Northeast Fisheries Science Center Reference Document 11-18

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TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

The Northeast Fisheries Science Center (NEFSC) has developed criteria to evaluate reports of human-caused injury and mortality to large whales. The criteria minimize the identification of false positive human-caused mortalities and serious injuries and provide a minimum value of human impact to whale stocks. Serious injury is defined as an injury that is likely to lead to death. This report describes determinations made for reports received from 2005 - 2009 involving North Atlantic right (*Eubalaena glacialis*), humpback (*Megaptera novaeangliae*), fin (*Balaenoptera physalus*), sei (*B. borealis*), blue (*B. musculus*), minke (*B. acutorostrata*), and Bryde's (*B. edeni*) whales observed along coastal Gulf of Mexico and the eastern seaboard of the United States and adjacent Canadian Maritimes. A total of 496 unique large whale events were verified during the period, of which 252 (51%) involved human interactions, 20 (4%) did not involve a human interaction, and for 224 (45%) of the events it was unknown if a human interaction occurred. Of the events involving human interactions, we confirmed 193 unique entanglements and 63 ship strikes. Four events had evidence of both entanglement and ship strike, and are included in the totals for both these event categories. Eighteen (9%) of the entanglements and 28 (44%) of the ship strikes were fatal. Serious injury was sustained in 22 (11%) of the entanglement events and in 2 (3%) of the confirmed ship strikes. Serious injury was prevented due to disentanglement efforts in 30 (16%) entanglement events. Forty-one (21%) of the entanglements and 11 (17%) of the ship strike events did not have adequate documentation to determine if serious injury occurred. Seventy-eight (40%) of the entanglement events and 18 (29%) of the ship strike events were determined to have not caused serious injury or death. We also confirmed a total of 308 mortalities: 46 (15%) due to human interaction, 16 (5%) due to natural causes and 246 (80%) which lacked sufficient evidence to determine cause of death. Minke whales had the greatest number of entanglement mortalities (n=7); humpback whales had the highest number of serious injury events resulting from entanglements (n=12); fin whales had the greatest number of ship strike mortalities (n=9); and right whales had the only serious injuries (n=2) from ship strikes. These mortality and serious injury numbers are minimum counts because of poor detection probabilities and inadequate documentation for the majority of events. Thus, the true level of human impact to these stocks is assumed to be greater than that reported here; the amount greater is unknown.

INTRODUCTION

As part of the 1994 amendments to the Marine Mammal Protection Act (MMPA), the NOAA National Marine Fisheries Service (NMFS) is mandated to establish monitoring programs to estimate incidental mortality and serious injury of marine mammals taken during commercial fishing operations. The agency is also charged with developing Take Reduction Plans (TRPs) that reduce commercial takes of strategic stocks of marine mammals to levels below their Potential Biological Removal (PBR) level within six months of implementation. The longer-term goal of all the TRPs is to reduce--within 5 years of implementation--commercial takes of marine mammals to insignificant levels approaching zero mortality, which has been defined as 10% of PBR (69 FR 43338; July 20, 2004).

The average rate of human-caused serious injury and mortality for the most recent five years of data is reported for each species in the annual marine mammal stock assessment report (SAR). This rate, when compared to a population's PBR, can be used as an index of the success of a recovery plan. The PBR is defined as the maximum number of animals-- not including natural mortalities--which may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population size (Wade and Angliss 1997).

This report presents the method and results of a process that calculates the rate of human-caused serious injury and mortality for North Atlantic right (*Eubalaena glacialis*), humpback (*Megaptera novaeangliae*), fin (*Balaenoptera physalus*), sei (*B. borealis*), blue (*B. musculus*), minke (*B. acutorostrata*), and Bryde's (*B. edeni*) whale stocks along the Gulf of Mexico and the US and Canadian eastern seaboards for the period 2005 - 2009.

