~~December 2009~~~~January~~March 2010

NORTH ATLANTIC RIGHT WHALE (*Eubalaena glacialis*): Western Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The western North Atlantic right whale population ranges primarily from calving grounds in coastal waters of the southeastern United States to feeding grounds in New England waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence. Knowlton *et al.* (1992) reported several long-distance movements as far north as Newfoundland, the Labrador Basin, and southeast of Greenland. In addition, recent resightings of photographically identified individuals have been made off Iceland, in the old Cape Farewell whaling ground east of Greenland (Hamilton *et al.* 2007), ~~and~~ northern Norway (Jacobsen *et al.* 2004), and the Azores (Hamilton *et al.* 2009). The September 1999 Norwegian sighting represents one of only two published sightings this century of a right whale in Norwegian waters, and the first since 1926. Together, these long-range matches indicate an extended range for at least some individuals and perhaps the existence of important habitat areas not presently well described. The few published records from the Gulf of Mexico (Moore and Clark 1963; Schmidly *et al.* 1972) represent either distributional anomalies, normal wanderings of occasional animals, or a more extensive historic range beyond the sole known calving and wintering ground in the waters of the southeastern United States. Whatever the case, the location of much of the population is unknown during the winter. Offshore (greater than 30 miles) surveys flown off the coast of northeastern Florida and southeastern Georgia from 1996 to 2001 had 3 sightings in 1996, 1 in 1997, 13 in 1998, 6 in 1999, 11 in 2000 and 6 in 2001 (within each year, some were repeat sightings of previously recorded individuals). Several of the years that offshore surveys were flown were some of the lowest count years for calves and for numbers of right whales in the Southeast recorded since comprehensive surveys began in the calving grounds. Therefore, the frequency with which right whales occur in offshore waters in the southeastern U.S. remains unclear.

Research results suggest the existence of six major habitats or congregation areas for western North Atlantic right whales: the coastal waters of the southeastern United States; the Great South Channel; Georges Bank/Gulf of Maine; Cape Cod and Massachusetts Bays; the Bay of Fundy; and the Scotian Shelf. However, movements within and between habitats are extensive. In 2000, one whale was photographed in Florida waters on 12 January, then again eleven days later (23 January) in Cape Cod Bay, less than a month later off Georgia (16 February), and back in Cape Cod Bay on 23 March, effectively making the round-trip migration to the Southeast and back at least twice during the winter season (Brown and Marx 2000). Results from satellite tags clearly indicate that sightings separated by perhaps two weeks should not necessarily be assumed to indicate a stationary or resident animal. Instead, telemetry data have shown rather lengthy and somewhat distant excursions, including into deep water off the continental shelf (Mate *et al.* 1997; Baumgartner and Mate 2005). Systematic surveys conducted off the coast of North Carolina during the winters of 2001 and 2002 sighted 8 calves, suggesting the calving grounds may extend as far north as Cape Fear. Four of the calves were not sighted by surveys conducted further south. One of the cows photographed was new to researchers, having effectively eluded identification over the period of its maturation (McLellan *et al.* 2004).

New England waters are an important feeding habitat for right whales, which feed in this area primarily on copepods (largely of the genera *Calanus* and *Pseudocalanus*). Research suggests that right whales must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo and Marx 1990). These dense zooplankton patches are likely a primary characteristic of the spring, summer, and fall right whale habitats (Kenney *et al.* 1986; 1995). While feeding in the coastal waters off Massachusetts has been better studied than in other areas, right whale feeding has also been observed on the margins of Georges Bank, in the Great South Channel, in the Gulf of Maine, in the Bay of Fundy, and over the Scotian Shelf. The characteristics of acceptable prey distribution in these areas are beginning to emerge (Baumgartner *et al.* 2003; Baumgartner and Mate 2003). NMFS (National Marine Fisheries Service) and Provincetown Center for Coastal Studies aerial surveys during springs of 1999-2006 found right whales along the Northern Edge of Georges Bank, in the Great South Channel, in Georges Basin, and in various locations in the Gulf of Maine including Cashes Ledge, Platts Bank and Wilkinson Basin. The consistency with which right whales occur in such locations is relatively high, but these studies also highlight the high interannual variability in right whale use of some habitats.

Genetic analyses based upon direct sequencing of mitochondrial DNA (mtDNA) have identified five mtDNA haplotypes in the western North Atlantic right whale (Malik *et al.* 1999). Schaeff *et al.*(1997) compared the genetic variability of North Atlantic and southern right whales (*E. australis*), and found the former to be significantly less diverse, a finding broadly replicated by Malik *et al.* (2000). The low diversity in North Atlantic right whales might be indicative of inbreeding, but no definitive conclusion can be reached using current data. Additional work comparing modern and historic genetic population structure, using DNA extracted from museum and archaeological specimens of baleen and bone, has suggested that the eastern and western North Atlantic populations were not genetically distinct (Rosenbaum *et al.* 1997; 2000). However, the virtual extirpation of the eastern stock and its lack of recovery in the last hundred years strongly suggests population subdivision over a protracted (but not evolutionary) timescale. Genetic studies concluded that the principal loss of genetic diversity occurred prior to the 18th century (Waldick *et al.* 2002). However, revised conclusions that nearly all the remains in the North American Basque whaling archaeological sites were Bowhead whales and not right whales (Rastogi *et al.* 2004) contradict the previously held belief that Basque whaling during the 16th and 17th centuries was principally responsible for the loss of genetic diversity.

High-resolution (using 35 microsatellite loci) genetic profiling has been completed for 66% of all identified North Atlantic right whales through 2001. This work has improved our understanding of genetic variability, number of reproductively active individuals, reproductive fitness, parentage and relatedness of individuals (Frasier *et al.* 2007).

One emerging result of the genetic studies is the importance of obtaining biopsy samples from calves on the calving grounds. Only 60% of all known calves are seen with their mothers in summering areas, when their callosity patterns are stable enough to reliably make a photo-ID match later in life. The remaining 40% are not seen on a known summering ground. Because the calf's genetic profile is the only reliable way to establish parentage, if the calf is not sampled when associated with its mother early on, then it is not possible to link it with a calving event or to its mother, and information such as age and familial relationships is lost. From 1980 to 2001, there were 64 calves born that were not sighted later with their mothers and thus unavailable to provide age-specific mortality information (Frasier *et al.* 2007). An additional interpretation of paternity analyses is that the population size may be larger than was previously thought. Fathers for only 45% of known calves have been genetically determined. However, genetic profiles were available for 69% of all photo-identified males (Frasier 2005). The conclusion was that the majority of these calves must have different fathers which cannot be accounted for by the unsampled males and the population of males must be larger (Frasier 2005). This inference of additional animals that have never been captured photographically and/or genetically suggests the existence of habitats of potentially significant use that remain unknown.

POPULATION SIZE

The western North Atlantic minimum stock size is based on a census of individual whales identified using photo-identification techniques. A review of the photo-ID recapture database as it existed on ~~30 May 2007~~24 June 2009 indicated that ~~345~~361 individually recognized whales in the catalog were known to be alive during 2005. This number represents a minimum population size. This count has no associated coefficient of variation.

Previous estimates using the same method with the added assumption that whales seen within the previous seven years were still alive have resulted in counts of 295 animals in 1992 (Knowlton *et al.* 1994) and 299 animals in 1998 (Kraus *et al.* 2001). An IWC workshop on status and trends of western North Atlantic right whales gave a minimum direct-count estimate of 263 right whales alive in 1996 and noted that the true population was unlikely to be substantially greater than this (Best *et al.* 2001).

Historical Abundance

An estimate of pre-exploitation population size is not available. Basque whalers were thought to have taken right whales during the 1500s in the Strait of Belle Isle region (Aguilar 1986), however, recent genetic analysis has shown that nearly all of the remains found in that area are, in fact, those of bowhead whales (Rastogi *et al.* 2004; Frasier *et al.* 2007). The stock of right whales may have already been substantially reduced by the time whaling was begun by colonists in the Plymouth area in the 1600s (Reeves *et al.* 2001; Reeves *et al.* 2007). A modest but persistent whaling effort along the coast of the eastern U.S. lasted three centuries, and the records include one report of 29 whales killed in Cape Cod Bay in a single day during January 1700. Based on incomplete historical whaling data, Reeves and Mitchell could conclude only that there were at least hundreds of right whales present in the western North Atlantic during the late 1600s. Reeves *et al.* (1992) plotted a series of population trajectories using historical data, assuming a present day population size of 350 animals. The results suggested that there may have

been at least 1,000 right whales in the population during the early to mid-1600s, with the greatest population decline occurring in the early 1700s. The authors cautioned, however, that the record of removals is incomplete, the results were preliminary, and refinements are required. Based on back calculations using the present population size and growth rate, the population may have numbered fewer than 100 individuals by 1935 when international protection for right whales came into effect (Hain 1975; Reeves *et al.* 1992; Kenney *et al.* 1995). However, little is known about the population dynamics of right whales in the intervening years.

Minimum Population Estimate

The western North Atlantic population size was estimated to be at least ~~345~~361 individuals in 2005 based on a census of individual whales identified using photo-identification techniques. This value is a minimum and does not include animals that were alive prior to ~~2003~~2005, but not recorded in the individual sightings database as seen during from 1 December ~~2003~~2004 to ~~10 October 2008~~24 June 2009 (note that matching of photos ~~from~~ taken during 2006 ~~and 2007 is~~ 2009 was not complete at the time the data were received). It also does not include some calves known to be born during 2005, or any other individual whale seen during 2005 but not yet entered into the catalog.

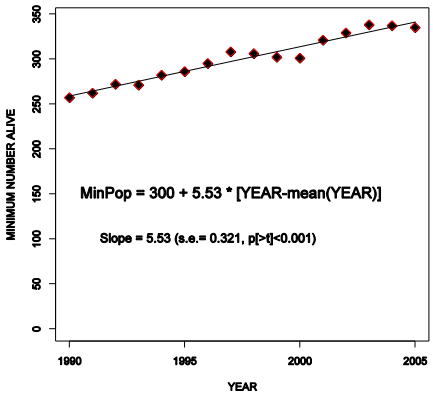
Current Population Trend

The population growth rate reported for the period 1986-1992 by Knowlton *et al.* (1994) was 2.5% (CV=0.12), suggesting that the stock was showing signs of slow recovery. However, work by Caswell *et al.* (1999) suggested that crude survival probability declined from about 0.99 in the early 1980s to about 0.94 in the late 1990s. The decline was statistically significant. Additional work conducted in 1999 was reviewed by the IWC workshop on status and trends in this population (Best *et al.* 2001); the workshop concluded based on several analytical approaches that survival had indeed declined in the 1990s. Although capture heterogeneity could negatively bias survival estimates, the workshop concluded that this factor could not account for the entire observed decline, which appeared to be particularly marked in adult females. Another workshop was convened by NMFS in September 2002, and reached similar conclusions regarding the decline in the population (Clapham 2002).

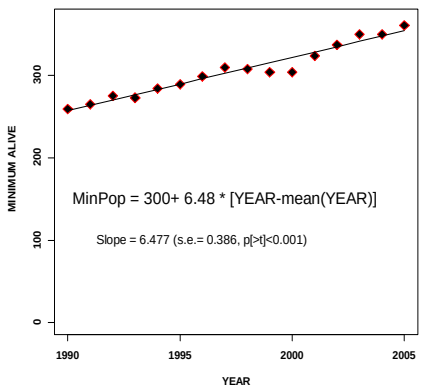
~~Recent mortalities, including those in the first half of 2005, suggest an~~ An increase in mortality in 2004 and 2005 was cause for serious concern ~~the annual mortality rate~~ (Kraus *et al.* 2005). Calculations based on demographic data through 1999 (Fujiwara and Caswell 2001) indicated that this mortality rate increase would reduce population growth by approximately 10% per year (Kraus *et al.* 2005). Of ~~these~~ those ~~recent~~ mortalities, six were adult females, three of which were carrying near-term fetuses. Furthermore, four of these females were just starting to bear calves, losing their complete lifetime reproduction potential.

Despite the preceding, examination of the minimum number alive population index calculated from the individual sightings database, as it existed on ~~10 October 2008~~24 June 2009, for the years 1990-2005 (Figure 1) suggests a positive trend in ~~numbers~~population size. These data reveal a significant increase in the number of catalogued whales alive during this period, but with significant variation due to apparent losses exceeding gains during 1998-99. Mean growth rate for the period was ~~1.8~~2.1%.

(a)



(b)



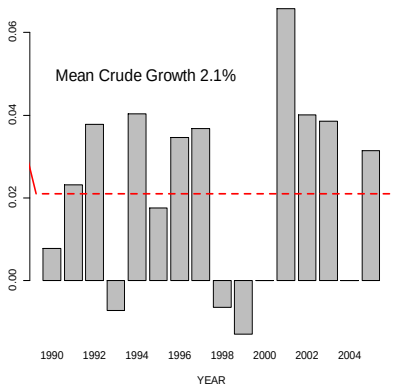


Figure 1. Minimum number alive (a) and crude annual growth rate (b) for cataloged North Atlantic right whales. Minimum number (N) of cataloged individuals known to be alive in any given year includes all whales known to be alive prior to that year and seen in that year or subsequently plus all whales newly catalogued that year. It does not include calves born that year or any other individuals not yet catalogued. Mean crude growth rate (dashed line) is the exponetiated mean of $\log_e [(N_{t+1}-N_t)/N_t]$ *for each year (t).*

The minimum number alive may increase slightly in later years as analysis of the backlog of unmatched but high-quality photographs proceeds. For example, the minimum number alive for 2002 was calculated to be 313 from a 15 June 2006 data set and revised to 325 using the 30 May 2007 data set.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

During 1980-1992, 145 calves were born to 65 identified cows. The number of calves born annually ranged from 5 to 17, with a mean of 11.2 (SE=0.90). The reproductively active female pool was static at approximately 51 individuals during 1987-1992. Mean calving interval, based on 86 records, was 3.67 years. There was an indication that calving intervals may have been increasing over time, although the trend was not statistically significant (P=0.083) (Knowlton *et al.* 1994).

(b)

Total reported calf production and calf mortalities from 1993 to ~~2007~~2009 are shown below in Table 1. The mean calf production for this ~~fifteen~~seventeen year period was 17.2 (15.~~6 (13.7-17.7~~3-19.4; 95% C.I.). During the 2004 and 2005 calving seasons three adult females were found dead with ~~near~~ near-term fetuses.

An updated analysis of calving intervals through the 1997/1998 season suggests that the mean calving interval increased since 1992 from 3.67 years to more than 5 years, a significant trend (Kraus *et al.* 2001). This conclusion ~~is~~ was supported by modeling work reviewed by the IWC workshop on status and trends in this population (Best *et al.* 2001); the workshop agreed that calving intervals had indeed increased and further that the reproductive rate was approximately half that reported from studied populations of southern right whales, *E. australis*. A workshop on possible causes of reproductive failure was held in April 2000 (Reeves *et al.* 2001). Factors considered included contaminants, biotoxins, nutrition/food limitation, disease, and inbreeding problems. While no conclusions were reached, a research plan to further investigate this topic was developed. Analyses completed since that workshop found that in the most recent years, calving intervals were closer to three years (Kraus *et al.* 2007).

An analysis of the age structure of this population suggests that it contains a smaller proportion of juvenile whales than expected (Hamilton *et al.* 1998; Best *et al.* 2001), which may reflect lowered recruitment and/or high juvenile mortality. In addition, it is possible that the apparently low reproductive rate is due in part to an unstable age structure or to reproductive senescence on the part of some females. However, few data are available on either factor and senescence has not been documented for any baleen whale.

