Multiple humpbacks were observed feeding off Long Island during July of 2016 (https://www.greateratlantic.fisheries.noaa.gov/mediacenter/2016/july/26_humpback_whales_visit_new_york.html, accessed 28 April 2017) and there were sightings during November–December 2016 near New York City (https://www.greateratlantic.fisheries.noaa.gov/mediacenter/2016/december/09_humans_and_humpbacks_of_new_york_2.html, accessed 28 April 2017).

A key question with regard to humpback whales off the southeastern and mid-Atlantic states is their stock identity. This topic was investigated using fluke photographs of living and dead whales observed in the region (Barco *et al.* 2002). In this study, photographs of 40 whales (alive or dead) were of sufficient quality to be compared to catalogs from the Gulf of Maine (i.e., the closest feeding ground) and other areas in the North Atlantic. Of 21 live whales, 9 (43%) matched to the Gulf of Maine, 4 (19%) to Newfoundland, and 1 (4.8%) to the Gulf of St Lawrence. Of 19 dead humpbacks, 6 (31.6%) were known Gulf of Maine whales. Although the population composition of the mid-Atlantic is apparently dominated by Gulf of Maine whales, lack of photographic effort in Newfoundland makes it likely that the observed match rates under-represent the true presence of Canadian whales in the region. Barco *et al.* (2002) suggested that the mid-Atlantic region primarily represents a supplemental winter feeding ground used by humpbacks.

In New England waters, feeding is the principal activity of humpback whales, and their distribution in this region has been largely correlated to abundance of prey species, although behavior and bathymetry are factors influencing foraging strategy (Payne *et al.* 1986, 1990). Humpback whales are frequently piscivorous when in New England waters, feeding on herring (*Clupea harengus*), sand lance (*Ammodytes* spp.), and other small fishes. In the northern Gulf of Maine, euphausiids are also frequently taken (Paquet *et al*. 1997). Humpback whales were densest

over the sandy shoals in the southwestern Gulf of Maine favored by the sand lance during much of the late 1970s and early 1980s, and humpback distribution appeared to have shifted to this area (Payne *et al.* 1986). An apparent reversal began in the mid-1980s, and herring and mackerel increased as sand lance again decreased (Fogarty *et al.* 1991). Humpback whale abundance in the northern Gulf of Maine increased markedly during 1992–1993, along with a major influx of herring (P. Stevick, pers. comm.). Humpback whales were few in nearshore Massachusetts waters in the 1992–1993 summer seasons. They were more abundant in the offshore waters of Cultivator Shoal, the Northeast Peak of Georges Bank, and Jeffreys Ledge; these latter areas are traditional locations of herring occurrence. In 1996 and 1997, sand lance and therefore humpback whales were once again abundant in the Stellwagen Bank area. However, unlike previous cycles, when an increase in sand lance corresponded to a decrease in herring, herring remained relatively abundant in the northern Gulf of Maine, and humpbacks correspondingly continued to occupy this portion of the habitat, where they also fed on euphausiids (Weinrich *et al.* 1997). Diel patterns in humpback foraging behavior have been shown to correlate with diel patterns in sand lance behavior (Friedlaender *et al.* 2009).

The key uncertainty in the stock definition for the Gulf of Maine stock of humpback whales is where along the Scotian shelf stock boundaries are drawn in a relatively contiguous range. Exact placement of the boundary should have little effect on conservation status because the whales along the southern Scotian shelf represent a relatively small fraction of either the Gulf of Maine or Labrador stocks.

POPULATION SIZE

Gulf of Maine stock - Earlier estimates

Please see Appendix IV for earlier estimates. As recommended in the 2016 guidelines for preparing stock assessment reports (NMFS 2016), estimates older than eight years are deemed unreliable and should not be used for PBR determinations.

