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 range which encompasses 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 northern Norway, including off Bear Island and Jan Mayen (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). Genetic analysis of mitochondrial DNA (mtDNA) has indicated that this fidelity has persisted over an evolutionary timescale in at least the Icelandic and Norwegian feeding grounds (Palsbøll *et al.* 1995; Larsen *et al.* 1996).

Previously, the North Atlantic humpback whale population was treated as a single stock for management purposes (Waring *et al.* 1999). Indeed, earlier genetic analyses (Palsbøll *et al.* 1995), based upon relatively small sample sizes, had failed to discriminate among the four western North Atlantic feeding areas. However, genetic analyses often reflect a timescale of thousands of years, well beyond those commonly used by managers. Accordingly, the decision was recently made to reclassify the Gulf of Maine as a separate feeding stock; this was based upon the strong fidelity by individual whales to this region, and the attendant assumption that, were this subpopulation wiped out, repopulation by immigration from adjacent areas would not occur on any reasonable management timescale. This reclassification has subsequently been supported by new genetic analysis based upon a much larger collection of samples than those utilized by Palsbøll *et al.* (1995). These analyses have found significant differences in mtDNA haplotype frequencies of the four western feeding areas, including the Gulf of Maine (Palsbøll *et al.* 2001). During the recent Comprehensive Assessment of North Atlantic humpback whales, the International Whaling Commission acknowledged the evidence for treating the Gulf of Maine as a separate stock for the purpose of management (IWC 2002).

During the summers of 1998 and 1999, the Northeast Fisheries Science Center conducted surveys for humpback whales on the Scotian Shelf. The objective of these surveys was 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 have now been compared to both the overall North Atlantic Humpback Whale Catalogue and a large regional catalogue 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.* (2002). 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 (26%, n=10 of 36 whales) and northern (27%, *n*=4 of 15 whales) ends of the Scotian Shelf, despite the additional distance of nearly 100 nautical miles (one whale was observed in both areas). In contrast, all (36 of 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 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, while it is not possible to define the Gulf of Maine population by drawing a strict geographical boundary, it appears that the effective range of many members of this stock does not extend onto the Scotian Shelf. Further work on the Scotian Shelf was conducted in August 2002; the results of this cruise are expected to further clarify the issue of stock identity from this region. The very low match rate between the two sampled years (only one animal was resighted in the region in both 1998 and 1999) suggests that the Scotian Shelf is host to a larger population of humpback whales than was previously thought.

In winter, whales from all feeding areas (including the Gulf of Maine) mate and calve primarily in the West Indies, where spatial and genetic mixing among subpopulations occurs (Clapham *et al.* 1993; Katona and Beard 1990; Palsbøll *et al.* 1997; Stevick *et al.* 1998). A few whales of unknown northern origin migrate to the Cape Verde Islands (Reiner *et al.*, 1996). In the West Indies, the majority of whales are found in the waters of the Dominican Republic, notably on Silver Bank, on Navidad Bank, and in Samana Bay (Balcomb and Nichols 1982; Whitehead and Moore 1982; Mattila *et al.* 1989, 1994). Humpback whales are also found at much lower densities throughout the remainder of the Antillean arc, from Puerto Rico to the coast of Venezuela (Winn *et al.* 1975; Levenson and Leapley 1978; Price 1985; Mattila and Clapham 1989).

It is apparent that not all whales migrate to the West Indies every winter, and that significant numbers of animals are found in mid- and high-latitude regions at this time (Clapham *et al.* 1993; Swingle *et al.* 1993). An increased number of 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 38 humpback whale strandings which occurred during 1985-1992 in the US 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 are becoming an increasingly important habitat for juvenile humpback whales and that anthropogenic factors may negatively impact whales in this area. There have also been a number of wintertime humpback sightings in coastal waters of the southeastern USA (NMFS unpublished data; New England Aquarium unpublished data; Florida DEP unpublished data). Whether the increased sightings represent a distributional change, or are simply due to an increase in sighting effort and/or whale abundance, is presently unknown.