Table 1: North Atlantic right whale calf production and mortality, 1993-2007

Year[a]	Reported calf production	Reported calf ~~mortalites~~mortalities
1993	8	2
1994	9	0
1995	7	0
1996	22	3
1997	20	1
1998	6	1
1999	4	0
2000	1	0
2001	31	4
2002	21	2
2003	19	0
2004	17	1
2005	28	0
2006	19	2
2007	23	2
2008	23	2
2009	39	1

a. includes December of the previous year

POTENTIAL BIOLOGICAL REMOVAL

Potential biological removal (PBR) is the product of minimum population size, one-half the maximum net productivity rate and a "recovery" factor for endangered, depleted, threatened stocks, or stocks of unknown status relative to OSP (MMPA Sec. 3. 16 U.S.C. 1362; Wade and Angliss 1997). The recovery factor for right whales is 0.10 because this species is listed as endangered under the Endangered Species Act (ESA). ~~Recent publications report unacceptable levels of mortality (Best *et al.* 2001), and forecast a high probability that North Atlantic right whales will go extinct in 200 years if anthropogenic mortality is not curtailed (Fugiwara and Caswell 2001); therefore, the PBR for this population is set to zero.~~The minimum population size is 361 and the observed net productivity is 0.02. PBR for the Western Atlantic Stock of North Atlantic Right whale is 0.7.

ANNUAL HUMAN-CAUSED SERIOUS INJURY AND MORTALITY

For the period 200~~3~~4 through 2008~~7~~, the minimum rate of annual human-caused mortality and serious injury to right whales averaged 2.8~~3.0~~ per year (U.S. waters, 2.2; Canadian waters, 0.6~~8~~). This is derived from two components: 1) incidental fishery entanglement records at 0.8 per year (U.S. waters, 0.6; Canadian waters, 0.2), and

2) ship strike records at 2.0~~2~~ per year (U.S. waters, 1.6; Canadian waters, 0.4~~6~~). Beginning with the 2001 Stock Assessment Report, Canadian records were incorporated into the mortality and serious injury rates of this report to reflect the effective range of this stock. It is also important to stress that serious injury determinations are made based upon the best available information; these determinations may change with the availability of new information (Cole *et al.* 2005). For the purposes of this report, discussion is primarily limited to those records considered confirmed human-caused mortalities or serious injuries. For more information on determinations for this period, see Glass *et al.* (2010~~09~~).

Background

The details of a particular mortality or serious injury record often require a degree of interpretation. The assigned cause is based on the best judgment of the available data; additional information may result in revisions. When reviewing Table 2 below, several factors should be considered: 1) a ship strike or entanglement may occur at some distance from the reported location; 2) the mortality or injury may involve multiple factors; for example, whales that have been both ship struck and entangled are not uncommon; 3) the actual vessel or gear type/source is often uncertain; and 4) in entanglements, several types of gear may be involved.

The serious injury determinations are susceptible to revision. There are several records where a struck and injured whale was re-sighted later, apparently healthy, or where an entangled or partially disentangled whale was re-sighted later free of gear. The reverse may also be true: a whale initially appearing in good condition after being struck or entangled is later re-sighted and found to have been seriously injured by the event. Entanglements of juvenile whales are typically considered serious injuries because the constriction on the animal is likely to become increasingly lethal as the whale grows (Cole *et al.* 2005; Nelson *et al.* 2007).

A serious injury was defined in 50 CFR part 229.2 as an injury that is likely to lead to mortality. We therefore 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 (Cole *et al.* 2005; Nelson *et al.* 2007; Glass *et al.* 2008; Glass *et al.* ~~2009~~2010). Determinations of serious injury were made on a case-by-case basis following recommendations from the workshop conducted in 1997 on differentiating serious and non-serious injuries (Angliss and DeMaster 1998). Injuries that impeded a 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. This conservative approach likely underestimates serious injury rates.

With these caveats, the total minimum detected~~estimated~~ annual average human-induced mortality and serious injury incurred by this stock (including fishery and non-fishery related causes) is ~~3~~2.8~~.2~~ right whales per year (U.S. waters 2.2~~4~~; Canadian waters, 0.6~~8~~). As with entanglements, some injury or mortality due to ship strikes is almost certainly undetected, particularly in offshore waters. 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. For these reasons, the estimate of 2.8~~3.2~~ right whales per year must be regarded as derived from ~~a~~ minimum count~~estimate~~ (Glass *et al.* 2010~~09~~).

Further, the small population size and low annual reproductive rate of right whales suggest that human sources of mortality may have a greater effect relative to population growth rates than for other whales. The principal factors believed to be retarding growth and recovery of the population are ship strikes and entanglement with fishing gear. Between 1970 and 1999, a total of 45 right whale mortalities ~~were~~ was recorded (IWC [International Whaling Commission] 1999; Knowlton and Kraus 2001; Glass *et al.* 2009). Of these, 13 (28.9%) were neonates that were believed to have died from perinatal complications or other natural causes. Of the remainder, 16 (35.6%) resulted from ship strikes, 3 (6.7%) were related to entanglement in fishing gear (in two cases lobster gear, and one gillnet gear), and 13 (28.9%) were of unknown cause. At a minimum, therefore, 42.2% of the observed total for the period and 50% of the 32 non-calf deaths were attributable to human impacts (calves accounted for three deaths from ship strikes). Young animals, ages 0-4 years, are apparently the most impacted portion of the population (Kraus 1990).

Finally, entanglement or minor vessel collisions may not kill an animal directly, but may weaken or otherwise affect it so that it is more likely to become vulnerable to further injury. Such was apparently the case with the two-year-old right whale killed by a ship off Amelia Island, Florida in March 1991 after having carried gillnet gear wrapped around its tail region since the previous summer (Kenney and Kraus 1993). A similar fate befell right whale #2220, found dead on Cape Cod in 1996.

Fishery-Related Serious Injury and Mortality

Reports of mortality and serious injury relative to PBR as well as total human impacts are contained in records

maintained by the New England Aquarium and the NMFS Northeast and Southeast Regional Offices (Table 2). From ~~2003~~ 2004 through ~~2007~~2008, 4 of ~~15~~ 14 records of mortality or serious injury (including records from both USA and Canadian waters) involved entanglement or fishery interactions. For this time frame, the average reported mortality and serious injury to right whales due to fishery entanglement was 0.8 whales per year (U.S. waters, 0.6; Canadian waters, 0.2). Information from an entanglement event often does not include the detail necessary to assign the entanglements to a particular fishery or location.

Although disentanglement is either unsuccessful or not possible for the majority of cases, during the period 2004~~3~~ through 2008~~7~~, there were at least four documented cases of entanglements for which the intervention of disentanglement teams averted a likely serious-injury determination. ~~An unidentified right whale was disentangled in the Bay of Fundy, Canada on 9 July 2003. The gear was tentatively identified as U.S. lobster gear and other unknown gear.~~ On 6 December 2004, a one-year-old female, #3314, was sighted with line wrapped on both its head and tail which would likely have been fatal. Following more than three weeks of attempts, the constricting fishing gear was removed. On 3 December 2005, #3445—the 2004 calf of #2145—was first sighted off Brunswick, Georgia, with line across its back and around its right flipper. Over 300 feet of trailing line was removed. This whale was resighted on 12 June 2006, apparently gear-free. An adult female, #2029, first sighted in the Great South Channel on 9 March 2007, may have avoided serious injury due to being partially disentangled on 18 September 2007 by researchers in the Bay of Fundy, Canada. On 8 December 2008, Eg number 3294 was successfully disentangled. Sometimes, even with disentanglement, an animal may die of injuries sustained from fishing gear. A female yearling right whale, #3107 was first sighted with gear wrapping its caudal peduncle on 6 July 2002 near Briar Island, Nova Scotia. Although the gear was removed on 1 September by the New England Aquarium disentanglement team, and the animal seen alive on an aerial survey on 1 October, its carcass washed ashore at Nantucket on 12 October, 2002 with deep entanglement injuries on the caudal peduncle. ~~On 8 December 2008, Eg number 3294 was successfully disentangled.~~

In January 1997, NMFS changed the classification of the Gulf of Maine and U.S. 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 (62 FR 33, Jan. 2, 1997).

The only bycatch of a right whale observed by the Northeast Fisheries Observer Program was in the pelagic drift gillnet fishery in 1993. No mortalities or serious injuries have been documented in any of the other fisheries monitored by NMFS.

Entanglement records from 1990 through 2008~~7~~ maintained by NMFS Northeast Regional Office (NMFS, unpublished data) included 47~~6~~ confirmed right whale entanglements, including right whales in weirs, gillnets, and trailing line and buoys. Because whales often free themselves of gear following an entanglement event, scarring may be a better indicator of fisheries interaction than entanglement records. In an analysis of the scarification of right whales, 338 of 447 (75.6%) whales examined during 1980-2002 were scarred at least once by fishing gear (Knowlton *et al.* 2005). Further research using the North Atlantic Right Whale Catalogue has indicated that, annually, between 14% and 51% of right whales are involved in entanglements (Knowlton *et al.* 2005). Incidents of entanglements in groundfish gillnet gear, cod traps, and herring weirs in waters of Atlantic Canada and the U.S. east coast were summarized by Read (1994). In six records of right whales that were entangled in groundfish gillnet gear in the Bay of Fundy and Gulf of Maine between 1975 and 1990, the whales were either released or escaped on their own, although several whales were observed carrying net or line fragments. A right whale mother and calf were released alive from a herring weir in the Bay of Fundy in 1976.

For all areas, specific details of right whale entanglement in fishing gear are often lacking. When direct or indirect mortality occurs, some carcasses come ashore and are subsequently examined, or are reported as "floaters" at sea. The number of unreported and unexamined carcasses is unknown, but may be significant in the case of floaters. More information is needed about fisheries interactions and where they occur.

Other Mortality

Ship strikes are a major cause of mortality and injury to right whales (Kraus 1990; Knowlton and Kraus 2001). Records from 2004~~3~~ through 2008~~7~~ have been summarized in Table 2. For this time frame, the average reported mortality and serious injury to right whales due to ship strikes was 2.~~2~~0 whales per year (U.S. waters, 1.6; Canadian waters, 0.4~~6~~).

~~Table 2. Confirmed human-caused mortality and serious injury records of North Atlantic right whales, January 2003 through December 2007.~~

Date[a]	Report Type[b]	Age, Sex, ID, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entang./ Fsh inter	
01/14/03	serious injury	Adult Female #2240 12m (est)	Jacksonville, FL		p	Body condition poor; no gear recovered
10/02/03	mortality	Adult Female #2150 15m (est)	Digby, NS	p		Large fracture in skull; subdermal hemorrhage
02/07/04	mortality	Adult Female #1004 16.0m	Virginia Beach, VA	p		Severe subdermal bruising; complete fracture of rostrum and laceration of oral rete
09/06/04	mortality	Adult Female #2301 15m (est)	Roseway Basin, NS		p	Extensive constricting line on head and left flipper; found dead March 3, 2005 on Ship Shoal Island, VA; gear recovered consists of 10 fathoms of 3/8" & 7/16" rope
11/24/04	mortality	Adult Female #1909 14.9m	Ocean Sands, NC	p		Left fluke lobe severed and large bore blood vessels exposed
01/12/05	mortality	Adult Female #2143 13.1m	Cumberland Island, GA	p		Healed propeller wounds from strike as a calf re-opened as a result of pregnancy
03/10/05	serious injury	Adult Female #2425	Cumberland Island, GA	p		43 ft power yacht partially severed left fluke; resighted 9/4/05 in extremely poor condition
04/28/05	mortality	Adult Female #2617 14.7m	Monomoy Island, MA	p		Significant bruising and multiple vertebral fractures
01/10/06	mortality	Calf Male 5.4m w/out fluke	Jacksonville, FL	p		Propeller lacerations associated with hemorrhaging and edema; flukes completely severed
01/22/06	mortality	Calf Female 5.6m	off Ponte Vedra Beach, FL		p	Significant pre-mortem lesions from entanglement in apparent monofilament netting; no gear present
03/11/06	serious injury	Yearling Male #3522	off Cumberland Island, GA	p		11 propeller lacerations across dorsal surface
07/24/06	mortality	age unknown Female	Campobello Island, NB	p		Propeller lacerations through blubber, into muscle and ribs

		~~9.6m~~				
~~08/24/06~~	~~mortality~~	~~Adult Female 14.7m~~	~~Roseway Basin, NS~~	~~P~~		~~16 fractured vertebrae; dorsal blubber bruise from head to genital region~~
~~12/30/06~~	~~mortality~~	~~Yearling Male #3508 12.6m~~	~~off Brunswick, GA~~	~~P~~		~~20 propeller lacerations along right side of head and back with associated hemorrhaging~~
~~03/31/07~~	~~mortality~~	~~Calf Male 7.7 m~~	~~Outer Banks, NC~~		~~P~~	~~Edema associated with flipper and dorsal & ventral thoracic musculature; epidermal abrasion indicated entangling body and flipper wraps; no gear recovered~~

~~a. 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.~~
~~b. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS (Glass *et al.* 2009) have been used here. Some assignments may change as new information becomes available and/or when national standards are established.~~

Table 2. Confirmed human-caused mortality and serious injury records of North Atlantic right whales, January 2004 through December 2008.

Date[a]	Report Type[b]	Age, Sex, ID, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entang./ Fsh inter	
02/07/04	mortality	Adult Female #1004 16.0m	Virginia Beach, VA	P		Severe subdermal bruising; complete fracture of rostrum and laceration of oral rete
09/06/04	mortality	Adult Female #2301 15m (est)	Roseway Basin, NS		P	Extensive constricting line on head and left flipper; found dead March 3, 2005 on Ship Shoal Island, VA; gear recovered consists of 10 fathoms of 3/8" & 7/16" rope
11/24/04	mortality	Adult Female #1909 14.9m	Ocean Sands, NC	P		Left fluke lobe severed and large bore blood vessels exposed
01/12/05	mortality	Adult Female #2143 13.1m	Cumberland Island, GA	P		Healed propeller wounds from strike as a calf re-opened as a result of pregnancy
03/10/05	serious injury	Adult[c] Female[c] #2425	Cumberland Island, GA	P		43 ft power yacht partially severed left fluke; last resighted 9/4/05 in extremely poor condition
04/28/05	mortality	Adult Female #2617	Monomoy Island, MA	P		Significant bruising and multiple vertebral fractures

		14.7m				
01/10/06	mortality	Calf Male 5.4m w/out fluke	Jacksonville, FL	P		Propeller lacerations associated with hemorrhaging and edema; flukes completely severed
01/22/06	mortality	Calf Female[c] 5.6m	off Ponte Vedra Beach, FL		P	Significant pre-mortem lesions from entanglement in apparent monofilament netting; no gear present
03/11/06	serious injury	Yearling Male #3522	Off Cumberland Island, GA	P		11 propeller lacerations across dorsal surface; not resighted since
07/24/06	mortality	age unknown Female 9.6m	Campobello Island, NB	P		Propeller lacerations through blubber, into muscle and ribs
08/24/06	mortality	Adult Female 14.7m	Roseway Basin, NS	P		16 fractured vertebrae; dorsal blubber bruise from head to genital region
12/30/06	mortality	Yearling Male #3508 12.6m	off Brunswick, GA	P		20 propeller lacerations along right side of head and back with associated hemorrhaging
03/31/07	mortality	Calf Male 7.7 m	Outer Banks, NC		P	Edema associated with flipper and dorsal & ventral thoracic musculature; epidermal abrasion indicated entangling body and flipper wraps; no gear recovered
02/03/08	serious injury	Adult Male #1980	Cape Hatteras, NC		P	Embedded wrap in rostrum; decline in health; no gear recovered; last resighted 04/16/2008

a. 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.
b. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS (Nelson *et al.* 2007) have been used here. Some assignments may change as new information becomes available and/or when national standards are established.
c. Additional information that was not included in previous reports.