Gulf of Maine Stock - Recent surveys and abundance estimates

Humpback whales are uniquely identifiable based primarily on coloration patterns of the ventral side of the fluke and identification can be augmented by other features such as dorsal fin shape, scars and genetic data (Smith *et al.* 1999). A recent count of the minimum number alive (MNA) for 2015 was produced by counting the number of unique individuals seen in 2015 in the Gulf of Maine stock area as well as seen both before and after 2015 (data provided by J. Robbins, Center for Coastal Studies, Provincetown, MA, USA). The humpback MNA for 2015 was 896 and includes not only cataloged whales but some calves born in 2015 but not yet identifiable. By comparison, an abundance of 335 (CV=0.42) humpback whales was estimated from a line-transect survey conducted during June–August 2011 by ship and plane (Palka 2012). The aerial portion that contributed to the abundance estimate covered 5,313 km of tracklines over waters north of New Jersey and shallower than the 100-m depth contour through the U.S. and Canadian Gulf of Maine and up to and including the lower Bay of Fundy. The shipboard portion covered 3,107 km of tracklines in waters deeper than the 100-m depth contour out to beyond the U.S. EEZ. Both sighting platforms used a two-simultaneous-team data collection procedure, which allows estimation of abundance corrected for perception bias (Laake and Borchers 2004). Estimation of abundance was based on the independent-observer approach assuming point independence (Laake and Borchers 2004) and calculated using the mark-recapture distance sampling option in the computer program Distance (version 6.0, release 2, Thomas *et al.* 2009). This estimate did not include the portion of the Scotian Shelf that is known to be part of the range used by Gulf of Maine humpback whales. This estimate should not be compared to previous estimates that were derived using a different methodology. The now-outdated estimate of 823 humpbacks in the Gulf of Maine and Bay of Fundy in 2008 was based on a minimum number alive calculation. While that type of estimate is generally more accurate than one derived from line-transect survey, the 2016 GAMMS guidelines (NMFS 2016) notes the decline of confidence in the reliability of abundance estimates older than eight years.

Minimum Population Estimate

For statistically-based estimates, 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 distribution as specified by Wade and Angliss (1997). However, MNA is a rigorous accounting of individuals and has no associated CV. It is both more recent and larger than the 2011 line transect estimate and has zero probability of overestimating abundance. Hence Nmin for purposes of this assessment is 896.

Table 1. Summary of abundance estimates for Gulf of Maine humpback whales with month, year, and area covered during each abundance survey, and resulting abundance estimate (Nbest) and coefficient of variation (CV).

Month/Year	Type	N_{best}	CV
Jun–Aug 2011	Virginia to lower Bay of Fundy	335	0.42
Jun–Oct 2015	Gulf of Maine and Bay of Fundy	896	0

Current Population Trend

As detailed below, previous analyses concluded that the Gulf of Maine humpback whale stock is characterized by a positive trend in abundance. This was consistent with an estimated average trend of 3.1% (SE=0.005) in the North Atlantic population overall for the period 1979–1993 (Stevick *et al.* 2003), although there are no feeding-area-specific estimates. An analysis of demographic parameters for the Gulf of Maine (Clapham *et al.* 2003) suggested a lower rate of increase than the 6.5% reported by Barlow and Clapham (1997), but results may have been confounded by distribution shifts. Whether the reported positive trends continued into the current evaluation period is uncertain. NMFS is working with J. Robbins (Center of Coastal Studies) to provide an evaluation of trend in the next stock assessment report.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Zerbini *et al.* (2010) reviewed various estimates of maximum productivity rates for humpback whale populations, and, based on simulation studies, they proposed that 11.8% be considered as the maximum rate at which the species could grow. Barlow and Clapham (1997), applying an interbirth interval model to photographic mark-recapture data, estimated the population growth rate of the Gulf of Maine humpback whale stock at 6.5% (CV=0.012). Maximum net productivity is unknown for this population, although a theoretical maximum for any humpback population can be calculated using known values for biological parameters (Brandão *et al.* 2000; Clapham *et al.* 2001). For the Gulf of Maine stock, data supplied by Barlow and Clapham (1997) and Clapham *et al.* (1995) give values of 0.96 for survival rate, 6 years as mean age at first parturition, 0.5 as the proportion of females, and 0.42 for annual pregnancy rate. From this, a maximum population growth rate of 0.072 is obtained according to the method described by Brandão *et al.* (2000). This suggests that the observed rate of 6.5% (Barlow and Clapham 1997) is close to the maximum for this stock.