A key question with regard to humpback whales off the southeastern and mid-Atlantic states is their population identity. This topic was recently investigated using fluke photographs of living and dead whales observed in the region (Barco *et al*. 2002). In this study, photographs of 40 whales (live or dead) were of sufficient quality to be compared to catalogues from the Gulf of Maine (the closest feeding ground) and other areas in the North Atlantic. Of 21 live whales, 9 (42.9%) matched to the Gulf of Maine, 4 (19.0%) 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 recent 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 that is used by humpbacks for more than one purpose.

Feeding is the principal activity of humpback whales in New England waters, and their distribution in this region has been largely correlated to prey species and abundance, although behavior and bottom topography are factors in foraging strategy (Payne *et al*. 1986, 1990). Humpback whales are frequently piscivorus when in these 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). Commercial depletion of herring and mackerel led to an increase in sand lance in the southwestern Gulf of Maine in the mid 1970s with a concurrent decrease in humpback whale abundance in the northern Gulf of Maine. 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 dramatically 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 and the Northeast Peak on Georges Bank, and on Jeffreys Ledge; these latter areas are more traditional locations of herring occurrence. In 1996 and 1997, sand lance, and thus humpback whales, were once again abundant in the Stellwagen Bank area. However, unlike previous cycles, where 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 (unpublished data, Center for Coastal Studies and College of the Atlantic).

In early 1992, a major research initiative known as the Years of the North Atlantic Humpback (YONAH) (Smith *et al*. 1999) was initiated. This project was a large-scale, intensive study of humpback whales throughout almost their entire North Atlantic range, from the West Indies to the Arctic. During two primary years of field work, photographs for individual identification and biopsy samples for genetic analysis were collected from summer feeding areas and from the breeding grounds in the West Indies. Additional samples were collected from certain areas in other years. Results pertaining to the estimation of abundance and to genetic population structure are summarized below.

POPULATION SIZE

The overall North Atlantic population (including the Gulf of Maine) was estimated from genetic tagging data collected by the YONAH project in the breeding range at 4,894 males (95% CI=3,374-7,123) and 2,804 females (95% CI=1,776-4,463) (Palsbøll *et al.* 1997). Since the sex ratio in this population is known to be even (Palsbøll *et al.* 1997), the excess of males is presumed to be a result of sampling bias, lower rates of migration among females or sex-specific habitat partitioning in the West Indies; whatever the reason, the combined total is an underestimate of overall population size in this ocean. Photographic mark-recapture analyses from the YONAH project gave an ocean-basin-wide estimate of 11,570 for 1992/93 (CV=0.069, Stevick *et al.* 2001), and an additional genotype-based analysis yielded a similar but less precise estimate of 10,400 (95% CI=8,000 to 13,600) (Smith *et al.* 1999). The estimate of 11,570 (CV=0.069) is regarded as the best available estimate for the North Atlantic, although because YONAH sampling was not spatially representative in the feeding grounds, this figure is negatively biased. In the northeastern North Atlantic, Øien (2001) estimated from sighting survey data that there were 889 (CV=0.32)humpback whales in the Barents and Norwegian Seas region.

Estimating abundance for the Gulf of Maine stock has proved problematic. Three approaches have been investigated: mark-recapture estimates, minimum population size, and line-transect estimates. Most of the mark-recapture estimates were affected by heterogeneity of sampling, which was heavily focused on the southwestern Gulf of Maine. However, an estimate of 652 (CV=0.29) derived from the more extensive and representative YONAH sampling in 1992 and 1993 was probably less subject to this bias.

The second approach uses photo-identification data to establish the minimum number of humpback whales known to be alive in a particular year, 1997. By determining the number of identified individuals seen either in that year, or in both a previous and subsequent year, it is possible to determine that at least 497 humpbacks were alive in 1997. This figure is also likely to be negatively biased, again because of heterogeneity of sampling. A similar calculation for 1992 (which would correspond to the YONAH estimate for the Gulf of Maine) yields a figure of 501 whales.