STATUS OF STOCK

The size of this stock is considered to be extremely low relative to OSP in the U.S. Atlantic EEZ, and this species is listed as endangered under the ESA. The North Atlantic right whale is considered one of the most critically endangered populations of large whales in the world (Clapham *et al.* 1999). A Recovery Plan has been published for the North Atlantic right whale and is in effect (NMFS [National Marine Fisheries Service] 2005). NMFS is presently engaged in evaluating the need for critical habitat designation for the North Atlantic right whale. Under a prior listing as northern right whale, t~~T~~hree critical habitats, Cape Cod Bay/Massachusetts Bay, Great South Channel, and the Southeastern U.S. were designated ~~for the Northern right whale~~ by NMFS (59 FR 28793, June 3, 1994). Two additional critical habitat areas in Canadian waters, Grand Manan Basin and Roseway Basin, were identified in Canada's final recovery strategy for the North Atlantic right whale (Brown *et al.* 2009). A National Marine Fisheries Service ESA status review in 1996 concluded that the western North Atlantic population remains endangered. This conclusion was reinforced by the International Whaling Commission (Best *et al.* 2001), which expressed grave concern regarding the status of this stock. Relative to populations of southern right whales, there are also concerns about growth rate, percentage of reproductive females, and calving intervals in this population. The total level of human-caused mortality and serious injury is unknown, but reported human-caused mortality and serious injury was a minimum of 3.0 right whales per year from 2004~~3~~ through 2008~~7~~. Given that PBR has been set to ~~zero~~0.7, no mortality

or serious injury for this stock can be considered insignificant. This is a strategic stock because the average annual human-related mortality and serious injury exceeds PBR, and also because the North Atlantic right whale is an endangered species.

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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 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 made to reclassify the Gulf of Maine as a separate feeding stock (Waring *et al.* 2000); 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 analyses 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 among whales sampled in four western feeding areas, including the Gulf of Maine (Palsbøll *et al.* 2001). 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).

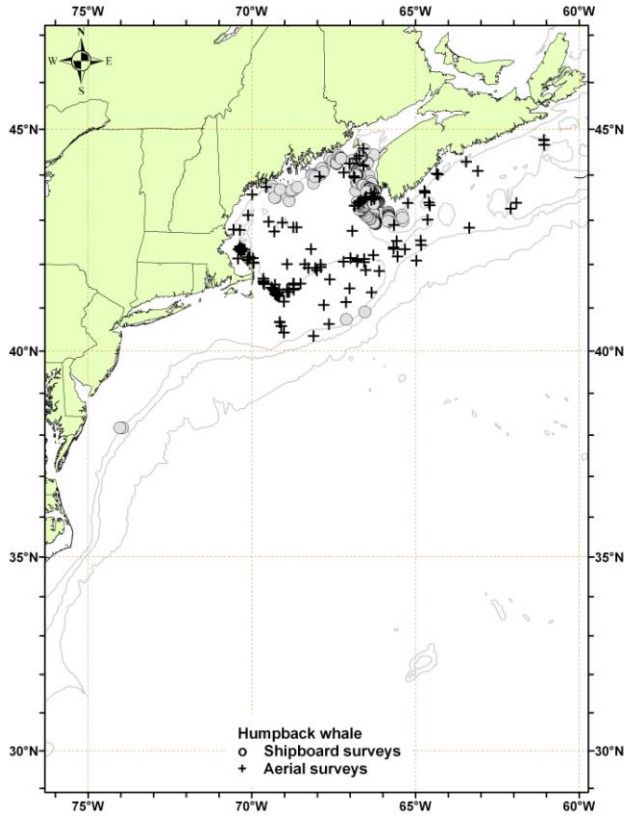

Figure 1. *Distribution of humpback whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004 2006, and 2007. Isobaths are the 100-m, 1000-m and 4000-m depth contours.*

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 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 Provincetown 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, despite the additional distance of nearly 100 nautical miles (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 subpopulations occurs (Katona and Beard 1990; Clapham *et al.* 1993; 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 and Navidad Bank, and in Samana Bay (Balcomb and Nichols 1982; Whitehead and Moore 1982; Mattila *et al.* 1989; Mattila *et al.* 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).

Not all whales migrate to the West Indies every winter, and 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 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. There have also been a number of wintertime humpback sightings in coastal waters of the southeastern U.S. (NMFS unpublished data; New England Aquarium unpublished data). 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.

A key question with regard to humpback whales off the southeastern and mid-Atlantic states is their population 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 (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 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 bottom topography 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). 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 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 and on the Northeast Peak on Georges Bank and on 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 (unpublished data, Provincetown Center for Coastal Studies and College of the Atlantic).

In early 1992, a major research program known as the Years of the North Atlantic Humpback (YONAH) (Smith *et al.* 1999) was initiated. This 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

North Atlantic Population

The overall North Atlantic population (including the Gulf of Maine), derived from genetic tagging data collected by the YONAH project on the breeding grounds, was estimated to be 4,894 males (95% CI=3,374-7,123) and 2,804 females (95% CI=1,776-4,463) (Palsbøll *et al.* 1997). Because the sex ratio in this population is known to be even (Palsbøll *et al.* 1997), the excess of males is presumed 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. Photographic mark-recapture analyses from the YONAH project provided an ocean-basin-wide estimate of 11,570 animals during 1992/1993 (CV=0.068, Stevick *et al.* 2003), and an additional genotype-based analysis yielded a similar but less precise estimate of 10,400 whales (CV=0.138, 95% CI=8,000 to 13,600) (Smith *et al.* 1999). 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.

Gulf of Maine stock - earlier estimates

Please see Appendix IV for earlier estimates. As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), 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

An abundance estimate of 521 (CV=0.67) humpback whales was obtained from an aerial survey conducted in July and August 2002 which covered 7,465 km of trackline over waters from the 1000 m depth contour on the southern edge of Georges Bank to Maine (Table 1; Palka 2006). The value of *g(0)* used for this estimation was derived from the pooled data of 2002, 2004 and 2006 aerial survey data.

An abundance estimate of 359 (CV=0.75) humpback whales was obtained from a line-transect sighting survey conducted from 12 June to 4 August 2004 by a ship and plane. The 2004 survey covered the smallest portion of the habitat (6,180 km of trackline), from the 100 m depth contour on the southern Georges Bank to the lower Bay of Fundy; while the Scotian shelf south of Nova Scotia was not surveyed.

An abundance estimate of 847 animals (CV=0.55) was derived from a line-transect sighting survey conducted during August 2006 which covered 10,676 km of trackline from the 2000 m depth contour on the southern edge of Georges Bank to the upper Bay of Fundy and to the Gulf of St. Lawrence. (Table 1; Palka pers. comm.) Some evidence exists to support a 25% exchange rate between Scotian shelf animals and with those in the Gulf of Maine (Clapham *et al.* 2003), which suggest that a 25% correction factor be applied to the humpback population estimate from the Scotian shelf stratum. Because the Scotian shelf was surveyed in only 2006, the 25% correction factor (described above) was applied to only the 2006 abundance estimate.

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 847 animals (CV=0.55). The minimum population estimate for this stock is 549 animals.

Table 1. Summary of abundance estimates for Gulf of Maine humpback whales.

Month/Year	Type	N	CV
Aug 2002	S. Gulf of Maine to Maine	521	0.67
Jun-Jul 2004	Gulf of Maine to lower Bay of Fundy	359	0.75
Aug 2006	S. Gulf of Maine to upper Bay of Fundy to Gulf of St. Lawrence	847	0.55

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 3.1% (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.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

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 confidence limits were not provided (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 (1992-1995) in which survival rates declined. It is possible that this shift resulted in calves that were born in those years imprinting on (and thus subsequently returning to) areas other than those in which intensive sampling occurred. If the decline is real, it may be related to known high mortality among young-of-the-year whales in the waters off 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 estimates of population growth rate for the Gulf of Maine stock, the maximum net productivity rate was assumed to be the default value of 0.04 for cetaceans (Barlow *et al.* 1995).

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 549 whales. The maximum productivity rate is the default value of 0.04. The "recovery" factor, which accounts for endangered, depleted, or 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 1.1 whales.

ANNUAL HUMAN-CAUSED SERIOUS INJURY AND MORTALITY

For the period 2004~~3~~ through 2008~~7~~, the minimum annual rate of human-caused mortality and serious injury to the Gulf of Maine humpback whale stock averaged 4.6~~4~~ animals per year (U.S. waters, 4.4~~0~~; Canadian waters, 0.2~~4~~). This value includes incidental fishery interaction records, 3.0~~2.8~~ (U.S. waters, 2.8~~4~~; Canadian waters, 0.2~~4~~); and records of vessel collisions, 1.6 (U.S. waters, 1.6; Canadian waters, 0) (Glass *et al.* 2010~~09~~).

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 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 confirmed human-caused mortalities or serious injuries.

Serious injury was defined in 50 CFR part 229.2 as an injury that is likely to lead to mortality. We therefore limited serious injury designations 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. Determinations of serious injury were made on a case-by-case basis following recommendations from the workshop conducted in 1997 on differentiating serious and non-serious injuries (Angliss and DeMaster 1998). Injuries that impeded a 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 might 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 represent a minimum estimate.

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 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. 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 six (30%) had major injuries possibly attributable to ship strikes, and five (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 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 was 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. Inspection of 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 five of the dead whales indicate that some were small for their age, and histories of live whales further indicate that the proportion of mature whales in the mid-Atlantic may be higher than suggested by the stranded sample.

Robbins and Mattila (2001) reported that males were more likely to be entangled than females. Their scarring data 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 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). Two humpbacks were reported entangled in fishing gear in Newfoundland and Labrador waters in 2005. One towed away the gear and was not re-sighted, and the other was released alive (Ledwell and Huntington 2006). Eighty-four humpbacks were reported entangled in fishing gear in Newfoundland and Labrador from 2000~~-~~ to 2006 (W. Ledwell, pers. comm.). 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.

Disturbance by whale watching may be an important issue in some areas of the population's range, notably the coastal waters of New England where the density of whale watching traffic is seasonally high. However, no studies have been conducted to address this question.

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 2004~~3~~ through 2008~~7~~, ~~11 records had some evidence of a collision with a vessel. Eight~~there are 8 ~~of these were~~ reports of mortalities as a result of ~~the~~ collision with a vessel. 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 (Glass *et al.* 2010~~09~~).

Fishery-Related Serious Injuries and Mortalities

A description of Fisheries is provided in Appendix III. Two mortalities were observed in the pelagic drift gillnet fishery, one in 1993 and the other in 1995. 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. Additional reports of mortality and serious injury, as well as description of total human impacts, are contained in records maintained by NMFS. A number of these records (11 entanglements involving lobster pot/trap gear) from the 1990-1994 period were the basis used to reclassify the lobster fishery (62 FR 33, Jan. 2, 1997).

For this report, the records of dead, injured, and/or entangled humpbacks (found either stranded or at sea) for the period 2004~~3~~ through 2008~~7~~ were reviewed. Entanglements accounted for ~~four~~ five mortalities and 10~~ten~~ serious injuries. With no evidence to the contrary, all 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 frequency of entanglements.

~~Table 2. Confirmed U.S. and Canadian human-caused mortality and serious injury records of North Atlantic humpback whales, January 2003 – December 2007. All records were assumed to involve members of the Gulf of Maine humpback whale stock unless a whale was confirmed to be a member of another stock. (Glass *et al.* 2009).~~

~~Date[a]~~	~~Report Type[b]~~	~~Age, Sex, ID, Length~~	~~Location[a]~~	~~Assigned Cause: P=primary, S=secondary~~		~~Notes/Observations~~
				~~Ship strike~~	~~Entang./ Fsh.inter~~	
~~06/06/03~~	~~mortality~~	~~Juvenile Female 8.3m~~	~~Chesapeake Bay mouth, VA~~	~~p~~		~~Major trauma to right side of head; hematoma~~

~~07/09/03~~	~~serious injury~~	~~Calf of Shockwave sex unknown~~	~~Bay of Fundy, NS~~		~~p~~	~~Constricting entanglement on a young whale; no gear recovered~~
~~07/12/03~~	~~serious injury~~	~~age & sex unknown~~	~~Oregon Inlet, NC~~		~~p~~	~~Entangled in substantial amount of gear; no gear recovered~~
~~08/15/03~~	~~mortality~~	~~Calf sex unknown 7.3m (est)~~	~~Petit Manan Island, ME~~		~~p~~	~~Floating offshore wrapped in line; gear recovered consists of a small portion of gillnet~~
~~08/16/03~~	~~serious injury~~	~~age & sex unknown~~	~~Cape Cod, MA~~		~~p~~	~~Poor body condition; line deeply embedded; gear recovered included sink gillnet, vessel anchoring system, surface buoy system and endline~~
~~08/18/03~~	~~serious injury~~	~~age & sex unknown~~	~~Cape Cod, MA~~		~~p~~	~~Extensive entanglement; no gear recovered~~
~~07/11/04~~	~~serious injury~~	~~Juvenile sex unknown "Lucky"~~	~~Briar Island, NS~~		~~p~~	~~Entanglement on a young whale; no gear recovered~~
~~10/03/04~~	~~mortality~~	~~age unknown Male 15m (est)~~	~~Georges Bank, U.S.~~		~~p~~	~~Fresh carcass with entangling line and high flyer; no gear recovered~~
~~12/19/04~~	~~mortality~~	~~Calf Female 8.0m~~	~~Bethany Beach, DE~~	~~p~~		~~Hematoma and skeletal fracturing~~
~~01/09/06~~	~~mortality~~	~~Adult Female #8667 14.0m~~	~~off Charleston, SC~~	~~p~~		~~Extensive muscle hemorrhaging; rib fractures; dislocated flipper on left side of animal~~
~~03/17/06~~	~~mortality~~	~~Juvenile Female 10.0m~~	~~Virginia Beach, VA~~	~~p~~		~~Crushed cranium and fractured mandible; hemorrhaging associated with fractures; ventral lacerations consistent with propeller wounds~~
~~03/25/06~~	~~serious injury~~	~~Juvenile sex unknown 8m (est)~~	~~Flagler Beach, FL~~		~~p~~	~~Heavy cyamid load; emaciated; spinal deformity that may or may not have been caused by the entanglement; gear recovered included line and buoys and was identified as lobster pot gear~~
~~08/06/06~~	~~serious injury~~	~~age & sex unknown~~	~~Georges Bank, U.S.~~		~~p~~	~~Multiple constricting wraps around head; line cutting into upper lip; wraps around both flippers; no gear recovered~~

~~08/23/06~~	~~serious injury~~	~~age & sex unknown 12m (est)~~	~~Great South Channel, U.S.~~		~~P~~	~~Flukes necrotic and nearly severed as a result of entanglement; pale skin and emaciated; gear recovered included heavy line and wire trap~~
~~09/06/06~~	~~mortality~~	~~age & sex unknown~~	~~East of Cape Cod, MA~~		~~P~~	~~Whale entangled through mouth continuing back to multiple wraps around peduncle; no gear recovered~~
~~10/15/06~~	~~mortality~~	~~Juvenile Female 10.1m~~	~~off Fenwick Island, DE~~	~~P~~	~~S~~	~~Large laceration, penetrating through the bone, across rostrum with accompanying fractures; no gear, but marks around right flipper consistent with entanglement; subdermal hemorrhaging and bone trauma at entanglement point~~
~~01/27/07~~	~~serious injury~~	~~age & sex unknown~~	~~off Beach Haven, NJ~~		~~P~~	~~Body wrap likely to become constricting; random cyamid patches; thin body condition.; probable flipper wraps; no gear recovered~~
~~05/10/07~~	~~mortality~~	~~Adult Female 12.5m~~	~~off Wachapreague, VA~~	~~P~~		~~Cranium shattered, hemorrhaging on left lateral side midway between flippers & fluke~~
~~05/13/07~~	~~mortality~~	~~Juvenile Male 9.3m~~	~~Rockport, MA~~	~~P~~		~~Areas of hemorrhaging indicate major blunt trauma to chest, neck & head~~
~~06/23/07~~	~~serious injury~~	~~age unknown Male "Egg Toss"~~	~~Wildcat Knoll~~		~~P~~	~~Body wrap of gear imbedded; no gear recovered~~
~~06/24/07~~	~~mortality~~	~~Juvenile Female "Tofu" 9.9m~~	~~Stellwagen Bank~~	~~P~~		~~Subdermal hemorrhaging involving blubber, fascia, & muscle extending from/around the insertion of the right flipper ventrally to the axilla~~
~~12/21/07~~	~~mortality~~	~~age unknown Male 9.4m~~	~~Ocean Sands, NC~~		~~P~~	~~Documented wrapped in gear, gear removed without permission prior to necropsy; external lesions at flukes, flippers, mouth, dorsal fin, dorsal keel & ventral pleats consistent with gillnet entanglement; animal emaciated; no gear recovered~~

~~a. 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.~~

~~b. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS (Glass *et al.* 2009) have been used here. Some assignments may change as new information becomes available and/or when national standards are established.~~

Table 2. Confirmed human-caused mortality and serious injury records of North Atlantic humpback whales, January 2004 - December 2008. All records were assumed to involve members of the Gulf of Maine humpback whale stock unless a whale was confirmed to be a member of another stock. This is in contrast to prior reports.