Clapham *et al.* (2003) updated the Barlow and Clapham (1997) analysis using data from the period 1992 to 2000. The population growth estimate was either 0% (for a calf survival rate of 0.51) or 4.0% (for a calf survival rate of 0.875). Although uncertainty was not strictly characterized by Clapham *et al.* (2003), their work might reflect a decline in population growth rates from the earlier study period. More recent work by Robbins (2007) places apparent survival of calves at 0.664 (95% CI: 0.517-0.784), a value between those used by Barlow and Clapham (1997) and in addition found productivity to be highly variable and well less than maximum.

Despite the uncertainty accompanying the more recent estimates of observed population growth rate for the Gulf of Maine stock, the maximum net productivity rate was assumed to be 6.5% calculated by Barlow and Clapham (1997) because it represents an observation greater than the default of 0.04 for cetaceans (Barlow *et al.* 1995) but is conservative in that it is well below the results of Zerbini *et al.* (2010).

POTENTIAL BIOLOGICAL REMOVAL

Potential Biological Removal (PBR) is the product of minimum population size, one-half the maximum productivity rate, and a recovery factor (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The minimum population size for the Gulf of Maine stock is 896 whales. The maximum productivity rate is 0.065. In the 2015 and prior SARs, the recovery factor was 0.10 because this stock was listed as an endangered species under the Endangered Species Act. The 2016 revision to the ESA listing of humpback whales concluded that the West Indies Distinct Population Segment (of which the Gulf of Maine stock is a part) did not warrant listing (81 FR 62259, September 8, 2016). Consequently, in the 2016 SAR the recovery factor was revised to 0.5, the default value for stocks of unknown status relative to OSP (Wade and Angliss 1997). PBR for the Gulf of Maine humpback whale stock is 14.6 whales.

ANNUAL HUMAN-CAUSED SERIOUS INJURY AND MORTALITY

For the period 2012 through 2016, the minimum annual rate of human-caused mortality and serious injury to the Gulf of Maine humpback whale stock averaged 9.7 animals per year. This value includes incidental fishery interaction records, 7.1; and records of vessel collisions, 2.6 (Table 2; Henry *et al.* in press).

In contrast to stock assessment reports before 2007, these averages include humpback mortalities and serious injuries that occurred in the southeastern and mid-Atlantic states that could not be confirmed as involving members of the Gulf of Maine stock. In past reports, only events involving whales confirmed to be members of the Gulf of Maine stock were counted against the PBR. Starting in the 2007 report, we assumed whales were from the Gulf of Maine unless they were identified as members of another stock. At the time of this writing, no whale was identified as a member of another stock. These determinations may change with the availability of new information. Canadian records from the southern side of Nova Scotia were incorporated into the mortality and serious injury rates, to reflect the effective range of this stock as described above. For the purposes of this report, discussion is primarily limited to those records considered to be confirmed human-caused mortalities or serious injuries.

To better assess human impacts (both vessel collision and commercial fishery mortality and serious injury) there needs to be greater emphasis on the timely recovery of carcasses and complete necropsies. The literature and review of records described here suggest that there are significant human impacts beyond those recorded in the data assessed for serious injury and mortality. For example, a study of entanglement-related scarring on the caudal peduncle of 134 individual humpback whales in the Gulf of Maine suggested that between 48% and 65% had experienced entanglements (Robbins and Mattila 2001). Decomposed and/or unexamined animals (e.g., carcasses reported but not retrieved or no necropsy performed) represent 'lost data', some of which may relate to human impacts.

Background

As with right whales, human impacts (vessel collisions and entanglements) may be slowing recovery of the humpback whale population. Van der Hoop *et al.* (2013) reviewed 1762 mortalities and serious injuries recorded for 8 species of large whales in the Northwest Atlantic for the 40 years 1970–2009. Of 473 records of humpback whales, cause of death could be attributed for 203. Of the 203, 116 (57%) mortalities were caused by entanglements in fishing gear, and 31 (15%) were attributable to vessel strikes.