In the third approach, data were used from a 28 July to 31 August 1999 line-transect sighting survey conducted by a ship and airplane covering waters from Georges Bank to the mouth of the Gulf of St. Lawrence. Total track line length was 8,212 km. However, in light of the information on stock identity of Scotian Shelf humpback whales noted above, only the portions of the survey covering the Gulf of Maine were used; surveys blocks along the eastern coast of Nova Scotia were excluded. Shipboard data were analyzed using the modified direct duplicate method (Palka 1995) that accounts for school size bias and *g(0)*, the probability of detecting a group on the track line. Aerial data were not corrected for *g(0)* (Palka 2000). These surveys yielded an estimate of 816 humpbacks (CV=0.45). However, given that the rate of exchange between the Gulf of Maine and both the Scotian Shelf and mid-Atlantic region is not zero, this estimate is likely to be somewhat conservative. Accordingly, inclusion of data from 25% of the Scotian Shelf survey area (to reflect the match rate of 25% between the Scotian Shelf and the Gulf of Maine) gives an estimate of 902 whales (CV=0.41). Since the mark-recapture figures for abundance and minimum population size given above falls above the lower bound of the CV of the line transect estimate, and given the known exchange between the Gulf of Maine and the Scotian Shelf, we have chosen to use the latter as the best estimate of abundance for Gulf of Maine humpback whales.

Minimum Population Estimate

The minimum population estimate is the lower limit of the two-tailed 60% confidence interval of the log-normally distributed best abundance estimate. This is equivalent to the 20th percentile of the log-normal distribution as specified by Wade and Angliss (1997). The best estimate of abundance for Gulf of Maine humpback whales is 902 (CV=0.41). The minimum population estimate for this stock is 647.

Table 1. Summary of abundance estimates for Gulf of Maine humpback whales. CCS = Center for Coastal Studies. COA = College of the Atlantic.

Month/Year	Type	N	CV	Source
1992/93	Mark-recapture estimate	652	0.29	Clapham *et al.* (2002)
1997	Minimum known to be alive	497	-	CCS + COA data
July/August 1999	Line transect, including a portion of the Scotian Shelf stratum	902	0.41	Palka 2000, Clapham *et al.* 2002

Current Population Trend

As detailed below, current data suggest that the Gulf of Maine humpback whale stock is steadily increasing in size. This is consistent with an estimated average trend of 3.2% (SE=0.005) in the North Atlantic population overall for the period 1979–1993 (Stevick *et al.* 2001), although there are no other feeding-area-specific estimates.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Barlow and Clapham (1997) applied an interbirth interval model to photographic mark-recapture data and 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.* 2001b). For the Gulf of Maine, data supplied by Barlow and Clapham (1997) and Clapham *et al.* (1995) gives values of 0.96 for survival rate, 6y 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) was close to the maximum for this stock.

Clapham *et al.* (2002) updated the Barlow and Clapham (1997) analysis using data from the period 1992 to 2000. The estimate was either 0% (for a calf survival rate of 0.51) or 4.0% (for a calf survival rate of 0.875). Although confidence limits are not available (because maturation parameters could not be estimated), both estimates of population growth rate are outside the 95% confidence intervals of the previous estimate of 6.5% for the period 1979 to 1991 (Barlow and Clapham 1997). It is unclear whether this apparent decline is an artifact resulting from a shift in distribution; indeed, such a shift occurred during exactly the period (1992-95) in which survival rates declined. It is possible that this shift resulted in calves born in those years imprinting on (and thus subsequently returning to) areas other than those in which intensive sampling occurs. If the decline is a real phenomenon it may be related to known high mortality among young-of-the-year whales in the waters of the U.S. mid-Atlantic states. However, calf survival appears to have increased since 1996, presumably accompanied by an increase in population growth.

In light of the uncertainty accompanying the more recent estimate of population growth rate for the Gulf of Maine, for purposes of this assessment the maximum net productivity rate was assumed to be the default value for cetaceans of 0.04 (Barlow *et al*. 1995).

Current and maximum net productivity rates are unknown for the North Atlantic population overall. As noted above, Stevick *et al.* (2001) calculated an average population growth rate of 3.2% (SE=0.005) for the period 1979–1993.