METHODS

Members of both US and Canadian stranding networks, large whale disentanglement teams, the US and Canadian Coast Guard, and civilians provided marine mammal stranding and human interaction reports to either the NMFS Northeast Regional Office (NERO), Southeast Regional Office (SERO), or the Northeast Fisheries Science Center (NEFSC). The Regional Offices obtained all available information for each report (photos, necropsy reports, etc.), which was then reviewed by NEFSC and NERO staff members. Confirmed reports were designated "events," and the species involved was verified, duplicate records identified, and relevant information from each source consolidated into a single record. Information from additional sightings of a previously documented event was added to the existing record. If an identified whale was involved in a second interaction, a new event record was assigned. Subsequent sighting and demographic information for injured whales were obtained, where available, from local population monitoring studies. NEFSC staff reviewed each mortality event and assigned a cause of death following the confirmation criteria listed below. Each injury event was similarly examined for indications of cause and identified as a serious injury if it was likely to lead to the whale's death. One staff member reviewed all determinations each year to ensure consistency in the application of determination criteria within and across years. Criteria indicated by an asterisk (*) in the lists below are new and were developed to accommodate events that were not well addressed by existing criteria. The revised criteria were applied to the 2007 - 2009 events only. Application of the revised criteria to events prior to 2007 will be completed in a separate document. These analyses are different from a serious injury determination process currently being developed by NOAA (see Andersen *et al.* 2008).

Large whale events from Newfoundland and Labrador are included in this analysis. Since humpbacks from these regions are known to be from feeding stocks that are distinct from the Gulf of Maine stock (Palsbøll et al. 2001), humpback events from these regions were not included in tallies. Similarly, due to the presence of other species not found in US waters, only events identified to species and involving trans-boundary stocks were included in tallies. Also, incidental take data provided by the National Marine Fisheries Service Observer Programs are not included in this report. These data are addressed in NESFC fisheries bycatch technical memoranda and included in separate tables in the relevant SARs.

Confirmation Criteria for Species and Event (listed in order of certainty)

The species and/or event was considered confirmed if it met one of the following criteria:

1. Photographs or video allowed identification;
2. A marine mammal expert reported as certain;
3. The report was made by trained observer or member of the disentanglement network and was then verified via interview by NMFS, disentanglement or stranding network staff; or
4. A fisherman reported a whale entangled in gear or a shipper reported colliding with a whale.

The species and/or event was considered confirmed in the following less certain cases:

1. Photographs or video allowed probable identification;
2. A marine mammal expert reported as possible;
3. An inexperienced observer's report allowed probable identification; or
4. An inexperienced observer's report was verified via interview by NMFS, disentanglement or stranding network staff.

The species and/or event was considered unconfirmed if:

1. Photographs or video were of insufficient quality to verify;
2. An inexperienced observer's report lacked photographs or video and/or detail to confirm;
3. An incomplete examination did not allow for identification; or
4. A carcass was too decomposed to identify.

Human-induced Mortality Determinations

Events were categorized as entanglement mortalities if one of the following indications were confirmed to be present on a whale carcass:

1. Fishing line constricted any body part, and subdermal hemorrhaging or extensive necrosis was present at point of attachment;
2. An extensive entanglement was evident*;
3. An entanglement prevented feeding*; or
4. A code 2 (fresh dead) whale was pulled up during fishing operations*.

Events were categorized as ship strike mortalities if one of the following indications was confirmed to be present on a whale carcass:

1. Large linear laceration(s) was present anywhere on body, as opposed to just dorsally as in Kraus (1990);

2. Large area(s) of subdermal hemorrhaging, hematoma, or edema was evident;
3. Extensive skeletal fracturing was evident; or
4. A code 2 (fresh dead) carcass was found on the bow of a ship.

Serious Injury Determinations

Events were categorized as entanglement serious injuries if one of the following indications was confirmed on a living whale:

1. Fishing line constricted any body part or was likely to become constricting as the whale grew;
2. It was uncertain if the line was constricting, but appendages near the entanglement's point of attachment were discolored and likely compromised;
3. The whale showed a marked decline in appearance following entanglement, including skin discoloration, lesions near the nares, fat loss, or increased cyamid loads;
4. The entanglement prevented feeding*;
5. The whale was anchored; or
6. The entanglement was extensive*.

A whale was typically not considered seriously injured if all constricting lines were removed or shed.

Events were categorized as ship-strike serious injuries if, following the appearance of a linear laceration or large gouge, a living whale exhibited a marked decline in appearance, including skin discoloration, lesions near the nares, fat loss, or increased cyamid loads.

No forecasts were made as to how an entanglement or injury might increase the whale's susceptibility to further injury (e.g., from additional entanglements or collisions with vessels).