Robbins and Mattila (2001) reported that males were more likely to be entangled than females, but this was an early analysis that has not held up (J. Robbins, pers. Comm 2017). Annually updated inferences made from scar prevalence and multistate models of GOM humpback whales that (1) younger animals are more likely to become entangled than adults, (2) juvenile scarring rates may be trending up, (3) maybe less than 10% of humpback entanglements are ever reported, and (4) 3% of the population may be dying annually as the result of entanglements (Robbins 2009, 2010, 2011, 2012). Humpback whale entanglements also occur in relatively high numbers in Canadian waters. Reports of interactions with fixed fishing gear set for groundfish around Newfoundland averaged 365 annually from 1979 to 1987 (range 174–813). An average of 50 humpback whale entanglements (range 26–66) was reported annually between 1979 and 1988, and 12 of 66 humpback whales entangled in 1988 died (Lien *et al.* 1988). A total of 965 humpbacks was reported entangled in fishing gear in Newfoundland and Labrador from 1979 to 2008 (Benjamins *et al.* 2012). Volgenau *et al.* (1995) reported that in Newfoundland and Labrador, cod traps caused the most entanglements and entanglement mortalities (21%) of humpbacks between 1979 and 1992. They also reported that gillnets were the primary cause of entanglements and entanglement mortalities (20%) of humpbacks in the Gulf of Maine between 1975 and 1990. In more recent times, following the collapse of the cod fishery, groundfish gillnets for other fish species and crab pot lines have been the most common sources of humpback entanglement in Newfoundland. Since the crab pot fishery is primarily an offshore activity on the Grand Banks, these entanglements are hard to respond to and are likely underreported. One humpback whale was reported released alive (status unknown) from a herring weir off Grand Manan in 2009 (H. Koopman, UNC Wilmington, pers. comm.). In U.S. waters, Johnson *et al.* (2005) found that 40% of humpback entanglements were in trap/pot gear and 50% were in gillnets, but sample sizes were small and much uncertainty still exists about the frequency of certain gear types involved in entanglement.

Wiley *et al.* (1995) reported that serious injuries attributable to ship strikes were more common and probably more serious than those from entanglements, but this claim is not supported by more recent analysis. Non-lethal interactions with gear are extremely common (see Robbins 2010, 2011, 2012) and recent analysis suggests entanglement serious injuries and mortalities are more common than ship strikes (van der Hoop *et al.* 2013). Furthermore, in the NMFS records for 2010 through 2014, there are only 9 reports of serious injuries and mortalities as a result of collision with a vessel and 40 records of injuries (prorated or serious) and mortalities attributed to entanglement. Because it has never been shown that serious injuries and mortalities related to ships or to fisheries interactions are equally detectable, it is unclear as to which human source of mortality is more prevalent. A major aspect of vessel collision that will be cryptic as a serious injury is blunt trauma; when lethal it is usually undetectable from an external exam (Moore *et al.* 2013). No whale involved in the recorded vessel collisions had been identified as a member of a stock other than the Gulf of Maine stock at the time of this writing (Henry *et al.*

2016).

Fishery-Related Serious Injuries and Mortalities

A description of fisheries is provided in Appendix III. See Appendix V for more information on historical takes.

In 2012 there was an observed interaction with a humpback whale in mid-Atlantic gillnet gear (non-serious injury). A recent review (Cassoff *et al*. 2011) describes in detail the types of injuries that baleen whales, including humpbacks, suffer as a result of entanglement in fishing gear.

Confirmed human-caused mortalities and serious injuries from the last five years reported to the NMFS Greater Atlantic and Southeast regional offices and to Atlantic Canadian Maritime stranding networks (Henry *et al*., *in press*) are listed in Table 2. When there was no evidence to the contrary, events were assumed to involve members of the Gulf of Maine stock. While these records are not statistically quantifiable in the same way as observer fishery records, they provide some indication of the minimum frequency of entanglements. Specifically to this stock, if the calculations of Robbins (2011, 2012) are reasonable then the 3% mortality due to entanglement that she calculates equates to a minimum average rate of 25.

Although disentanglement is often unsuccessful or not possible for many cases, there are several documented cases of entanglements for which the intervention of disentanglement teams averted a likely serious-injury determination. Twenty-nine serious injuries were prevented by intervention during 2012–2016 (Henry *et al*. in press).