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 is 647. The maximum productivity rate is the default value of 0.04. The "recovery" factor, which accounts for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP) is assumed to be 0.10 because this stock is listed as an endangered species under the Endangered Species Act (ESA). PBR for the Gulf of Maine humpback whale stock is 1.3 whales.

ANNUAL HUMAN-CAUSED SERIOUS INJURY AND MORTALITY

For the period 1997 through 2001, the total estimated human-caused mortality and serious injury to the Gulf of Maine humpback whale stock is estimated as 2.6 per year (USA waters, 2.0; Canadian waters, 0.6). This average is derived from two components: 1) incidental fishery interaction records, 2.2 (USA waters, 6; Canadian waters, 0.6); and 2) records of vessel collisions, 0.4 (USA waters, 0.4; Canadian waters, 0). There were additional 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. These records represent an additional minimum annual average of 1.6 human-caused mortalities and serious injuries to humpbacks over the time period, of which 1.2 per year are attributable to incidental fishery interactions and 0.4 per year are attributable to vessel collisions.

Note that in the 1998 stock assessment report, a six-year time frame was used to calculate the averages for fishery interactions and vessel collisions. A five-year period has been used since to be consistent with the time frames used for calculating the averages for the observed fishery and for other species. Beginning with the 2001 Stock Assessment Report, Canadian records were incorporated into the mortality and serious injury rates, to reflect the effective range of this stock as described above. In addition, records from the southeastern and mid-Atlantic states involving individuals that could not be identified as members of the Gulf of Maine stock were tallied separately. Conversely, records involving unidentified individuals reported between New York and the Bay of Fundy were assumed to be whales from the Gulf of Maine stock. It is also important to stress that serious injury determinations are made based upon the best available information at the time of writing; these determinations may change with the availability of new information. For the purposes of this report, discussion is primarily limited to those records considered confirmed human-caused mortalities or serious injuries.

To better assess human impacts (both vessel collision and gear entanglement), and considering the number of decomposed and incompletely or unexamined animals in the records, 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 fishery observer data. 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 necropsied) represent 'lost data', some of which may relate to human impacts.

In addition, we have limited the serious injury designation to only those reports that had substantiated evidence that the injury, whether from entanglement or vessel collision, was likely to lead to the whale's death. Injuries that impeded the whale's locomotion or feeding were not considered serious injuries unless they were likely to be fatal in the foreseeable future. There was no forecasting of how the entanglement or injury may increase the whale's susceptibility to further injury, namely from additional entanglements or vessel collisions. For these reasons, the human impacts listed in this report must be considered a minimum estimate.

Background

As with right whales, human impacts (vessel collisions and entanglements) are factors which may be slowing recovery of the humpback whale population. There is an average of 4 to 6 entanglements of humpback whales a year in waters of the southern Gulf of Maine and additional reports of vessel-collision scars (unpublished data, Center for Coastal Studies). Of 20 dead humpback whales (principally in the mid-Atlantic, where decomposition did not preclude examination for human impacts), Wiley *et al*. (1995) reported that 6 (30%) had major injuries possibly attributable to ship strikes, and 5 (25%) had injuries consistent with possible entanglement in fishing gear. One whale displayed scars that may have been caused by both ship strike and entanglement. Thus, 60% of the whale carcasses which were suitable for examination showed signs that anthropogenic factors may have contributed to, or been responsible for, their death. Wiley *et al*. (1995) further reported that all stranded animals were sexually immature, suggesting a winter or migratory segregation and/or that juvenile animals are more susceptible to human impacts.

An updated analysis of humpback whale mortalities from the mid-Atlantic states region has recently been produced by Barco *et al.* (2002). Between 1990 and 2000, there were 52 known humpback whale mortalities in the waters of the U.S. mid-Atlantic states. Length data from 48 of these whales (18 females, 22 males and 8 of unknown sex) suggested that 39 (81.2%) were first-year animals, 7 (14.6%) were immature and 2 (4.2%) were adults. However, sighting histories of 5 of the dead whales indicate that some were small for their age, and histories of live whales further indicate that the population contains a greater percentage of mature animals than is suggested by the stranded sample.