Date[a]	Report Type[b]	Age, Sex, ID, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entang./ Fsh.inter	
07/11/04	serious injury	Juvenile sex unknown "Lucky"	Briar Island, NS		P	Entanglement on a young whale; no gear recovered
10/03/04	mortality	age unknown Male 15m (est)	Georges Bank		P	Fresh carcass with entangling line and high flyer; no gear recovered
12/19/04	mortality	Calf Female 8.0m	Bethany Beach, DE	P		Hematoma and skeletal fracturing
01/09/06	mortality	Adult Female #8667 14.0m	off Charleston, SC	P		Extensive muscle hemorrhaging; rib fractures; dislocated flipper on left side of animal
03/17/06	mortality	Juvenile Female 10.0m	Virginia Beach, VA	P		Crushed cranium and fractured mandible; hemorrhaging associated with fractures; ventral lacerations consistent with propeller wounds
03/25/06	serious injury	Juvenile sex unknown 8m (est)	Flagler Beach, FL		P	Heavy cyamid load; emaciated; spinal deformity that may or may not have been caused by the entanglement; gear recovered included line and buoys and was identified as lobster pot gear
08/06/06	serious injury	age & sex unknown	Georges Bank		P	Multiple constricting wraps around head; line cutting into upper lip; wraps around both flippers; no gear recovered
08/23/06	serious injury	age & sex unknown 12m (est)	Great South Channel		P	Flukes necrotic and nearly severed as a result of entanglement; pale skin and emaciated; gear recovered included heavy line and wire trap
09/06/06[c]	mortality	age & sex unknown	East of Cape Cod, MA		P	Whale entangled through mouth, continuing back to multiple wraps around peduncle; no gear recovered
10/15/06	mortality	Juvenile Female 10.1m	off Fenwick Island, DE	P	S	Large laceration, penetrating through the bone, across rostrum with accompanying fractures; no gear, but marks around right flipper consistent with entanglement; subdermal hemorrhaging and bone trauma at entanglement point

01/27/07	serious injury	age & sex unknown	off Beach Haven, NJ		P	Body wrap likely to become constricting; random cyamid patches; thin body condition; probable flipper wraps; no gear recovered
05/10/07	mortality	Adult Female 12.5m	off Wachapreague, VA	P		Cranium shattered, hemorrhaging on left lateral side midway between flippers & fluke
05/13/07	mortality	Juvenile Male 9.3m	Rockport, MA	P		Areas of hemorrhaging indicate major blunt trauma to chest, neck & head
06/23/07	serious injury	age unknown "Egg Toss" Male	Wildcat Knoll		P	Body wrap of gear imbedded; no gear recovered
06/24/07	mortality	Juvenile Female "Tofu" 9.9m	Stellwagen Bank	P		Subdermal hemorrhaging involving blubber, fascia, & muscle extending from/around the insertion of the right flipper ventrally to the axilla
12/21/07	mortality	age unknown Male 9.4m	Ocean Sands, NC		P	Documented wrapped in gear, gear removed without permission prior to necropsy; external lesions at flukes, flippers, mouth, dorsal fin, dorsal keel & ventral pleats consistent with gillnet entanglement; emaciated; no gear recovered
01/06/08	serious injury	age & sex unknown 10m (est)	off Cape Lookout, NC		P	Constricting line cutting into right flipper in several places; heavy cyamid load; emaciated; no gear recovered
05/30/08	mortality	age & sex unknown	Georges Bank		P	Constricting body wraps, one wrap under lower jaw; open wound on right flipper; no gear recovered
06/09/08	mortality	age & sex unknown	Georges Bank		P	Constricting body wrap; gear analysis pending
07/08/08	serious injury	Adult Female "Estuary"	off Nauset, MA		P	Cuts were made, but no gear was removed; emaciated; moderate cyamid coverage; deep wounds in fluke blades from gear; hunched over position maintained after cuts were made to the gear; gear analysis pending
08/13/08	serious injury	age & sex unknown 10m (est)	off NJ		P	Partial disentanglement; emaciated; lethargic; heavy cyamid load; gear analysis pending
08/21/08	serious injury	age & sex unknown	off Chatham, MA		P	Evidence of decline in health; no gear recovered

11/04/08	mortality	Juvenile Male 10.1m	Assateague, MD	P		Cranial fractures with associated hemorrhaging

a. 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.
b. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS (Nelson *et al.* 2007) have been used here. Some assignments may change as new information becomes available and/or when national standards are established.
c. Record was added after review of carcasses sighted on 08/20/06 and 09/06/06. Previous reports stated these were the same animal. Recent review could not confirm the resight, therefore they are now being treated as two separate events. There was inconclusive evidence with regard to the carcass on 08/20/06 to determine mortality due to entanglement.

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.

In July 2003, an Unusual Mortality Event (UME) was invoked in offshore waters when an estimated minimum of 12-15 humpback whales died in the vicinity of the Northeast Peak of Georges Bank. Preliminary tests of samples taken from some of these whales were positive for domoic acid at low levels, but it is currently unknown what levels would affect the whales and therefore no definitive conclusions can yet be drawn regarding the cause of this event or its effect on the status of the Gulf of Maine humpback whale population. 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, still considered ongoing at the end of 2007. Causes of these UME events have not been determined.

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 the population and made recommendations for further research (IWC 2002). Although recent estimates of abundance indicate continued population growth, the size of the humpback whale stock may be below OSP in the U.S. Atlantic EEZ. This is a strategic stock because the humpback whale is listed as an endangered species under the ESA. A Recovery Plan was published and is in effect (NMFS 1991). There are insufficient data to reliably determine current population trends for humpback whales in the North Atlantic overall. The average annual rate of population increase was estimated at 3.1% (SE=0.005, Stevick *et al.* 2003). 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. The total level of U.S. fishery-caused mortality and serious injury is unknown, but reported levels are more than 10% of the calculated PBR and, therefore, cannot be considered to be insignificant or approaching zero mortality and serious injury rate. This is a strategic stock because the average annual human-related mortality and serious injury exceeds PBR, and because the North Atlantic humpback whale is an endangered species.

As part of a large-scale assessment called More of North Atlantic Humpbacks (MoNAH) project, extensive sampling was conducted on humpbacks in the Gulf of Maine/Scotian Shelf region and the primary wintering ground on Silver Bank during 2004-2005. These data are being analyzed along with additional data from the U.S. mid-Atlantic to estimate abundance and refine knowledge of the North Atlantic humpback whales' population structure. The work is intended to update the YONAH population assessment in preparation for a status review under the ESA.

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~~December 2009~~March 2010

FIN WHALE (*Balaenoptera physalus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The Scientific Committee of the International Whaling Commission (IWC) has proposed stock boundaries for North Atlantic fin whales. Fin whales off the eastern United States, Nova Scotia and the southeastern coast of Newfoundland are believed to constitute a single stock under the present IWC scheme (Donovan 1991). However, the stock identity of North Atlantic fin whales has received relatively little attention, and whether the current stock boundaries define biologically isolated units has long been uncertain. The existence of a subpopulation structure was suggested by local depletions that resulted from commercial overharvesting (Mizroch *et al.* 1984).

A genetic study conducted by Bérubé *et al.* (1998) using both mitochondrial and nuclear DNA provided strong support for an earlier population model proposed by Kellogg (1929) and others. This postulates the existence of several subpopulations of fin whales in the North Atlantic and Mediterranean with limited gene flow among them. Bérubé *et al.* (1998) also proposed that the North Atlantic population showed recent divergence due to climatic changes (i.e., postglacial expansion), as well as substructuring over even relatively short distances. The genetic data are consistent with the idea that different subpopulations use the same feeding ground, a hypothesis that was also originally proposed by Kellogg (1929).

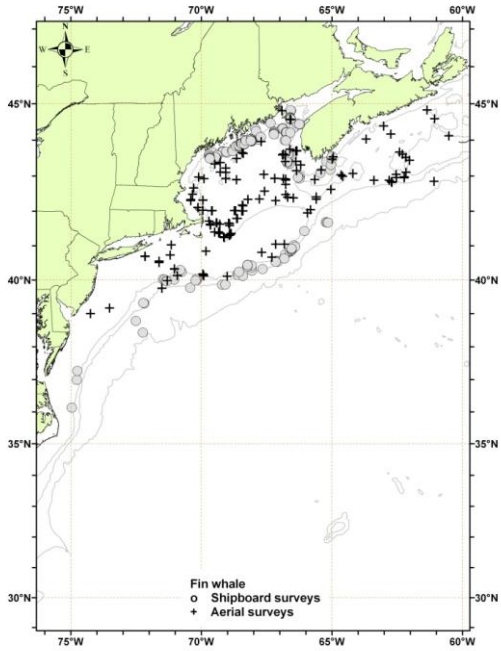

Figure 1. *Distribution of fin whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004, 2006 and 2007. Isobaths are the 100-m, 1000-m and 4000-m depth contours.*

Fin whales are common in waters of the U. S. Atlantic Exclusive Economic Zone (EEZ), principally from Cape Hatteras northward (Figure 1). Fin whales accounted for 46% of the large whales and 24% of all cetaceans sighted over the continental shelf during aerial surveys (CETAP 1982) between Cape Hatteras and Nova Scotia during 1978-82. While much remains unknown, the magnitude of the ecological role of the fin whale is impressive. In this region fin whales are probably the dominant large cetacean species during all seasons, having the largest standing stock, the largest food requirements, and therefore the largest impact on the ecosystem of any cetacean species (Hain *et al.* 1992; Kenney *et al.* 1997).

New England waters represent a major feeding ground for fin whales. There is evidence of site fidelity by females, and perhaps some segregation by sexual, maturational or reproductive class in the feeding area (Agler *et al.* 1993). Seipt *et al.* (1990) reported that 49% of fin whales sighted on the Massachusetts Bay area feeding grounds were resighted within the same year, and 45% were resighted in multiple years. The authors suggested that fin whales on these grounds exhibited patterns of seasonal occurrence and annual return that in some respects were similar to those shown for humpback whales. This was reinforced by Clapham and Seipt (1991), who showed ~~maternally-~~maternally-directed site fidelity for fin whales in the Gulf of Maine. Information on life history and vital rates is also available in data from the Canadian

fishery, 1965-1971 (Mitchell 1974). In seven years, 3,528 fin whales were taken at three whaling stations. The station at Blandford, Nova Scotia, took 1,402 fin whales.

Hain *et al.* (1992), based on an analysis of neonate stranding data, suggested that calving takes place during October to January in latitudes of the U.S. mid-Atlantic region; however, it is unknown where calving, mating, and wintering occurs for most of the population. Results from the Navy's SOSUS program (Clark 1995) indicate a substantial deep-ocean distribution of fin whales. It is likely that fin whales occurring in the U.S. Atlantic EEZ undergo migrations into Canadian waters, open-ocean areas, and perhaps even subtropical or tropical regions. However, the popular notion that entire fin whale populations make distinct annual migrations like some other mysticetes has questionable support in the data; in the North Pacific, year-round monitoring of fin whale calls found no evidence for large-scale migratory movements (Watkins *et al.* 2000).

POPULATION SIZE

The best abundance estimate available for the western North Atlantic fin whale stock is ~~2,269~~3,985 (CV= 0.~~37~~24). ~~This August 2006 estimate is recent and provides an estimate when the largest portion of the population was within the study area. However, this estimate must be considered extremely conservative in view of the incomplete coverage of the known habitat of the stock and the uncertainties regarding population structure and whale movements between surveyed and unsurveyed areas.~~This is the sum of the estimate derived from the August 2006 Gulf of Maine survey and the estimate derived from the July-Aug 2007 northern Labrador to Scotian Shelf survey. The abundance estimates of fin whales include a percentage of the estimate of animals identified as fin/sei whales (the two species being sometimes hard to distinguish). The percentage used is the ratio of positively identified fin whales to the total number of positively identified fin whales and positively identified sei whales.

Earlier abundance estimates

Please see Appendix IV for earlier abundance estimates. As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable and should not be used for PBR determinations.

Recent surveys and abundance estimates

An abundance estimate of ~~2,933~~1,716 (CV=0.~~49~~40) fin whales was obtained from an aerial survey conducted in August 2002 which covered 7,465 km of trackline over waters from the ~~1000~~-1000-m depth contour on the southern edge of Georges Bank to Maine (Table 1; Palka 2006). The value of *g(0)* used for this estimation was derived from the pooled ~~data of~~ 2002, 2004 and 2006 aerial survey data.

An abundance estimate of 1,925 (CV=0.55) fin whales was derived from a line-transect sighting survey conducted during 12 June to 4 August 2004 by a ship and plane that surveyed 10,761 km of trackline in waters north of Maryland (38ºN) (Table 1; Palka 2006). Shipboard data were collected using the ~~two~~-two-~~independent~~-independent-team ~~line~~-line-transect method and analyzed using the modified ~~direct~~-direct-duplicate method (Palka 1995) accounting for biases due to school size and other potential covariates, reactive movements (Palka and Hammond 2001), and *g(0)*, the probability of detecting a group on the track line. Aerial data were collected using the Hiby circle-back ~~line~~-line-transect method (Hiby 1999) and analyzed accounting for *g(0)* and biases due to school size and other potential covariates (Palka 2005). The value of *g(0)* used for this estimation was derived from the pooled ~~data of~~ 2002, 2004 and 2006 aerial survey data.

An abundance of 2,269 (CV=0.37) fin whales was estimated from an aerial survey conducted in August 2006 which covered 10,676 km of trackline in the region from the 2000-m depth contour on the southern edge of Georges Bank to the upper Bay of Fundy and to the entrance of the Gulf of St. Lawrence (Table 1; Palka pers. comm.). The value of *g(0)* used for this estimation was derived from the pooled ~~data of~~ 2002, 2004 and 2006 aerial survey data.

An abundance estimate of 1,~~352~~-716 (~~95%CI=821-2,226~~CV=0.26) fin whales was generated from the Canadian Trans North Atlantic Sighting Survey (TNASS) in July-August 2007. This aerial survey covered area from northern Labrador to the Scotian Shelf, providing full coverage of the Atlantic Canadian coast. Estimates from this survey have not yet been corrected for availability and perception biases (Lawson and Gosselin 2009)~~(Lawson and Gosselin 2008)~~.

Table 1. Summary of recent abundance estimates for western North Atlantic fin whales. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Aug 2002	S. Gulf of Maine to Maine	2,933	0.49
Jun-July 2004	Gulf of Maine to lower Bay of Fundy	1,925	0.55
Aug 2006	S. Gulf of Maine to upper Bay of Fundy to Gulf of St. Lawrence	2,269	0.37
July-Aug 2007	N. Labrador to Scotian Shelf	1,~~352~~716	0.26
Aug 2006+Jul-Aug 2007	S. Gulf of Maine to N. Labrador (COMBINED)	3,985	0.24

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 fin whales is ~~2,269~~ 3,985(CV=0.~~37~~24). The minimum population estimate for the western North Atlantic fin whale is ~~1,678~~3,269.

Current Population Trend

There are insufficient data to determine population trends for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Based on photographically identified fin whales, Agler *et al.* (1993) estimated that the gross annual reproduction rate was at 8%, with a mean calving interval of 2.7 years.