Table 2. Confirmed human-caused mortality and serious injury records of humpback whales (Megaptera novaeangliae) where the cause was assigned as either an entanglement (EN) or a vessel strike (VS): 2012–2016 [a]

Date[b]	Injury Determination	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
29-Apr-12	Serious Injury	-	off Chatham, MA	EN	1	US	NR	SI based on description of body position, which indicates anchored
29-Jul-12	Serious Injury	-	off Gloucester, MA	EN	1	XU	NR	Calf w/ line cutting into peduncle
4-Aug-12	Serious Injury	Aphid	off Provincetown, MA	EN	1	XU	NR	Line exiting both sides of mouth, under flippers, twisting together aft of the dorsal fin & trailing 75 ft past flukes; no wraps. Health decline: thin w/ graying skin.
21-Aug-12	Prorated Injury	2011 Calf of Wizard	off Provincetown, MA	EN	0.75	XU	MF	Full configuration unknown
24-Aug-12	Serious Injury	Forceps	off Provincetown, MA	EN	1	US	NR	Closed, possibly weighted, bridle w/ large tangle of line just above left eye. SI due to odd behavior & apparent difficulty staying at the surface.
3-Apr-13	Mortality	-	off Ft Story, VA	VS	1	US	-	Fractured orbitals & ribs w/ associated bruising

Date[b]	Injury Determination	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
13-Sep-13	Mortality	-	York River, VA	VS	1	US	-	6 lacerations penetrate into muscle w/ associated hemorrhaging
16-Sep-13	Prorated Injury	-	off Chatham, MA	EN	0.75	XU	NR	Partial disentanglement; original & final configurations unknown
28-Sep-13	Mortality	-	off Saltaire, NY	EN	1	XU	GU	Embedded line in mouth w/ associated hemorrhaging & necrosis; evidence of constriction at pectorals, peduncle & fluke w/ associated hemorrhaging; emaciated
1-Oct-13	Mortality	-	Buzzards Bay, MA	EN	1	US	NP	Evidence of underwater entrapment & subsequent drowning.
4-Oct-13	Serious Injury	-	off Chatham, MA	EN	1	XU	NR	Full configuration unknown, but evidence of health decline: emaciation & pale skin
02-Jun-14	Prorated Injury	-	15 mi E of Monomoy Island, MA	EN	0.75	XU	NR	Free-swimming with buoy and highflier trailing 100ft aft of flukes. Attachment point(s) unknown. Unable to confirm if resighted on 21Jun2014.
21-Jun-14	Prorated Injury	-	5 mi E of Gloucester, MA	EN	0.75	XU	NR	Free-swimming trailing a buoy and possibly another buoy/highflier aft. Attachment point(s) unknown. Unable to confirm if this is a resight of 02Jun2014.
18-Jul-14	Serious Injury	-	Provincetown Harbor, MA	EN	1	XU	NR	Free-swimming, trailing short amount of line from left side of mouth. No other gear noted, but evidence of previously more complicated, constricting entanglement. Current configuration deemed non-life threatening. Unsuccessful disentanglement attempt. In poor condition - emaciated with some cyamids. No resights

Date[b]	Injury Determination	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
09/03/2014	Prorated Injury		off Long Island Beach, NJ	EN	.75	XU	NR	Full/final config. unknown. Seen with new vessel strike lacerations on 14Aug2014. No resights. Previously reported as being gear free (SI value=0) but gear status determined to be unconfirmed.
11-Sep-14	Mortality	Spinnaker	10 nm SE of Frenchboro, ME	EN	1	XU	GN	Free-swimming with gillnet gear. Found anchored on 12Sep2014. Gillnet panel lodged in mouth and tightly wrapping forward part of body. Panel entangled in pots with 20+ wraps of pot lines around flukes and peduncle. Mostly disentangled--left with short section of gillnet in mouth expecting to shed. Animal entangled again (14May2015 - anchored and disentangled). Carcass found 11Jun2015. Necropsy revealed gillnet from 2014 entanglement embedded deep into the maxilla and through the vomer. Bone had started to grow around the line. Gillnet is unknown origin. Pot/trap is US gear.
20-Sep-14	-	NYC0010	off Rockaway Beach, Long Island, NY	EN	.75	US	NR	Free-swimming with netting and rope with floats wrapping flukes. Entanglement noticed during photo processing. Full configuration unknown. No resights.
01-Oct-14	-	-	15 mi E of Metompkin Inlet, VA	EN	.75	XU	NR	Free-swimming whale with line & netting on left fluke blade. Gear appeared heavy. Full configuration unknown. No resights.