In their study of entanglement rates estimated from caudal peduncle scars, Robbins and Mattila (2001) found that males were more likely to be entangled than females. The scarring data also suggested that yearlings were more likely than other age classes to be involved in entanglements. Finally, female humpbacks showing evidence of prior entanglements produced significantly fewer calves, suggesting that entanglement may significantly impact reproductive success.

Humpback whale entanglements also occur in relatively high numbers in Canadian waters. Reports of collisions 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) were reported annually between 1979 and 1988, and 12 of 66 humpback whales that were entangled in 1988 died (Lien *et al*. 1988). Volgenau *et al*. (1995) also summarized existing data and concluded 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 are the gear that has been the primary cause of entanglements and entanglement mortalities (20%) of humpbacks in the Gulf of Maine between 1975 and 1990.

Disturbance by whalewatching may prove to be an important habitat issue in some areas of this population's range, notably the coastal waters of New England where the density of whalewatching traffic is seasonally high. No studies have been conducted to address this question, and its impact (if any) on habitat occupancy and reproductive success is unknown.

Fishery-Related Serious Injuries and Mortalities

Two mortalities were observed in the pelagic drift gillnet fishery since 1989. In winter 1993, a juvenile humpback was observed entangled and dead in a pelagic drift gillnet along the 200 m isobath northeast of Cape Hatteras; in early summer 1995, a humpback was entangled and dead in a pelagic drift gillnet on southwestern Georges Bank (see below).

Additional reports of mortality and serious injury relevant to comparison to PBR, as well as description of total human impacts, are contained in records maintained by NMFS. A number of these records (11 entanglements involving lobster gear) from the 1990-1994 period were used in the 1997 List of Fisheries classification (62 FR 33, Jan. 2, 1997). For this report, the records of dead, injured, and/or entangled humpbacks (either found stranded or at sea) for the period 1997 through 2001 were reviewed. Out of 106 records, 85 were eliminated from further consideration due to an absence of any evidence of human impact or, in the case of an entangled whale, it was documented that the animal had become disentangled. Of the remaining records, the Gulf of Maine stock sustained 3 mortalities attributable to fishery interactions and 8 cases of serious injuries — 1 records in the five-year period (Table 2). In addition, 4 mortalities and 2 serious injuries were documented in the southeastern and mid-Atlantic states that involved interactions with fisheries. At the time of this writing, no genetic results were available to identify which of these cases may have involved whales from the Gulf of Maine stock. While these records are not statistically quantifiable in the same way as the observed fishery records, they provide some indication of the frequency of entanglements.

Fishery Information

Data on current incidental takes in USA fisheries are available from several sources. In 1986, NMFS established a mandatory self-reported fisheries information system for large pelagic fisheries. Data files are maintained at the Southeast Fisheries Science Center (SEFSC). The Northeast Fisheries Science Center (NEFSC) Sea Sampling Observer Program was initiated in 1989, and several fisheries have been covered by the program. In late 1992 and in 1993, the SEFSC provided coverage of pelagic longline vessels fishing off the Grand Banks (Tail of the Banks) and provides observer coverage of vessels fishing south of Cape Hatteras. Bycatch has been observed by NMFS Sea Samplers in the pelagic drift gillnet fishery, but no mortalities or serious injuries have been documented in other fisheries monitored by NMFS.

In January 1997 (62 FR 33, Jan. 2, 1997), NMFS changed the classification of the Gulf of Maine and USA mid-Atlantic lobster pot fisheries from Category III to Category I based on examination of stranding and entanglement records of large whales from 1990 to 1994 (including 11 serious injuries or mortalities of humpback whales).