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

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 ~~1,678~~3,269. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, or threatened stocks, or stocks of unknown status relative to optimum sustainable population (OSP), is assumed to be 0.10 because the fin whale is listed as endangered under the Endangered Species Act (ESA). PBR for the western North Atlantic fin whale is ~~3.4~~6.5.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

For the period ~~2003~~ 2004 through ~~2007~~2008, the minimum annual rate of human-caused mortality and serious injury to fin whales was 3.2~~2.8~~ per year (U.S. waters, 2.4~~2.0~~; Canadian waters, 0.8). This value includes incidental fishery interaction records, 1.2 (U.S. waters, 1.0; Canadian waters, 0.2); and records of vessel collisions, 2.0~~1.6~~ (U.S. waters, 1.~~2~~4; Canadian waters, 0.6~~4~~)(Glass 2010). Detected mortalities should not be considered an unbiased representation of human-caused mortality. Detections are haphazard and not the result of a designed sampling scheme. As such they represent a minimum estimate of human-caused mortality.

Fishery-Related Serious Injury and Mortality

No confirmed fishery-related mortalities or serious injuries of fin whales have been reported in the NMFS Sea Sampling bycatch database. A review of the records of stranded, floating or injured fin whales for the period 2004~~3~~ through 2008~~7~~ on file at NMFS found three records with substantial evidence of

fishery interactions causing mortality, and three records resulting in serious injury (Table 2), which results in an annual rate of serious injury and mortality of 1.2 fin whales from fishery interactions. While these records are not statistically quantifiable in the same way as the observer fishery records, they give a minimum count of entanglements for the species.

~~Table 2. Confirmed human-caused mortality and serious injury records of western North Atlantic fin whales, January 2003 – December 2007.~~

~~Date[a]~~	~~Report Type[b]~~	~~Age, Sex, Length~~	~~Location[a]~~	~~Assigned Cause: P=primary, S=secondary~~		~~Notes/Observations~~
				~~Ship strike~~	~~Entang. / Fsh.inter~~	
~~02/12/04~~	~~serious injury~~	~~age & sex unknown~~	~~Pea Island, NC~~		~~P~~	~~Entangled whale noticeably emaciated; no gear recovered~~
~~02/25/04~~	~~mortality~~	~~Adult Female 16.3m~~	~~Port Elizabeth, NJ~~	~~P~~		~~Displaced vertebrae; ruptured aorta~~
~~06/30/04~~	~~mortality~~	~~age & sex unknown 12m (est)~~	~~Georges Bank~~		~~P~~	~~Freshly dead; heavy line constricting mid-section; no gear recovered~~
~~09/26/04~~	~~mortality~~	~~age & sex unknown 15m (est)~~	~~St. Johns, NB~~	~~P~~		~~Fresh carcass on bow of 293 m cruise ship~~
~~03/26/05~~	~~mortality~~	~~Adult Female 16.3m~~	~~off Virginia Beach, VA~~	~~P~~		~~Extensive hemorrhaging and vertebral fractures~~
~~04/03/05~~	~~mortality~~	~~Adult[c] Female 18.8m~~	~~Southampton, NY~~	~~P~~		~~Subdermal hemorrhaging~~
~~08/23/05~~	~~mortality~~	~~Juvenile Male 13.7m~~	~~Port Elizabeth, NJ~~	~~P~~		~~Brought in on bow of 294 m ship~~

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~~09/11/05~~	~~mortality~~	~~Juvenile Male 11.0m~~	~~Bonne Esperance, QC~~	~~p~~		~~Bottom jaw completely severed/broken~~
~~09/17/06~~	~~serious injury~~	~~age & sex unknown 18m (est)~~	~~off Mt. Desert Rock, ME~~		~~p~~	~~Pale skin overall; cyamid load at point of attachment; emaciated; no gear recovered~~
~~03/25/07~~	~~mortality~~	~~age unknown Female 18.0m~~	~~Norfolk Harbor, VA~~	~~p~~		~~Extensive fracturing of ribs, skull and vertebrae w/ associated hemorrhage & edema~~
~~05/24/07~~	~~mortality~~	~~age unknown Male~~	~~Newark Bay, NJ~~	~~p~~		~~Hemorrhage (epaxial muscle, diaphragm, pleural lining) and multiple fractures of the ribs, vertebrae & sternum and the trailing tissue of the animal was marked by propeller cuts~~
~~06/25/07~~	~~serious injury~~	~~age & sex unknown~~	~~Great South Channel~~		~~p~~	~~Wrap on tail assoc w/ cyamid load; flippers & mouth involved; extremely emaciated; lethargic; no gear recovered~~
~~8/11/07~~	~~mortality~~	~~age & sex unknown~~	~~Cabot Strait, NS~~		~~p~~	~~Constricting wrap around body, between the head and flippers; no gear recovered~~
~~09/26/07~~	~~mortality~~	~~Juvenile Male 13m (est)~~	~~off Martha's Vineyard, MA~~		~~p~~	~~Freshly dead, scavenged carcass with gear present; evidence of multiple body wraps with associated hemorrhaging; no gear recovered~~

~~a. 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.~~

~~b. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS have been used here. Some assignments may change as new information becomes available and/or when national standards are established.~~

Table 2. Confirmed human-caused mortality and serious injury records of western North Atlantic fin whales, January 2004 - December 2008.

Date[a]	Report Type[b]	Age, Sex, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entang./ Fsh.inter	

02/12/04	serious injury	age & sex unknown	Pea Island, NC		P	Emaciated; no gear recovered
02/25/04	mortality	Adult Female 16.3m	Port Elizabeth, NJ	P		Displaced vertebrae; ruptured aorta
06/30/04	mortality	age & sex unknown 12m (est)	Georges Bank		P	Freshly dead; heavy line constricting mid-section; no gear recovered
09/26/04	mortality	age & sex unknown 15m (est)	St.aint Johns, NB	P		Fresh carcass on bow of ship
03/26/05	mortality	Adult[c] Female 16.3m	off Virginia Beach, VA	P		Extensive hemorrhaging and vertebral fractures
04/03/05	mortality	Adult[c] Female 18.8m	Southampton, NY	P		Subdermal hemorrhaging
08/23/05	mortality	Juvenile[c] Male 13.7m	Port Elizabeth, NJ	P		Brought in on bow of ship
09/11/05	mortality	Juvenile[c] Male 11.0m	Bonne Esperance, QC	P		Bottom jaw completely severed/broken
09/13/05[d]	mortality	age & sex unknown	Blanc Sablon, Newfoundland	P		Lower jaw broken associated with massive areas of bruising
09/17/06	serious injury	age & sex unknown 18m (est)	off Mt. Desert Rock, ME		P	Pale skin overall; cyamid load at point of attachment; emaciated; no gear recovered
03/25/07	mortality	age unknown Female 18.0m	Norfolk Harbor, VA	P		Extensive fracturing of ribs, skull and vertebrae w/ associated hemorrhage & edema
05/24/07	mortality	age unknown Male	Newark Bay, NJ	P		Hemorrhage (epaxial muscle, diaphragm, pleural lining) and multiple fractures of the ribs, vertebrae & sternum and the

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						trailing tissue of the animal was marked by propeller cuts
06/25/07	serious injury	age & sex unknown	Great South Channel		P	Wrap on tail assoc w/ cyamid load; flippers & mouth involved; extremely emaciated; lethargic; no gear recovered
08/11/07	mortality	age & sex unknown	Cabot Strait, Nova Scotia		P	Constricting wrap around body, between the head and flippers; no gear recovered
09/26/07	mortality	Juvenile Male 13m (est)	off Martha's Vineyard, MA		P	Freshly dead, scavenged carcass with gear present; evidence of multiple body wraps with associated hemorrhaging; no gear recovered
07/02/08	mortality	age unknown Male 14.8m	Barnegat Inlet, NJ	P		Vertebral fractures with associated hemorrhaging; hemorrhaging around ball joint of right flipper

a. 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.
b. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS (Glass 2010) ~~(Nelson *et al.* 2007)~~ have been used here. Some assignments may change as new information becomes available and/or when national standards are established.
c. The gender and length were misreported in the 2006 Stock Assessment Report. This table shows the correct values.
d. Additional record which was not included in previous reports.

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Other Mortality

After reviewing NMFS records for ~~2003~~ 2004 through ~~2007~~2008, ~~eight~~ ten were found that had sufficient information to confirm the cause of death as collisions with vessels ~~(Table 2~~(Table 2;Glass 2010)~~)~~. These records constitute an annual rate of serious injury or mortality of ~~1.6~~2.0 fin whales from vessel collisions. ~~NMFS data include one additional record of fin whale collisions with vessels, but the available supporting documentation is insufficient to determine if the whale sustained mortal injuries from the encounter.~~ The number of fin whales taken at 3 whaling stations in Canada from 1965 to 1971 totaled 3,528 whales (Mitchell 1974).

STATUS OF STOCK

The status of this stock relative to OSP in the U.S. Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine the population trend for fin whales. The total level of human-caused mortality and serious injury is unknown. NMFS records represent coverage of only a portion of the area surveyed for the population estimate for the stock. The total U.S.

fishery-related mortality and serious injury for this stock derived from the available records is not less than 10% of the calculated PBR, and therefore cannot be considered insignificant and approaching the ZMRG. This is a strategic stock because the fin whale is listed as an endangered species under the ESA. A ~~Draft~~ revised Recovery ~~recovery~~ Plan ~~plan~~ for fin whales has been ~~prepared and is available for review~~published (NMFS 2006).

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SEI WHALE (*Balaenoptera borealis borealis*): Nova Scotia Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Mitchell and Chapman (1977) reviewed the sparse evidence on stock identity of northwest Atlantic sei whales, and suggested two stocks - a Nova Scotia stock and a Labrador Sea stock. The range of the Nova Scotia stock includes the continental shelf waters of the northeastern U.S., and extends northeastward to south of Newfoundland. The Scientific Committee of the International Whaling Committee (IWC), while adopting these general boundaries, noted that the stock identity of sei whales (and indeed all North Atlantic whales) was a major research problem (Donovan 1991). In the absence of evidence to the contrary, the proposed IWC stock definition is provisionally adopted, and the "Nova Scotia stock" is used here as the management unit for this stock assessment. The IWC boundaries for this stock are from the U.S. east coast to Cape Breton, Nova Scotia, thence east to longitude 42° W.

Indications are that, at least during the feeding season, a major portion of the Nova Scotia sei whale stock is centered in northerly waters, perhaps on the Scotian Shelf (Mitchell and Chapman 1977). The southern portion of the species' range during spring and summer includes the northern portions of the U.S. Atlantic Exclusive Economic Zone (EEZ) - the Gulf of Maine and Georges Bank. Spring is the period of greatest abundance in U.S. waters, with sightings concentrated along the eastern margin of Georges Bank and into the Northeast Channel area, and along the southwestern edge of Georges Bank in the area of Hydrographer Canyon (CETAP 1982). NMFS aerial surveys in 1999, 2000 and 2001 found concentrations of sei and right whales along the northern edge of Georges Bank in the spring. The sei whale is often found in the deeper waters characteristic of the continental shelf edge region (Hain *et al.* 1985), and NMFS aerial surveys found substantial numbers of sei whales in this region, in particular south of Nantucket, in the spring of 2001. Similarly, Mitchell (1975) reported that sei whales off Nova Scotia were often distributed closer to the 2,000-m depth contour than were fin whales.

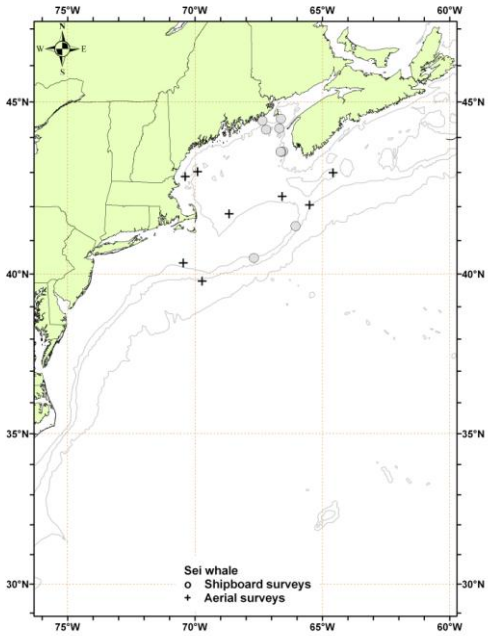

Figure 1. *Distribution of sei whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004, 2006 and 2007. Isobaths are the 100-m, 1000-m and 4000-m depth contours.*

This general offshore pattern of sei whale distribution is disrupted during episodic incursions into more shallow and inshore waters. Although known to take piscine prey, sei whales (like right whales) are largely planktivorous, feeding primarily on euphausiids and copepods (Flinn *et al.* 2002). A review by prey preferences by Horwood (1987) show that in the N Atlantic sei whales seem to prefer copepods over all other prey species. In Nova Scotia sampled stomachs from captured sei whales showed a clear preference for copepods between June and October and euphasiids were taken only in May and November (Mitchell 1975). In years of reduced predation on copepods by other predators, and thus greater abundance of this prey source, sei whales are reported in more inshore locations, such as the Great South Channel (in 1987 and 1989) and Stellwagen Bank (in 1986) areas (R.D. Kenney, pers. comm.; Payne *et al.* 1990). An influx of sei whales into the southern Gulf of Maine occurred in the summer of 1986 (Schilling *et al.* 1993). Such episodes, often punctuated by years or even decades of absence from an area, have been reported for sei whales from various places worldwide (Jonsgård and Darling 1977).

Based on analysis of records from the Blandford, Nova Scotia, whaling station, where 825 sei whales were taken between

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1965 and 1972, Mitchell (1975) described two "runs" of sei whales, in June-July and in September-October. He speculated that the sei whale population migrates from south of Cape Cod and along the coast of eastern Canada in June and July, and returns on a southward migration again in September and October; however, such a migration remains unverified.

POPULATION SIZE

The total number of sei whales in the U.S. Atlantic EEZ is unknown. However, five abundance estimates are available for portions of the sei whale habitat: from Nova Scotia during the 1970's, in the U.S. Atlantic EEZ during the springs of 1979-1981, and in the U.S. and Canadian Atlantic EEZ during the summers of 2002, 2004, and 2006. The August 2004 abundance estimate (386) is considered the best available for the Nova Scotia stock of sei whales. However, this estimate must be considered conservative in view of the known range of the sei whale in the entire western North Atlantic, and the uncertainties regarding population structure and whale movements between surveyed and unsurveyed areas. The abundance estimates of sei whales include a percentage of the estimate of animals identified as fin/sei whales (the two species being sometimes hard to distinguish). The percentage used is the ratio of positively identified sei whales to the total of positively identified fin whales and positively identified sei whales.

Earlier abundance estimates

Please see appendix IV for earlier abundance estimates. As recommended in the GAMMS Workshop Report (Wade and Angliss 1997), estimates older than eight years are deemed unreliable and should not be used for PBR determinations.

Recent surveys and abundance estimates

An abundance estimate of 71 (CV=1.01) sei whales was obtained from an aerial survey conducted in August 2002 which covered 7,465 km of trackline over waters from the 1000 m depth contour on the southern edge of Georges Bank to Maine (Table 1; Palka 2006). The value of *g(0)* used for this estimation was derived from the pooled data of the 2002, 2004 and 2006 aerial surveys.

An abundance estimate of 386 (CV=0.85) sei whales was derived from a line-transect sighting survey conducted during 12 June to 4 August 2004 by a ship and plane that surveyed 10,761 km of trackline in waters north of Maryland (38ºN)(Table 1; Palka 2006). There were 6,180 km of trackline within known sei whale habitat, from the 100 m depth contour on the southern Georges Bank to the lower Bay of Fundy. The Scotian shelf south of Nova Scotia was not surveyed. Shipboard data were collected using the two independent team line-transect method and analyzed using the modified direct duplicate method (Palka 1995) accounting for biases due to school size and other potential covariates, reactive movements (Palka and Hammond 2001), and *g(0)*, the probability of detecting a group on the trackline. Aerial data were collected using the Hiby circle-back line transect method (Hiby 1999) and analyzed accounting for *g(0)* and biases due to school size and other potential covariates (Palka 2005). The value of *g(0)* used for this estimation was derived from the pooled data of the 2002, 2004 and 2006 aerial surveys.