Date[b]	Injury Determination	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
15-Dec-14	Prorated Injury	-	8.5 nm S of Grand Manan, NB	EN	.75	XC	PT	Fisherman found animal entangled in trawl. Grappled line, animal dove. Upon surfacing, appeared free of gear, but unable to confirm gear free. Original and final configuration unknown.
25-Dec-14	Mortality	Triomphe	Little Cranberry Island, ME	EN	1	XU	NP	Fresh carcass with evidence of extensive constricting entanglement. No necropsy, but robust body condition and histopathology results of samples support EN as COD.
01-Feb-15	Serious Injury	-	off Beaufort, NC	EN	1	XU	NR	Constricting wrap at fluke insertion with line and monofilament netting trailing from flukes. Partial disentanglement by fisherman. Left with embedded gear and at least 40 ft of trailing line and netting. Unknown if there are additional attachment points. No resights.
03-Feb-15	Mortality	-	Corolla, NC	EN	1	US	NP	Fresh carcass with injuries consistent with constricting gear. No gear present. Full stomach indicating fed recently. COD likely peracute under water entrapment.
13-Apr-15	Mortality	-	off Fire Island, NY	VS	1	US	-	Extensive bruising and hemorrhaging at left gape and pectoral, throat, and right and left lateral thorax.
18-Apr-15	Mortality	-	Smith Point, NY	VS	1	US	-	Multifocal hemorrhage and edema in right lateral abdomen.
29-Jun-15	Mortality	-	Fire Island, NY	VS	1	US	-	Extensive fracturing of cranial bones with associated bruising. Additional extensive bruising along dorsal and right lateral body.

Date[b]	Injury Determination	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
09-Jul-15	Prorated Injury	-	off Sandy Hook, NJ	EN	0.75	XU	NR	High flier trailing 30 ft aft of flukes. Attachment point(s) and configuration unknown. No resights.
02-Aug-15	Serious Injury	-	off Race Point, Provincetown, MA	EN	1	XU	GN	Free-swimming with two sets of gear through its mouth: Primary gear=a closed bridle of gillnet joining mid-belly and trailing just past flukes and restricting movement; Secondary gear=an open bridle with one end leading to a buoy and the other to a pot. Disentangled from both sets of gear. Left with very short amount of gillnet through mouth that is expected to shed. Emaciated. No resights. Gillnet is primary cause of injury and of unknown origin. Pot/trap is US gear.
02-Aug-15	Prorated Injury	-	off Chatham, MA	EN	0.75	XU	NR	Calf with line around tail leading to buoys 4 ft aft of flukes. Full configuration unknown. No resights post 22Aug2015.
07-Sep-15	Prorated Injury	-	off Race Point, Provincetown, MA	EN	0.75	XU	MF	Monofilament line trailing from flukes. Attachment point(s) and configuration unknown. No resights.
24-Sep-15	Prorated Injury	-	off Hampton, NH	EN	0.75	US	Anchor system	Became entangled in anchor line of fishing vessel during the night. Believed to be towing the entire system--45 lb anchor, 20 ft of chain, 350 ft of anchor line, 150 ft of float line, polyball and acorn buoy--in an unknown configuration. No resights.

Date[b]	Injury Determination	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
25-Sep-15	Serious Injury	-	off Menemsha Harbor, MA	EN	1	XU	NR	Evidence of constricting body wrap, unable to confirm if gear embedded. Trailing 10 ft of line from flukes, full configuration unknown. Animal emaciated with heavy cyamids. No resights.
17-Oct-15	Mortality	-	Lloyd Neck Harbor, NY	VS	1	US	-	Extensive bruising and edema around right cranial and pectoral.
04-Dec-15	Prorated Injury	-	off Brier Island, NS	EN	0.75	CN	PT	Likely anchored in gear. Partially disentangled by fishermen. Left free-swimming with a body wrap aft of blowholes and 2 balloon floats close to body. Final configuration unknown. No resights.
15-Dec-15	Prorated Injury	-	off North East Harbour, NS	EN	0.75	CN	PT	Likely anchored in gear. Partially disentangled by fishermen. Left free-swimming with buoy and lines around front of whale and lines on the peduncle. Attachment point(s) and final configuration unknown. No resights.
07-Jan-16	Prorated Injury	--	off Greenwich, CT	EN	0.75	US	PT	Anchored in gear with line through mouth and around tail. Partially disentangled - all gear removed from mouth and some from tail. Post intervention whale was using pectorals to swim and tail was down, but unable to confirm if any gear remained and in what configuration. No resights.
09-Jan-16	Serious Injury	HDRV A053	off Fort Story, VA	VS	1	US	-	Deep laceration across back - penetrating into muscle and impacting ability to dive. No resights.