Pelagic Drift Gillnet

In 1996 and 1997, the NMFS issued management regulations which prohibited the operation of this fishery in 1997. The fishery was active during 1998. Then, in January 1999, NMFS issued a Final Rule to prohibit the use of drift net gear in the North Atlantic swordfish fishery (50 CFR Part 630). The estimated total number of hauls in the Atlantic pelagic drift gillnet fishery increased from 714 in 1989 to 1,144 in 1990; thereafter, with the introduction of quotas, effort was severely reduced. The estimated number of hauls in 1991, 1992, 1993, 1994, 1995 and 1996 were 233, 243, 232, 197, 164 and 149, respectively. Fifty-nine different vessels participated in this fishery at one time or another between 1989 and 1993. In 1994 to 1998, there were 12, 11, 10, 0 and 11 vessels, respectively, in the fishery. Observer coverage, expressed as percent of sets, was 8% in 1989, 6% in 1990, 20% in 1991, 40% in 1992, 42% in 1993, 87% in 1994, 99% in 1995, 64% in 1996, no fishery in 1997 and 99% coverage during 1998. Observer coverage dropped during 1996 because some vessels were deemed too small or unsafe by the contractor that provided observer coverage to NMFS. Fishing effort was concentrated along the southern edge of Georges Bank and off Cape Hatteras. Examination of the species composition of the catch and locations of the fishery throughout the year, suggested that the drift gillnet fishery be stratified into two strata, a southern or winter stratum, and a northern or summer stratum. Estimates of the total bycatch, for each year from 1989 to 1993, were obtained using the aggregated (pooled 1989-1993) catch rates, by strata (Northridge 1996). Total annual bycatches after 1993 were estimated separately for each year by summing the observed caught with the product of the average bycatch per haul and number of unobserved hauls as recorded in SEFSC logbooks. Variances were estimated using bootstrap re-sampling techniques. Estimated annual fishery-related mortality and serious injury (CV in parentheses) was 0 in 1994 (0), 1.0 in 1995 (0), 0 in 1996 (0), and 0 in 1998 (0). Since this fishery no longer exists, records of its incidental takes have been excluded from Table 2.

Table 2. Summarized records of mortality and serious injury likely to result in mortality, for North Atlantic humpback whales, January 1997 - December 2001. Causes of mortality or injury, assigned as primary or secondary, are based on records maintained by NMFS. Records counted as from the Gulf of Maine humpback whale stock are indicated by an asterisk (*) following the date.

Date	Report Type	Sex, age, ID length	Location	Assigned Cause: P=primary, S=secondary		Notes
				Ship strike	Entang./ Fsh.inter	
12/10/97	mortality	9.0 m male	Beaufort Inlet, NC	P		massive hemorrhage consistent with forceful blunt trauma
3/4/98	mortality	8.6 m female	Ocracoke Island, NC (35° 12' 75° 40')		P	Coast Guard present when whale drowned entangled in croaker gillnet gear
5/3/98*	mortality	10.2 m male	Cape Cod, MA		P	fresh entanglement lesions around head and flippers
7/19/98*	serious injury	age and sex unknown	Bay of Fundy, Canada		P	whale partially disentangled from gillnet gear, but swam away still badly wrapped
8/4/98*	serious injury	age and sex unknown	Mount Desert Rock (44° 06' 67° 44')		P	line through mouth and several wraps around tail with fresh chafing
8/23/98*	serious injury	adult, sex unknown	Montauk Pt., NY (40° 36' 70° 43')		P	whale anchored by offshore lobster gear, struggling to breathe; not relocated by Coast Guard search
11/5/98	mortality	8.9 m male	Nags Head, NC (35° 59' 75° 38')		P	Deep abrasions around tail stock with subdermal hemorrhaging
1/12/99*	mortality	9.7 m male	Martha’s Vineyard, MA		P	Fresh and extensive rope marks on carcass with associated hemorrhaging