An abundance estimate of 207 (CV=0.62) sei whales was obtained from an aerial survey conducted in August 2006 which covered 10,676 km of trackline in the region from the 2000-m depth contour on the southern edge of Georges Bank to the upper Bay of Fundy and to the entrance of the Gulf of St. Lawrence (Table 1; Palka pers. comm.). The value of *g(0)* used for this estimation was derived from the pooled data of the 2002, 2004 and 2006 aerial surveys.

Table 1. Summary of recent abundance estimates for Nova Scotia sei whales. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Aug 2002	S. Gulf of Maine to Maine	71	1.01
Jun-Jul 2004	Gulf of Maine to lower Bay of Fundy	386	0.85
Aug 2006	S. Gulf of Maine to upper Bay of Fundy to Gulf of St. Lawrence	207	0.62

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 the Nova Scotia stock sei whales is 386 (CV=0.85). The

minimum population estimate is 208.

Current Population Trend

~~There are insufficient data to determine~~A population ~~trends~~ trend analysis has not been done for this species.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

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 208. The maximum productivity rate is 0.04, the default value for cetaceans. 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 the sei whale is listed as endangered under the Endangered Species Act (ESA). PBR for the Nova Scotia stock of the sei whale is 0.4.

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

For the period ~~2003~~ 2004 through 2008~~7~~, the minimum annual rate of human-caused mortality and serious injury to sei whales was ~~0.8~~1.0. This value includes incidental fishery interaction records, 0.~~2~~6, and records of vessel collisions, 0.~~6~~ 4 (Glass *et al.* ~~2009~~2010). ~~(2010)~~ Detected mortalities should not be considered an unbiased representation of human-caused mortality. Detections are haphazard and not the result of a designed sampling scheme. As such they represent a minimum estimate of human-caused mortality which is almost certainly biased low.

Fishery-Related Serious Injury and Mortality

No confirmed fishery-related mortalities or serious injuries of sei whales have been reported in the NMFS Sea Sampling bycatch database. A review of the records of stranded, floating or injured sei whales for the period 2004~~3~~ through 2008~~7~~ on file at NMFS found 3~~one~~ records with substantial evidence of fishery interactions causing serious injury (Table 2), which results in an annual rate of serious injury and mortality of 0.6~~2~~ sei whales from fishery interactions. ~~The fishery entanglement serious injury was discovered on Jeffreys Ledge on 16 September 2006.~~

~~Table 2. Confirmed human-caused mortality and serious injury records of Nova Scotian sei whales, 2003 – 2007.~~

~~Date[a]~~	~~Report Type[b]~~	~~Age, Sex, Length~~	~~Location[a]~~	~~Assigned Cause: P=primary, S=secondary~~		~~Notes/Observations~~
				~~Ship strike~~	~~Entang./ Fsh inter~~	
~~02/19/03~~	~~mortality~~	~~age unknown Male 11.0m~~	~~Norfolk, VA~~	~~p~~		~~Large gash into muscle, hematoma and abrasions~~
~~04/17/06~~	~~mortality~~	~~Juvenile Male 10.9m~~	~~Baltimore, MD~~	~~p~~		~~Brought in on bow of ship, freshly dead; massive hemorrhaging on right side; large blood clot behind head; several broken ribs~~
~~09/16/06~~	~~serious injury~~	~~age & sex unknown~~	~~Jeffreys Ledge~~		~~p~~	~~Constricting wrap cutting into skin; no gear recovered~~
~~05/30/07~~	~~mortality~~	~~Adult Female~~	~~off Deer Island, MA~~	~~p~~		~~Broken left flipper, 8 vertebral processes, and 4 ribs; right flipper~~

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		~~14.4m~~				~~sheared off; lower jaw dislocated; hemorrhaging and/or edema associated with lower jaw and left flipper region~~

~~a. 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.~~

~~b. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS (Glass *et al.* 2009) have been used here. Some assignments may change as new information becomes available and/or when national standards are established.~~

Table 2. Confirmed human-caused mortality and serious injury records of Nova Scotian sei whales, 2004 - 2008.

Date[a]	Report Type[b]	Age, Sex, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entang./ Fsh inter	
04/17/06	mortality	Juvenile Male 10.9m	Baltimore, MD	P		Brought in on bow of ship, freshly dead; massive hemorrhaging on right side; large blood clot behind head; several broken ribs
09/16/06	serious injury	age & sex unknown	Jeffreys Ledge		P	Constricting wrap cutting into skin; no gear recovered
05/30/07	mortality	Adult Female 14.4m	off Deer Island, MA	P		Broken left flipper, 8 vertebral processes, and 4 ribs; right flipper sheared off; lower jaw dislocated; hemorrhaging and/or edema associated with lower jaw and left flipper region
04/09/08	serious injury	age & sex unknown	Great South Channel		P	Constricting wrap on fluke; skin sloughing; no gear recovered
06/29/08	mortality	age & sex unknown 15m (est)	Slacks Cove, New Brunswick		P	Extensive entanglement evident; no gear present

a. 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.

b. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS (Nelson *et al.* 2007) have been used here. Some assignments may change as new information becomes available and/or when national standards are established.

Other Mortality

For the period 2004 through 2008 files at NMFS included 2 records with substantial evidence of vessel collisions causing serious injury or mortality (Table 2). Previous NMFS records of human-caused sei whale mortalities include one from 17 November 1994, when a sei whale carcass was observed on the bow of a container ship as it docked in Boston, Massachusetts, and one from 2 May 2001 when the carcass of a 13 m female sei whale slid off the bow of a ship arriving in New York harbor.

STATUS OF STOCK

The status of this stock relative to OSP in the U.S. Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine population trends for sei whales. The total U.S. fishery-related mortality and serious injury for this stock derived from the available records is not less than 10% of the calculated PBR, and therefore cannot be considered insignificant and approaching the ZMRG. This is a strategic stock because the average annual human-related mortality and serious injury exceeds PBR, and because the sei whale is listed as an endangered species under the ESA. A Recovery Plan for sei whales has been written and is awaiting legal clearance.

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MINKE WHALE (*Balaenoptera acutorostrata acutorostrata*): Canadian East Coast Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Minke whales have a cosmopolitan distribution~~, being distributed in polar~~in~~,~~ temperate and tropical waters. In the North Atlantic, there are four recognized populations—Canadian East Coast, west Greenland, central North Atlantic, and northeastern North Atlantic (Donovan 1991). These divisions were defined by examining segregation by sex and length, catch distributions, sightings, marking data and pre-existing ICES boundaries. However, there were very few data from the Canadian East Coast population.

Minke whales off the eastern coast of the United States are considered to be part of the Canadian East Coast stock, which inhabits the area from the western half of the Davis Strait (45ºW) to the Gulf of Mexico. The relationship between this stock and the other three stocks is uncertain. It is also uncertain if there are separate sub-stocks within the Canadian East Coast stock.

The minke whale is common and widely distributed within the U.S. Atlantic Exclusive Economic Zone (EEZ) (CETAP 1982). There appears to be a strong seasonal component to minke whale distribution. Spring and summer are times of relatively widespread and common occurrence, and when the whales are most abundant in New England waters. In New England waters during fall there are fewer minke whales, while during winter the species appears to be largely absent. Like most other baleen whales, minke whales generally occupy the continental shelf proper, rather than the continental shelf edge region. Records summarized by Mitchell (1991) hint at a possible winter distribution in the West Indies, and in the mid-ocean south and east of Bermuda. As with several other cetacean species, the possibility of a deep-ocean component to the distribution of minke whales exists but remains unconfirmed.

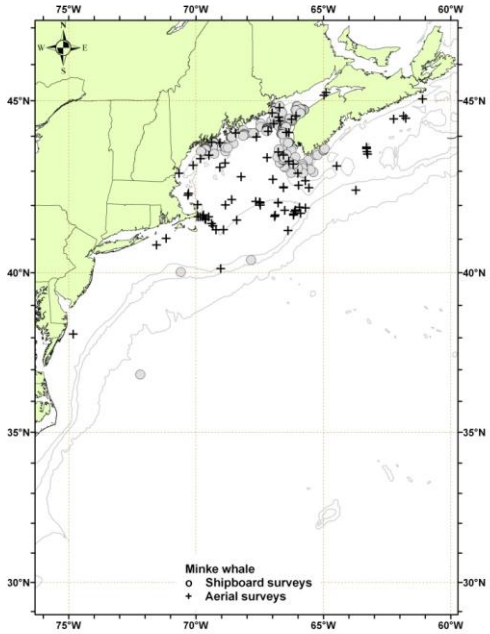

Figure 1. *Distribution of minke whale sightings from NEFSC and SEFSC shipboard and aerial surveys during the summers of 1998, 1999, 2002, 2004, 2006 and 2007. Isobaths are the 100-m, 1000-m and 4000-m depth contours.*

POPULATION SIZE

The total number of minke whales in the Canadian East Coast population is unknown. However, eleven estimates are available for portions of the habitat (see Appendix IV for details on these surveys and estimates). ~~The best available current abundance estimate for minke whales, 3,312 (CV=0.74), is obtained from the 2006 aerial survey because this survey is recent and covered the largest portion of the animal's habitat.~~ The best recent abundance estimate for this stock is 8,987 (CV=0.32) (Table 2), which is the sum of the August 2006 U.S. survey (3,312 CV=0.74) and the Jul-Aug 2007 Canadian survey (5,675 CV=0.25).

Earlier estimates

For earlier abundance estimates please see Appendix IV.

Recent surveys and abundance estimates

An abundance estimate of 756 (CV=0.90) minke whales was derived from an aerial survey conducted in August 2002 which covered 7,465 km of trackline over waters from the ~~1000~~ 1000-m depth contour on the southern edge of Georges Bank to Maine (Table 1). The value of *g(0)* used for this estimation was derived from the pooled data of the 2002, 2004 and 2006 aerial surveys.

An abundance estimate of 600 (CV=0.61) minke whales was obtained from a line-transect sighting survey conducted during 12 June to 4 August 2004 by a ship and plane that surveyed 6,180 km of trackline from the ~~100~~ 100-m depth contour on ~~the~~ southern Georges Bank to the lower Bay of Fundy. The Scotian shelf south of Nova Scotia was not surveyed (Table 1; Palka 2006). Shipboard data were collected using the ~~two~~ two ~~independent~~ independent-team ~~line~~ line-transect method and analyzed using the modified ~~direct~~ direct-duplicate method (Palka 1995) accounting for biases due to school size and other potential covariates, reactive movements (Palka and Hammond 2001), and *g(0)*, the probability of detecting a group on the track line. Aerial data were collected using the Hiby circle-back line transect method (Hiby 1999) and analyzed accounting for *g(0)* and biases due to school size and other potential covariates (Palka 2005). The value of *g(0)* used for this estimation was derived from the pooled data of the 2002, 2004 and 2006 aerial surveys.

An abundance estimate of 3,312 (CV=0.74) minke whales was generated from an aerial survey conducted in August 2006 which surveyed 10,676 km of trackline in the region from the ~~2000~~ 2000-m depth contour on the southern edge of Georges Bank to the upper Bay of Fundy and to the entrance of the Gulf of St. Lawrence. (Table 1; Palka pers. comm.). The value of *g(0)* used for this estimation was derived from the pooled data of the 2002, 2004 and 2006 aerial surveys.

An abundance estimate of ~~3,242~~ 5,675 (95%CI=2,~~051~~214-~~4,845~~6,745) minke whales was generated ~~form~~ from the Canadian ~~Trans~~ Trans-North Atlantic Sighting Survey (TNASS) in July-August 2007. This survey covered ~~area~~ from northern Labrador to the Scotian Shelf, providing full coverage of the Atlantic Canadian coast. Estimates from this survey have not yet been corrected for availability and perception biases (Lawson and Gosselin 2009)~~(Lawson and Gosselin 2008)~~.

Table 1. Summary of abundance estimates for the Canadian east coast stock of minke whales. Month, year, and area covered during each abundance survey, and resulting abundance estimate (N_{best}) and coefficient of variation (CV).

Month/Year	Area	N_{best}	CV
Aug 2002	S. Gulf of Maine to Maine	756	0.90
Jun-Jul 2004	Gulf of Maine to lower Bay of Fundy	600	0.61
Aug 2006	S. Gulf of Maine to upper Bay of Fundy to Gulf of St. Lawrence	3,312	0.74
Jul-Aug 2007	N. Labrador to Scotian Shelf	~~3,242~~5,675	0.21-0.27
Aug 2006 + Jul-Aug 2007	S. Gulf of Maine to N. Labrador (COMBINED)	8,987	0.32

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 minke whales is 8,987~~3,312~~ animals (CV=0.~~74~~32). The minimum population estimate for the Canadian East Coast minke whale is 6,909~~1,899~~ animals.

Current Population Trend

~~There are insufficient data to determine population trends for this species.~~A population trend analysis for this species has not been conducted.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. Life history parameters that could be used to estimate net productivity are that females mature between 6~~-~~ and 8 years of age, and pregnancy rates are approximately 0.86 to 0.93. Based on these parameters, the calving interval is between 1 and 2 years. Calves are probably born during October to March after 10 to 11 months gestation and nursing lasts for less than 6 months. Maximum ages are not known, but for Southern Hemisphere minke whales maximum age appears to be about 50 years (IWC 1991; Katona *et al.* 1993).

For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

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 6,909~~1,899~~. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for endangered, depleted, or threatened stocks, or stocks of unknown status, relative to optimum sustainable population (OSP) is assumed to be 0.5 because this stock is of unknown status. PBR for the Canadian east coast minke whale is ~~19~~69.

ANNUAL HUMAN-CAUSED MORTALITY AND INJURY

~~Recent minke whale takes have been observed in – or have been attributed to – the Northeast bottom trawl, Northeast/Mid-Atlantic lobster trap/pot, and unknown fisheries, although not all takes have resulted in mortalities (Tables 2 to 56).~~

~~Data to estimate the mortality and serious injury of minke whales come from the Northeast Fisheries Science Center Observer Program and from records of strandings and entanglements in U.S. waters. For the purposes of this report, only those strandings and entanglement records considered confirmed human-caused mortalities or serious injuries are shown in Tables 3-4 through 5.~~

During 2004~~3~~ to 2008~~7~~, the ~~U.S.~~ total annual minimum detected~~estimated~~ average human-caused mortality and serious injury was ~~3~~2~~.4~~ 2.8 minke whales per year (CV=unknown). This is derived from three components: ~~0.~~62 ~~minke whales per year from U.S. fisheries using observer data,~~ 1.~~0~~2~~8~~ minke whales per year (unknown CV) from U.S. fisheries using strandings and entanglement data, 1.~~4~~2 minke whales per year (unknown CV) from Canadian fisheries using strandings and entanglement data, and 0.4 minke whales per year from U.S. ship strikes (Glass 2010) ~~(Glass *et al.* 2009)~~.

Data to estimate the mortality and serious injury of minke whales come from the Northeast Fisheries Science Center Observer Program and from records of strandings and entanglements in U.S. waters. For the purposes of this report, only those strandings and entanglement records considered confirmed human-caused mortalities or serious injuries are shown in Table 2.

Detected mortalities in the strandings and entanglement data should not be considered an unbiased representation of human-caused mortality. Detections are haphazard and not the result of a designed sampling scheme. As such they represent a minimum estimate~~ of human-caused mortality~~ which is almost certainly biased low.

Fishery Information

Detailed fishery information is reported in Appendix III.