Date[b]	Injury Determination	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
03-Mar-16	Serious Injury	HDRV A045	off Virginia Beach, VA	VS	1	US	-	Deep laceration on left fluke blade, near insertion. Fluke blade necrotic. No resights.
24-Apr-16	Prorated Injury	-	off Race Point, Provincetown, MA	EN	0.75	XU	NR	Free-swimming with 2 buoys - submerged orange at 5 ft and white bullet at 10 ft - trailing behind flukes. Line appears to wrap flukes. Subsequent sighting only reported white buoy, but only one surfacing and no photos. Attachment point(s) and configuration unknown. No resights.
25-Apr-16	Mortality	-	Marshfield, MA	VS	1	US	-	Bruising deep to muscle and fascia by right pectoral and mandible at the base of the skull. Limited necropsy but depth and area of bruising consistent with blunt trauma from vessel strike.
25-Apr-16	Mortality	-	Napreague Bay, NY	VS	1	XU	-	Extensive bruising to ventral thoracic region along with fractured ribs.
18-May-16	Serious Injury	Foggy	off Gloucester, MA	EN	1	XU	GU	Anchored with lines through mouth and 2 embedded body wraps with large float alonside by right body. Entangling gear fouled in 2 other sets of gear. Animal in emaciated. Partial disentanglement - left with an open bridle of 2 lines through the mouth. Subsequent sightings show lines had relooped into a closed bridle and health continued to decline. No resights post July 2016.

Date[b]	Injury Determination	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
21-May-16	Prorated Injury	-	off Mantoloking, NJ	EN	0.75	XU	GN	Full configuration unknown, but minimally wrapped in gear from head to dorsal. Unknown amount of gear removed by public. Unable to confirm if gear free. No resights.
15-Jun-16	Mortality	-	off Fenwick Island, DE	VS	1	US	-	Large area of hemorrhaging around neck and head. Organs displaced forward in body cavity. Full stomach.
24-Jun-16	Mortality	-	off Shinnecock Inlet, NY	VS	1	US	-	Extensive bruising to connective tissue and muscles of the left side, back, and right peduncle.
26-Jun-16	Mortality	Snowplow	off Rockport, MA	VS	1	US	-	Limited necropsy, but significant evidence of blunt trauma to left head and pectoral consistent with vessel strike.
05-Jul-16	Serious Injury	-	off Chatham, MA	EN	1	XU	GU	Free-swimming with embedded wraps at base of flukes and buoy trailing 50 ft. Partially disentangled. Peduncle wraps loosened and expect to shed. Pronosis poor - flukes compromised and deteriorating. Animal swimming with flippers. No resights.
02-Sep-16	Prorated Injury	-	off Gloucester, MA	EN	0.75	XU	NR	Free-swimming and trailing red buoy. Attachment point(s) and configuration unknown. No resights.

Date[b]	Injury Determination	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
10-Sep-16	Mortality	-	Martha's Vineyard, MA	EN	1	XU	NP	No gear present, but evidence of constricting entanglement with associated reactive tissue at fluke insertions. State of decomposition at time of exam precluded COD determination, but injuries and thin blubber layer are consistent with chronic entanglement.
16-Oct-16	Mortality	-	off Ipswich, MA	EN	1	US	PT	No necropsy, but extensive entanglement. Line through mouth with constricting wraps on both flippers, body, and peduncle. Entanglement as COD most parsimonious. Confirmed as same individual released from weir on 27Sep2016 (see Appendix 1).
13-Nov-16	Prorated Injury	NYC0052	off Belmar, NJ	EN	0.75	XU	MF	Free-swimming with monofilament over peduncle and trailing from flukes. Attachment point(s) and configuration unknown. No resights.
14-Nov-16	Prorated Injury	-	off Stone Harbor, NJ	EN	0.75	XU	NR	Free-swimming with line wrapping left flipper and flukes and trailing. Full configuration unclear. No resights.
04-Dec-16	Prorated Injury	-	off Quogue, NY	EN	0.75	XU	NR	Free-swimming with high flier near flukes. Attachment point(s) and configuration unknown. No resights.
16-Dec-16	Mortality	HDRVA078	off Dam Neck, VA	EN	1	US	NP	No gear present, but evidence of extensive constricting entanglement. Fresh carcass with disgestive system full of fish. COD dry drowning due to entanglement.