Date	Report Type	Sex, age, ID length	Location	Assigned Cause: P=primary, S=secondary		Notes
				Ship strike	Entang./ Fsh.inter	
8/2/99*	serious injury	9.4 m estimated	Bay of Fundy, Canada		P	Single wrap of ½ inch poly line pinning flippers
9/23/99*	serious injury	unknown	off Chatham, MA		P	Line out of mouth and several wraps around body; possibly anchored
1/8/00	serious injury	9.9 m estimated	30mi east Cape Lookout, NC		P	whale swam off with 600' of sea trout sink gillnet, a chain anchor and a high flyer in tow
8/4/00*	serious injury	10.7 m estimated	Bay of Fundy, Canada		P	gillnet wrapped on head with weighted trailing line giving tension
9/6/00*	serious injury	<1 yr old, calf of "Giraffe"	Stellwagen Bank, MA		P	single line wrapped across back; constriction will increase as whale grows
10/14/00	serious injury	9.9 m estimated	off Ocean City Inlet, MD		P	Heavily entangled in line and netting; constrictive--fresh wounds noted
10/20/00*	serious injury	10 yr old male "Tribble"	Stellwagen Bank, MA		P	Entangled in green poly line on multiple body parts; appears constrictive
1/25/01	mortality	6.9 m estimated	Avon, NC	P		extensive hemorrhaging along left thoracic, clean cut through center of vertebrae; ship strike
4/8/01	mortality	7.9 m juvenile male	Myrtle Beach, SC	S	P	pre-mortem evidence of chronic line entanglement; severe prop wounds
4/8/01	mortality	7.6 m juvenile male	Emerald Isle, NC		P	entanglement around peduncle caused extensive edema, hemorrhaging
4/9/01*	mortality	8.8 m juvenile female "Inland"	offshore of Sandbridge, Virginia Beach		P	found anchored in gillnet gear; line wraps around rostrum had immobilized the whale
7/29/01*	mortality	8.5 m juvenile female	floating south of Verazano Bridge, NY	P		large laceration on left side of head, extensive fracturing of skull
10/1/01*	mortality	11.4 m 3 yr old female "Pitfall"	Duxbury Beach, MA	P		massive fracturing to skull, focal bruising indicative of pre-mortem ship strike

Table notes:

1. 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.
2. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS (62 FR 33, Jan. 2, 1997) have been used here. Some assignments may change as new information becomes available and/or when national standards are established.
3. Assigned cause based on best judgement of available data. Additional information may result in revisions.
4. Entanglements of juvenile whales may become more serious as the whale grows.

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 mortalities occurred during this event which went unrecorded. 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, but is a cause for some concern.

As reported by Wiley *et al*. (1995), injuries possibly attributable to ship strikes are more common and probably more serious than those from entanglements. In the NMFS records for 1997 through 2001, 11 records had some evidence of a collision with a vessel. Of these, 4 were mortalities as a result of the collision, 5 did not have sufficient information to confirm the collision as the cause of death. Of the remaining 2, one incident occurred on 10/4/01 and involved a whale watch vessel. Photos taken at the time of the collision confirmed that the injury was minor and follow-up documentation provided evidence that the injury sustained had healed. The last record involved a whale watch vessel that collided with a humpback on 8/2/98; the seriousness of the injury could not be assessed. The whale was sighted after the collision with a large gash in its back, but was reported as "not struggling to breathe". It was seen in the company of other humpbacks several times over three weeks following the incident. However, among the members of this cohort with similar sighting history patterns through 1998, this injured animal was the only one that has not been resighted in subsequent years. Two out of the 4 cases of mortality from a vessel collision involved whales identified as members of the Gulf of Maine stock (7/29/01 and 10/1/01; see Table 2).

STATUS OF STOCK

The status of the North Atlantic humpback whale population was the topic of an International Whaling Commission Comprehensive Assessment in June 2001, and again in May 2002; these meetings conducted a detailed review of all aspects of this population (IWC 2002). Although the most recent estimates of abundance indicate continued population growth, the size of the humpback whale stock may be below OSP in the US Atlantic EEZ. This is a strategic stock because the humpback whale is listed as an endangered species under the ESA. A Recovery Plan has been published and is in effect (NMFS 1991). There are insufficient data to reliably determine population trends for humpback whales in the North Atlantic overall. The average annual rate of population increase was estimated at 3.2% (SE=0.005, Stevick *et al.* 2001). As noted above, a recent analysis of demographic parameters for the Gulf of Maine (Clapham *et al.* 2002) 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. The total level of human-caused mortality and serious injury is unknown, but current data indicate that it is significant. In particular, the continued high level of mortality among humpback whales off the U.S. mid-Atlantic states (Barco *et al.* 2002), is cause for considerable concern given that at least some of these animals are known to be from the Gulf of Maine. This is a strategic stock because the average annual fishery-related mortality and serious injury exceeds PBR, and because the North Atlantic humpback whale is an endangered species.

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