Earlier Interactions

Little information is available about fishery interactions that took place before the 1990s. Read (1994) reported that a minke whale was found dead in a Rhode Island fish trap in 1976. A minke whale was caught and released alive in the Japanese tuna longline fishery in 3,000 m of water, south of Lydonia Canyon on Georges Bank, in September 1986 (Waring *et al.* 1990).

Two minke whales were observed taken in the Northeast sink gillnet fishery~~ between 1989 and the present~~. The take in July 1991, south of Penobscot Bay, Maine was a mortality, and the take in October 1992, off the coast of New Hampshire near Jeffreys Ledge, was released alive.

A minke whale was trapped and released alive from a herring weir off northern Maine in 1990.

Four minke whale mortalities were observed in the Atlantic pelagic drift gillnet fishery during 1995; the fishery

closed in 1998.~~.~~

One minke whale was reported caught in an Atlantic tuna purse seine off Stellwagen Bank in 1991 (D. Beach, NMFS NE Regional Office, pers. comm.) and another in 1996. The minke caught during 1991 was released uninjured after a crew member cut the rope wrapped around the tail. The minke whale caught during 1996 escaped by diving beneath the net.

One minke whale, reported in the strandings and entanglement database~~ maintained by the New England Aquarium and the Northeast Regional Office/NMFS~~, was taken in a 6-inch gill net on 24 June 1998 off Long Island, New York. This take was assigned to the mid-Atlantic gillnet fishery. No minke whales have been taken in this fishery during observed trips in 1993 to 2008~~7~~.

The strandings and entanglement database reported 7 minke whale mortalities and serious injuries that were attributed to the Northeast/Mid-Atlantic Lobster Trap/Pot ~~F~~fishery during 1990 to 1994; 1 in 1990 (may be serious injury), 2 in 1991 (1 mortality and 1 serious injury), 2 in 1992 (both mortalities), 1 in 1993 (serious injury) and 1 in 1994 (mortality) (1997 List of Fisheries 62FR33, 2 January 1997). The one confirmed minke whale mortality during 1995 was attributed to the lobster fishery. No confirmed mortalities or serious injuries of minke whales occurred in 1996. From the four confirmed 1997 records, one minke whale mortality was attributed to the lobster trap fishery. In 2002, one minke whale mortality and one live release were attributed to this fishery. The 28 June 2003 mortality, while wrapped in lobster gear, cannot be confirmed to have become entangled in the area, and so is not attributed to the fishery. Annual mortalities due to the Northeast/Mid-Atlantic Lobster Trap/Pot fishery, as determined from strandings and entanglement records that have been audited, were 1 in 1991, 2 in 1992, 1 in 1994, 1 in 1995, 0 in 1996, 1 in 1997, 0 in 1998 to 2001, 1 in 2002, and 0 in 2003 through 2008.

U.S.

Northeast Bottom Trawl

The fishery is active in New England waters in all seasons. Detailed fishery information is reported in Appendix III. One freshly dead minke whale was caught in 2004 on the northeast tip of Georges Bank in US waters (Table~~s~~ 2 ~~and 45)~~). Two ~~fresh~~ dead minkes were reported by observers in 2008 but due to scavenging evidence and emaciation not consistent with the length of the tows, these deaths were not attributed to the fishery. During 2004 to 2008, as determined from fishery observer as well as strandings and entanglement records, the minimum detected average annual mortality and serious injury is 0.2 minke whales per year in this fishery (Table 2).

~~An expanded bycatch estimate has not been generated because with only one observed take, it is not possible to generate an accurate bycatch estimate~~~~is being developed for this bycatch~~. ~~Therefore, this catch is reported as 1, with a resulting 5-year mean annual mortality of 0.2.~~

~~**Northeast/Mid-Atlantic Lobster Trap/Pot Fishery**~~

~~The strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, reported 7 minke whale mortalities and serious injuries that were attributed to the lobster fishery during 1990 to 1994; 1 in 1990 (may be serious injury), 2 in 1991 (1 mortality and 1 serious injury), 2 in 1992 (both mortalities), 1 in 1993 (serious injury) and 1 in 1994 (mortality) (1997 List of Fisheries 62FR33, 2 January 1997). The one confirmed minke whale mortality during 1995 was attributed to the lobster fishery. No confirmed mortalities or serious injuries of minke whales occurred in 1996. From the four confirmed 1997 records, one minke whale mortality was attributed to the lobster trap fishery. In 2002, one minke whale mortality and one live release were attributed to this fishery. The 28 June 2003 mortality, while wrapped in lobster gear, cannot be confirmed to have become entangled in the area, and so is not attributed to the fishery (Table 5). Annual mortalities due to this fishery, as determined from strandings and entanglement records that have been audited, were 1 in 1991, 2 in 1992, 1 in 1994, 1 in 1995, 0 in 1996, 1 in 1997, 0 in 1998 to 2001, 1 in 2002, and 0 in 2003 through 2007~~2008~~. ~~Estimated average annual mortality related to this fishery during 2003~~ 2004 ~~to 2007~~ 2008 ~~was 0 minke whales per year).~~

Unknown Fisheries

The strandings and entanglement database, maintained by the New England Aquarium and the Northeast Regional Office/NMFS, include 36 records of minke whales within U.S. waters for 1975-1992. The gear include unspecified fishing nets, unspecified cables or lines, fish traps, weirs, seines, gillnets, and lobster gear. One confirmed entanglement was an immature female minke whale, entangled with line around the tail stock, which

came ashore on the Jacksonville, Florida jetty on 31 January 1990 (R. Bonde, USFWS, Gainesville, FL, pers. comm.).

The audited NE Regional Office/NMFS entanglement/stranding database contains records of minke whales, of which the confirmed mortalities and serious injuries from the last five years are reported in Table ~~4~~2~~5~~. Mortalities (and serious injuries) that were likely a result of a U.S. fishery interaction with an unknown fishery include 3 (0) in 1997, 3 (0) in 1999, 1 (1) in 2000, 2 (0) in 2001, 1 (0) in 2002, 5 (0) in 2003, 2 (0) in 2004, 0 (0) in 2005, 0 (0) in 2006,~~ and ~~-1 (1) in 2007, and 1 (0) in 2008 (Table~~s 3 and 4~~ 2). ~~Examination of minke entanglement records from 1997 indicates that 4 out of 4 confirmed records of mortality were likely a result of fishery interactions. One was attributed to the lobster pot fishery (see above), and three were not attributed to any particular fishery because the information from the entanglement event did not contain the necessary details. Of the five mortalities in 1999, two were attributed to an unknown trawl fishery and three to some other fishery. Of the two interactions with an unknown fishery in 2000, one was a mortality and one was a serious injury. In 2001, the two confirmed fishery interactions were both from an unknown fishery. In 2002, there was one mortality in an unknown fishery. In 2003, 5 of 5 confirmed mortalities were due to interactions with an unknown fishery (Tables 3 and 5). In 2004, of the four confirmed mortalities, two were due to an interaction with an unknown fishery. In 2005 and 2006 there were no mortalities attributed to fishery interactions. In 2007 there was one mortality and one serious injury, both attributed to unknown fisheries.~~

~~In general, an entangled or stranded cetacean could be an animal that is part of an expanded bycatch estimate from an observed fishery and thus it is not possible to know if an entangled or stranded animal is an additional mortality. During 1997 through 2008~~7~~, no minke whale bycatch estimates were generated from observed takes in any fishery observed by the NEFSC Observer Program, therefore, the strandings from those years in which mortalities were attributable to fishery interactions can be added into the human-caused mortality estimate.~~ During 2004~~3~~ to 2008~~7~~, as determined from strandings and entanglement records, the minimum detected~~estimated~~ average annual mortality and serious injury is 1.0~~8~~ minke whales per year in unknown fisheries (Table ~~3~~2).

CANADA

Read (1994) reported interactions between minke whales and gillnets in Newfoundland and Labrador, in cod traps in Newfoundland, and in herring weirs in the Bay of Fundy. Hooker *et al*. (1997) summarized bycatch data from a Canadian fisheries observer program that placed observers on all foreign fishing vessels operating in Canadian waters, on between 25% and 40% of large Canadian fishing vessels (greater than 100 feet long), and on approximately 5% of smaller Canadian fishing vessels. During 1991 through 1996, no minke whales were observed taken.

Herring Weirs

During 1980 to 1990, 15 of 17 minke whales were released alive from herring weirs in the Bay of Fundy. During January 1991 to September 2002, 26 minke whales were trapped in herring weirs in the Bay of Fundy. Of these 26, 1 died (H. Koopman, pers. comm.) and several (number unknown) were released alive and unharmed (A. Westgate, pers. comm.).

Other Fisheries

Six minke whales were reported entangled during 1989 in the ~~now non-operational~~ groundfish gillnet fishery in Newfoundland and Labrador (Read 1994). One of these animals escaped and was still towing gear, the remaining five animals died.

Salmon gillnets in Canada, now no longer used, had taken a few minke whales. In Newfoundland in 1979, one minke whale died in a salmon net. In Newfoundland and Labrador, between 1979 and 1990, it was estimated that 15% of the Canadian minke whale takes were in salmon gillnets. A total of 124 minke whale interactions were documented in cod traps, groundfish gillnets, salmon gillnets, other gillnets, and other traps. The salmon gillnet fishery ended in 1993 as a result of an agreement between the fishermen and North Atlantic Salmon Fund (Read 1994).

Five minke whales were entrapped and died in Newfoundland cod traps during 1989. The cod trap fishery closed in Newfoundland in 1993 due to the depleted groundfish resources (Read 1994).

In 2004, two minke whales were reported dead in entangled fishing gear off of Newfoundland and Labrador, one in a blackback flounder net, and one in crab gear (Ledwell and Huntington 2004). ~~(Tables 3 and 4).~~ Only the flounder net animal had enough information to include it as a human-caused mortality. In 2005, four minke whales were reported entangled in fishing gear in Newfoundland and Labrador. Two (entangled in salmon net and mackerel trap gear) were released alive and two (involved with whelk pot and toad crab pot fisheries~~ (Tables 3 and 4)~~) were

dead (Ledwell and Huntington 2006). The whelk pot mortality could not be conclusively attributed to human causes. In 2006, one minke whale was reported dead in a mackerel trap off of Newfoundland (Ledwell and Huntington 2007) (Tables 3 and 4). In 2007, f~~F~~our minke whales in Newfoundlandland and Labrador were reported entangled, but released alive (Ledwell and Huntington 2008)~~in 2007 in Newfoundlandland and Labrador, where a. All were released alive (Ledwell and Huntington 2007)~~. In 2008, four minkes were reported entangled in Newfoundland and Labrador. Two of these were dead (Tables 3 and 4) and two were released alive, though one of the live releases was listed as 'condition uncertain" (Ledwell and Huntington 2009). In 2008, one minke was reported dead in an unknown fishery off of New Brunswick (Tables 3 and 4). Mortalities (and serious injuries) that were likely a result of a Canadian fishery interaction with an unknown fishery include 1(0) in 2004, 1(0) in 2005, 1(0) in 2006, 0(0) in 2007, and 3(0) in 2008. During 2004 to 2008, as determined from Canadian strandings and entanglement records, the minimum detected~~estimated~~ average annual mortality ~~i~~was 1.~~4~~2 minke whales per year in fisheries (Table ~~3~~2).

~~Table 2. Summary of the incidental mortality of minke whales (*Balaenoptera acutorostrata*) by U.S. commercial fishery including the years sampled (Years), the number of vessels active within the fishery (Vessels), the type of data used (Data Type), the annual observer coverage (Observer Coverage), the mortalities recorded by on-board observers (Observed Mortality), the estimated annual mortality (Estimated Mortality), the estimated CV of the annual mortality (Estimated CVs) and the mean annual mortality (CV in parentheses).~~

~~Fishery~~	~~Years~~	~~Vessels~~	~~Data Type [a]~~	~~Observer Coverage[b]~~	~~Observed Mortality~~	~~Estimated Mortality~~	~~Estimated CVs~~	~~Mean Annual Mortality~~
~~Northeast Bottom Trawl~~	~~0304~~ ~~0708~~	~~unk~~	~~Obs. Data~~	~~.03, .04, .05, .06, .06, 0.08~~	~~0, 1, 0, 0, 0, 2~~	~~1[c]~~3[c]	~~unk[c]~~	~~0.2[c]~~6[c]
~~Total~~								~~0.2[c]~~6[c]

Table 3. From strandings and entanglement data, summary of confirmed incidental mortalities and serious injuries of minke whales (*Balaenoptera acutorostrata*) by commercial fishery: includes years sampled (Years), number of vessels active within the fishery (Vessels), type of data used (Data Type), mortalities and serious injuries assigned to this fishery (Assigned Mortality), and mean annual mortality and serious injuries. See Table 45 for details. (NA=Not Available)					
Fishery	Years	Vessels	Data Type [a]	Assigned Mortality	Mean Annual Mortality
U.S. unknown Fisheries	043-087	NA	Entanglement & Strandings [a]	5, 2, 0, 0, 2, 1	1.08
Canadian fisheries	04-08	NA	Entanglement & Strandings [b]	2, 1, 1, 0, 3	1.4
TOTAL					21.48 (CV=unk)
a. Data from records in the entanglement and strandings data base maintained by the New England Aquarium and the Northeast Regional Office/NMFS (Entanglement and Strandings). B. Data from records in the entanglement and strandings data base maintained by …					

Table 4. Summary of minke whales (*Balaenoptera acutorostrata*) released alive, by commercial fishery, years sampled (Years), ratio of observed mortalities recorded by on-board observers to the estimated mortality (Ratio), the number of observed animals released alive and injured (Injured), and the number of observed animals released alive and uninjured (Uninjured). (NA = Not Available)				
Fishery	Years	Ratio	Injured	Uninjured
Pelagic longline	03-07	0	0	1[a]
Minke whale released alive from pelagic longline gear in 2003.				

Table 425. Confirmed U.S. and Canadian human-caused mortality and serious injury records of Canadian East Coast stock of minke whales, January 20043 through December 20087.