Date[b]	Injury Determination	ID	Location[b]	Assigned Cause	Value against PBR[c]	Country[d]	Gear Type[e]	Description
19-Dec-16	Prorated Injury	-	off Tiverton, NS	EN	0.75	XC	NR	Free-swimming with line around tail and buoy trailing. Full configuration unknown. No resights.

Assigned Cause	Five-year mean (US/CN/XU/XC)
Vessel strike	2.6(2.4/ 0.00/ 0.20/ 0.00)
Entanglement	7.1 (1.65/ 0.30/ 4.85/ 0.30)

a. For more details on events please see Henry *et al.* in press.
b. The date sighted and location provided in the table are not necessarily when or where the serious injury or mortality occurred; rather, this information indicates when and where the whale was first reported beached, entangled, or injured.
c. Mortality events are counted as 1 against PBR. Serious injury events have been evaluated using NMFS guidelines (NOAA 2012).
d. CN=Canada, US=United States, XC=Unassigned 1st sight in CN, XU=Unassigned 1st sight in US.
e. H=hook, GN=gillnet, GU=gear unidentifiable, MF=monofilament, NP=none present, NR=none recovered/received, PT=pot/trap, WE=weir.

Other Mortality

Between November 1987 and January 1988, at least 14 humpback whales died after consuming Atlantic mackerel containing a dinoflagellate saxitoxin (Geraci *et al.* 1989). The whales subsequently stranded or were recovered in the vicinity of Cape Cod Bay and Nantucket Sound, and it is highly likely that other unrecorded mortalities occurred during this event. During the first six months of 1990, seven dead juvenile (7.6 to 9.1 m long) humpback whales stranded between North Carolina and New Jersey. The significance of these strandings is unknown.

Between July and September 2003, an Unusual Mortality Event (UME) that included 16 humpback whales was invoked in offshore waters of coastal New England and the Gulf of Maine. Biotoxin analyses of samples taken from some of these whales found saxitoxin at very low/questionable levels and domoic acid at low levels, but neither were adequately documented and therefore no definitive conclusions could be drawn. Seven humpback whales were considered part of a large whale UME in New England in 2005. Twenty-one dead humpback whales found between 10 July and 31 December 2006 triggered a humpback whale UME declaration. Additionally, in January 2016 a humpback whale UME was declared for the U.S. Atlantic coast due to elevated numbers of mortalities (a total of 59 strandings in 2016 and 2017; https://www.fisheries.noaa.gov/national/marine-life-distress/2016-2018-humpback-whale-unusual-mortality-event-along-atlantic-coast). Causes of these UME events have not been determined.

STATUS OF STOCK

NMFS conducted a global status review of humpback whales (Bettridge *et al.* 2015) and recently revised the ESA listing of the species (81 FR 62259, September 8, 2016). The Distinct Population Segments (DPSs) that occur in waters under U.S. jurisdiction, as established in the Final Rule, do not necessarily equate to the existing MMPA stocks. NMFS is evaluating the stock structure of humpback whales under the MMPA, but no changes to current stock structure are proposed at this time. As noted within the humpback whale ESA-listing Final Rule, in the case of a species or stock that achieved its depleted status solely on the basis of its ESA status, such as the humpback whale, the species or stock would cease to qualify as depleted under the terms of the definition set forth in MMPA Section 3(1) if the species or stock is no longer listed as threatened or endangered. The final rule indicated that until the stock delineations are reviewed in light of the DPS designations, NMFS would consider stocks that do not fully or partially coincide with a listed DPS as not depleted for management purposes. Therefore, the Gulf of Maine stock is considered not depleted because it does not coincide with any ESA-listed DPS. The detected level of U.S. fishery-caused mortality and serious injury derived from the available records, which is surely biased low, does not exceed the calculated PBR and, therefore, this is not a strategic stock if the recovery factor is set at 0.5. Because both the abundance determination and the accounting of human caused mortality are biased low, the uncertainties associated with this assessment may have produced an incorrect determination of strategic status.

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