Date[a]	Report Type[b]	Age, Sex, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entang. / Fsh. Inter.	
05/24/03	mortality	Adult Male 7.6m	Gloucester, MA		p	Unknown fishery; line marks on head and dorsal fin; no line present; cut across back anterior to dorsal fin; no gear recovered

~~05/31/03~~	~~mortality~~	~~Juvenile Female 3.6m (est)~~	~~Martha's Vineyard, MA~~		~~P~~	~~Unknown fishery; whale stranded live wrapped in about 15 feet of 5.5 inch mesh netting, probably trawl gear~~
~~06/28/03~~	~~mortality~~	~~Yearling Male 5.1m~~	~~Chatham, MA~~		~~P~~	~~Unknown fishery; wrapped in lobster gear; gear not recovered~~
~~08/09/03~~	~~mortality~~	~~Juvenile Female, 3.5m (est)~~	~~Harwich, MA~~		~~P~~	~~Unknown fishery; hemorrhaging in areas with net marks on whale; no gear recovered~~
~~09/13/03~~	~~mortality~~	~~Juvenile Female 6m (est)~~	~~Casco Bay, ME~~		~~P~~	~~Unknown fishery; freshly dead; external chaffing marks and belly slit open; no gear recovered~~
05/06/04	mortality	Adult Female 7.7m	Martha's Vineyard, MA		P	Unknown fishery; constricting line marks on peduncle; indications of drowning from internal exam; no gear present
06/01/04	mortality	Juvenile Female 6.5m	Chatham, MA	P		Large area of subdermal hemorrhaging
07/19/04	mortality	Adult Female 7.9m	Eastham, MA		P	Unknown fishery; extensive entanglement markings; no gear recovered
08/04	mortality	age & sex unknown 4m (est)	Georges Bank, USA		P	Northeast Bottom Trawl; fresh dead, rigid, had to cut out of net, rope in mouth; from fisheries observer records
08/09/04[c]	mortality	age & sex unknown	Cape Broyle Head, Newfoundland		P	Blackback flounder net; partial disentanglement; fishermen witnessed death of animal in remaining gear
~~09/07/04[c]~~	~~mortality~~	~~age & sex unknown~~	~~off Square Islands, Labrador~~		~~P~~	~~Crab gear; constricting gear through mouth and around~~
05/23/05	mortality	Juvenile Male 5.9m	Port Elizabeth, NJ	P		Ribs shattered; liver ruptured; evidence of internal hemorrhaging
08/24/05[c]	mortality	age & sex unknown	Bridgeport, New World Island, Newfoundland		P	Toad crab pots; constricting gear through mouth with flipper and tail wraps

09/22/06[c]	mortality	age & sex unknown	Woods Cove, Northern Peninsula, Newfoundland		P	Mackerel trap; anchored by tail in doorways of the gear
07/16/07	serious injury	age & sex unknown 10m (est)	Trescott, ME		P	Unknown fishery; wrapped in gear and anchored; no gear recovered
08/05/07	mortality	Juvenile Female 4.3m	Cape Cod Bay, MA		P	Unknown fishery; chronic entanglement with severe emaciation and dehydration and loss of protein; line lacerated blubber layer across back and at flipper insertions; severe hemorrhage and necrosis of blubber at gear entanglement points; gear consists of 11/164" diameter floating rope
06/14/08	mortality	Juvenile Female 4.7m	Orleans, MA		P	Unknown fishery; braided line impressions wrapped the body in 3 places and left a deep, hemorrhaged laceration across the rostrum and blowholes; hemorrhaged abrasions present on roof of mouth; wet, blood-filled lungs indicate drowning; no gear present
07/23/08	mortality	age & sex unknown 7m (est)	Kelligrews, Newfoundland		P	Unknown fishery; constricting wraps of gear on caudal peduncle; 5/8" polypropylene rope
07/26/08	mortality	age & sex unknown	Conception Bay, Newfoundland		P	Blackback flounder net; constricting wraps of gear through mouth and around tail
08/25/08	mortality	age & gender unknown 8m (est)	off Richibucto Cape, New Brunswick		P	Unknown fishery; evidence of constricting body wraps; gear not recovered

			ship strike	entanglement	
5-year totals	**~~serious injury~~US waters**	**serious injury ~~US waters~~**	**0**	**1**	
		mortality ~~Canadian waters~~	**2**	**5**	
	~~mortality~~Canadian	**serious injury ~~US waters~~**	**0**	**0**	

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	waters	**mortality** ~~**Canadian waters**~~	**0**	**6**	

a. 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.
b. National guidelines for determining what constitutes a serious injury have not been finalized. Interim criteria as established by NERO/NMFS (Glass *et al.* 2009; Glass 2010)~~(Glass *et al.* 2009)~~ have been used here. Some assignments may change as new information becomes available and/or when national standards are established.
c. Additional record which was not included in previous reports.

Other Mortality

Minke whales have been and continue to be hunted in the North Atlantic. From the Canadian East Coast population, documented whaling occurred from 1948 to 1972 with a total kill of 1,103 animals (IWC 1992). Animals from other North Atlantic minke populations are presently still being harvested~~ at low levels~~.

U.S.

Minke whales inhabit coastal waters during much of the year and are thus subject to collision with vessels. According to the NMFS/NER marine mammal entanglement and stranding database, on 7 July 1974, a necropsy of a minke whale suggested a vessel collision; on 15 March 1992, a juvenile female minke whale with propeller scars was found floating east of the St. Johns Channel entrance (R. Bonde, USFWS, Gainesville, FL, pers. comm.); and on 15 July 1996 the captain of a vessel reported hitting a minke whale offshore of Massachusetts. After reviewing this record, it was concluded the animal struck was not a serious injury or mortality. On 12 December 1998, a minke whale was struck and presumed killed by a whale watching vessel in Cape Cod Bay off Massachusetts.

During 1999 to 2003, no minke whale was confirmed struck by a ship. During 2004 and 2005, one minke whale mortality was attributed to ship strike in each year (Table ~~4~~2~~5~~). During 2006 to~~and~~ 2008~~7~~, no minke whale was confirmed struck by a ship. Thus, during 2004~~3~~ to 2008~~7~~, as determined from stranding and entanglement records, the minimum detected~~estimated~~ annual average was 0.4 minke whales per year struck by ships.

In October 2003, an Unusual Mortality Event was declared involving minke whales and harbor seals along the coast of Maine;~~.~~ ~~sTwo of the seven criteria established to designate such an event were met by these species. Specifically, there was a marked increase in mortalities when compared with historical records, and the mortalities were occurring in a localized area of the Maine coast. From 11-30 September 2003, nine minke whales were reported along the mid-coast to southern Maine. Results from analyses for biotoxins failed to show the presence of either saxitoxin or domoic acid (by ELISA and Receptor Binding Assay). Most whale carcasses that were examined appeared to be in good body condition immediately prior to death. S~~since then~~October 2003~~, the number of minke whale stranding reports has returned to normal. There were two minke whale stranding mortalities in NC in 2005 but in neither case could cause of death be attributed to human causes (Glass *et al.* 2008). There were 7 minke whale stranding mortalities reported along the US Atlantic coast in 2006. Three were in New Jersey, one in Massachusetts, one in Rhode Island, and two in the EEZ. One of the stranding mortalities from New Jersey was reported with signs of human interaction due to pieces of plastic found in the stomach.

CANADA

The Nova Scotia Stranding Network documented whales and dolphins stranded on the coast of Nova Scotia between 1991 and 1996 (Hooker *et al.* 1997). Researchers with the Dep~~t~~artment of Fisheries and Oceans, Canada documented strandings on the beaches of Sable Island (Lucas and Hooker 2000). Sable Island is approximately 170 km southeast of mainland Nova Scotia. Lucas and Hooker (2000) reported 4 minke whales stranded on Sable Island between 1970 and 1998, 1 in spring 1982, 1 in January 1992, and a mother/calf in December 1998. On the mainland of Nova Scotia, a total of 7 reported minke whales stranded during 1991 to 1996. The 1996 stranded minke whale was released alive off Cape Breton on the Atlantic Ocean side, the rest were found dead. All the minke whales stranded between July and October. One was from the Atlantic Ocean side of Cape Breton, 1 from Minas Basin, 1 was at an unknown location, and the rest stranded in the vicinity of Halifax, Nova Scotia. It is unknown how many of the strandings resulted from fishery interactions.

Whales and dolphins stranded between 1997 and 2008 on the coast of Nova Scotia as recorded by the Marine Animal Response Society (MARS) and the Nova Scotia Stranding Network are as follows: 4 minke whales stranded

in 1997, 0 documented strandings in 1998 to 2000, 1 in September 2001, 4 in 2002, 2 in 2003, 0 in 2004, 3 in 2005, 8 in 2006, 1 in 2007, and ~~3~~ 4 (~~not~~ including the entangled animal listed in ~~table~~ Table 2) in 2008.

The Whale Release and Strandings program has reported ten minke whale stranding mortalities in Newfoundland and Labrador between 2004 and 2008, ~~seven~~ five of which are included in Table 2 (Ledwell and Huntington 2004; 2006; 2007; 2008; 2009).

STATUS OF STOCK

The status of minke whales, relative to OSP, in the U.S. Atlantic EEZ is unknown. The minke whale is not listed as endangered under the Endangered Species Act (ESA). The total U.S. fishery-related mortality and serious injury for this stock is ~~not~~ less than 10% of the calculated PBR and, therefore, can~~not~~ be considered to be insignificant and approaching zero mortality and serious injury rate. This is not a strategic stock because estimated human-related mortality and serious injury does not exceed PBR and the minke whale is not listed as a threatened or endangered species under the ESA.

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BLUE WHALE (*Balaenoptera musculus musculus*): Western North Atlantic Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

The distribution of the blue whale, *Balaenoptera musculus musculus*, in the western North Atlantic generally extends from the Arctic to at least mid-latitude waters. Blue whales are most frequently sighted in the waters off eastern Canada, with the majority of recent records from the Gulf of St. Lawrence (Sears *et al.* 1987). The species was hunted around Newfoundland in the first half of the 20th century (Sergeant 1966). The present Canadian distribution, broadly described, is spring, summer, and fall in the Gulf of St. Lawrence, especially along the north shore from the St. Lawrence River estuary to the Strait of Belle Isle and off eastern Nova Scotia. The species occurs in winter off southern Newfoundland and also in summer in Davis Strait (Mansfield 1985). Individual identification has confirmed the movement of a blue whale between the Gulf of St. Lawrence and western Greenland (Sears and Larsen 2002), although the extent of exchange between these two areas remains unknown. Similarly, a blue whale photographed by a NMFS large whale survey in August 1999 had previously been observed in the Gulf of St. Lawrence in 1985 (R. Sears and P. Clapham, unpublished data) and there have been additional photographic resightings between the Gulf of Maine, Scotian Shelf and Gulf of St. Lawrence (R. Sears, pers. comm.).

The blue whale is best considered as an occasional visitor in US Atlantic Exclusive Economic Zone (EEZ) waters, which may represent the current southern limit of its feeding range (CETAP 1982; Wenzel *et al.* 1988). All of the five sightings described in the foregoing two references were in August. Yochem and Leatherwood (1985) summarized records that suggested an occurrence of this species south to Florida and the Gulf of Mexico, although the actual southern limit of the species' range is unknown.

Using the U.S. Navy's SOSUS program, blue whales have been detected and tracked acoustically in much of the North Atlantic, including in subtropical waters north of the West Indies and in deep water east of the US Atlantic EEZ, indicating the potential for long~~-~~ distance movements (Clark 1995). Most of the acoustic detections were around the Grand Banks area of Newfoundland and west of the British Isles. Historical blue whale observations collected by Reeves *et al*. ~~(~~(2004)~~)~~ ~~collection of historical blue whales observations~~ show a broad longitudinal distribution in tropical and warm temperate latitudes during the winter months~~-~~, with a narrower, more northerly distribution in summer. Sigurjónsson and Gunnlaugsson (1990) note that North Atlantic blue whales appear to have been depleted by commercial whaling to such an extent that they remain rare in some formerly important habitats, notably in the northern and northeastern North Atlantic.

Photo-identification in eastern Canadian waters indicates that blue whales from the St. Lawrence, Newfoundland, Nova Scotia, New England and Greenland all belong to the same stock, while blue whales photographed off Iceland and the Azores appear to be part of a separate population (CETAP 1982; Wenzel *et al.* 1988; Sears and Calambokidis 2002; Sears and Larsen 2002).

POPULATION SIZE

Little is known about the population size of blue whales except for ~~in~~ the Gulf of St. Lawrence area. From 1979 to the summer of 2009, a total of 440 blue whales was~~ere~~ photo-identified mainly in the St. Lawrence estuary and northwestern Gulf of St. Lawrence (R. Sears, pers. comm.). Biopsies were taken on nearly 40% of this population (R. Sears, pers. comm.). Each year, from 20 to 105 blue whales are identified in this region. Approximately 40% of the identified blue whales return frequently ~~return~~ to the study area, the others have been observed during fewer than three seasons between 1979 and 2002, which suggests that these individuals range mostly outside the St. Lawrence, possibly in the waters at the edge of the continental shelf, from the Labrador Sea and Davis Strait in the north, east to the Flemish Cap and south to New England (Sears and Calambokidis 2002). Photo-identification data from outside the estuary and Gulf of St. Lawrence are limited. A few blue whales have been photographed along the coast of Newfoundland, on the Scotian Shelf and in the Gulf of Maine, and some are not included among the 440 blue whales that have been identified in the estuary and northwest of the Gulf of St. Lawrence (Sears and Calambokidis, 2002; J. Lawson, pers. comm.). Ramp *et al.* (2006) estimated the survival rate at 0.975 and the gender ratio of the 139 biopsy sampled individuals at 79 males for 67 females (Sears 2003). Given the small proportion of the distribution range that has been sampled and considering the low number of blue whales encountered and photographed, the current data, based on photo-identification, do~~es~~ not allow for an estimate of abundance of this species in the Northwest Atlantic with a minimum degree of certainty ~~the abundance of this species in the Northwest Atlantic~~ (Sears *et al.* 1987; Hammond *et al.* 1990; Sears *et al.* 1990; Sears and Calambokidis 2002; Fisheries and Oceans Canada 2009). ~~()~~ Mitchell (1974) estimated that the blue whale population in the western North Atlantic may

number only in the low hundreds. R. Sears (pers. comm.) suggests that 400 to 600 individuals may be found in the western North Atlantic.~~.~~

Minimum Population Estimate

The catalogue count ~~440~~of 440 recognizable individuals from the Gulf of St. Lawrence ~~area which were catalogued by Sears *et al*. (1987; 1990; pers. comm.)~~ is considered to be a minimum population estimate for the western North Atlantic stock.

Current Population Trend

There are insufficient data to determine population trends for this species. Off western and southwestern Iceland, an increasing trend of 4.9% a year was reported for the period 1969-1988 (Sigurjonsson and Gunnlaugsson 1990). Pike *et al*. (2009) conducted ship surveys in the Central and Northeast Atlantic in 1987, 1989, 1995 and 2001. Blue whales were most commonly sighted off western Iceland, and to a lesser extent northeast of Iceland. They were very rare or absent in the Northeast Atlantic. Sightings were combined over all surveys to estimate the detection function using standard line-~~-~~transect methodology, with the addition of a covariate to account for differences between surveys. Total abundance was highest in 1995 (979, 95% CI 137-2,542) and lowest in 1987 (222, 95% CI 115-440). Uncertainty in species identity had little effect on estimates of abundance. There was a significant positive trend in abundance northeast of Iceland and in the total survey area. These estimates should be treated with caution given the effort biases underlying the sightings data on which it was based.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

Current and maximum net productivity rates are unknown for this stock. For purposes of this assessment, the maximum net productivity rate was assumed to be 0.04. This value is based on theoretical modeling showing that cetacean populations may not grow at rates much greater than 4% given the constraints of their reproductive life history (Barlow *et al.* 1995).

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 440. The maximum productivity rate is 0.04, the default value for cetaceans. The "recovery" factor, which accounts for stocks which are endangered, depleted, or threatened ~~stocks, or stocks of unknown status relative to optimum sustainable population (OSP)~~or of unknown status relative to optimum sustainable population (OSP), is assumed to be 0.10 because the blue whale is listed as endangered under the Endangered Species Act (ESA). PBR for the Western North Atlantic stock of blue whale is 0.9.~~However, the minimum population size figure given above is outdated and thus is not usable for the calculation of PBR (see Wade and Angliss 1997). Consequently, no PBR can be calculated for this stock because of lack of any data on current minimum population size.~~

ANNUAL HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Threats for North Atlantic blue whales are poorly ~~un~~known, but may include ship strikes, pollution, entanglement in fishing gear, and long-term changes in climate (which could affect the abundance of their zooplankton prey). During winter and early spring, ice-related strandings and entrapments have been documented on the southwestern and eastern coasts of Newfoundland (Sears and Calambokidis 2002). There are no recent confirmed records of mortality or serious injury to blue whales in the US Atlantic EEZ. However, in March 1998 a dead 20-~~-~~m (66-ft) male blue whale was brought into Rhode Island waters on the bow of a tanker. The cause of death was determined to be ship strike. Although it appears likely that the vessel concerned was responsible, the necropsy revealed some injuries that were difficult to explain in this context. The location of the strike was not determined; given the known rarity of blue whales in US Atlantic waters, and the vessel's port of origin (Antwerp), it seems reasonable to suppose that the whale died somewhere to the north or east of the US Atlantic EEZ.

Fishery Information

No fishery information is presented because there are no observed fishery-related mortalities or serious injury.

STATUS OF STOCK

The status of this stock relative to OSP in the US Atlantic EEZ is unknown, but the species is listed as endangered under the ESA. There are insufficient data to determine population trends for blue whales. The total level of human-caused mortality and serious injury is unknown, but it is believed to be insignificant and approaching a zero mortality and serious injury rate. This is a strategic stock because the blue whale is listed as an endangered

species under the ESA. A Recovery Plan has been published (Reeves *et al.* 1998) and is in effect.

Field Code Changed

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