RESULTS

A total of 496 unique events were confirmed during 2005 - 2009, involving both live and dead whales (Table 1). Of these, 252 (51%) involved human interactions, 20 (4%) did not involve a human interaction, and for 224 (45%) of the events it was unknown if a human interaction had occurred. Human interaction events were categorized as either entanglement or ship strikes, with four cases having evidence of both types of interaction. Of these human interactions, 193 entanglement events were verified and determined to be the cause of death in 18 events and cause of serious injury in 22 events. There were 78 entanglement events which did not result in serious injuries (this includes cases where the animal was freed by a disentanglement team or shed gear on its own). Thirty of these events warranted serious injury classification had the animal not been disentangled. Additionally, there were 41 entanglement events for which the available information was not sufficient to determine if a serious injury had occurred (Table 2). The remaining 34 entanglement events were comprised of 31 mortalities where cause of death could not be confirmed as entanglement, two that were confirmed as ship strike mortalities, and one that was assigned as serious-injury due to unknown cause. Of the 63 confirmed ship strike events, 28 were determined to have been lethal and two caused serious injury. Eighteen ship strike events occurred which did not result in serious injury, and 11 ship strikes lacked sufficient evidence to make a determination (Table 3). The remaining four events comprised of two mortalities where cause of death could not be confirmed as ship strike, one that was a confirmed entanglement mortality, and one that was assigned as serious-injury due to

unknown cause. There were 5 events involving whales entrapped in fishing weirs – 4 minke and 1 right whale. All of these occurred in Canadian waters and all animals were successfully released and deemed non-seriously injured. These events are not classified as entanglements as the animals were free-swimming within the weirs.

A total of 308 mortalities were documented, of which 46 (15%) were confirmed to be the result of human interactions, 16 (5%) were due to natural causes and 246 (80%) for which there was insufficient evidence to determine cause of death (Table 1). Annual human-caused mortality and serious injury rates for 2005 - 2009 are presented for each large whale stock in Table 4. Tables 5 - 10 provide details of each confirmed human interaction event resulting in serious injury or mortality.

Over the 5 year period, there were 60 confirmed events involving North Atlantic right whales, of which 29 were confirmed entanglements and 17 were confirmed ship strikes (Tables 1-3). Of the 20 verified right whale mortalities, 2 were due to entanglements, 6 due to ship strikes, 5 due to natural causes, and 7 were from undetermined causes (Table 1). Serious injury was assigned for three entanglement events and two ship strikes (details in Table 5). Serious injury classification was warranted in six additional entanglements, but was prevented by the intervention of disentanglement teams. There was an additional event which warrants noting: one right whale was documented with evidence of both entanglement and vessel collision and exhibited signs of extreme health decline. However, the precise cause of the decline could not be determined. Therefore that animal is tallied as both an entanglement and ship strike event, but is considered a serious-injury due to unknown cause.

Humpbacks, involved in 202 verified events, were the most commonly observed entangled whale species, and the most commonly observed dead whale (115 confirmed mortalities; Table 1). Of the 94 confirmed entanglements, 6 resulted in mortality and 12 in serious injury. An additional 16 events would have resulted in serious injury had disentanglement teams not intervened. Humpbacks were involved in 18 verified ship strike events, 7 of which were fatal (Table 6). We assumed all humpback events occurring in or near US and southeast Canadian waters involved the Gulf of Maine stock unless a whale was confirmed to be from another stock. Humpback events from Labrador and Newfoundland were assumed to not involve the Gulf of Maine stock.

Of 46 documented fin whale events, 14 were confirmed entanglements. Two of these resulted in fatalities--yielding the highest percentage for any of the whale species (14%)--and two resulted in serious injury. Twelve ship strike events were documented, 9 of which were fatal (Table 7).

Mortalities accounted for 10 of the 12 confirmed sei whale events. Three of these mortalities were attributed to ship strikes. There were 3 confirmed entanglement events, one of which resulted in mortality and two in serious injury (Table 8).

Minke whales were involved in 110 verified events, of which 48 were confirmed entanglements. Seven of the entanglement events were fatal, while three resulted in serious injury. In eight entanglement events, disentanglement teams removed gear that would have warranted a serious injury classification. There were only two verified ship strike events, both of which resulted in mortality (Table 9).

Bryde’s whales had the lowest number of documented events—two mortalities. One was attributed to natural causes while the other mortality was a result of ship strike (Table 10).

There were no reported events involving blue whales.

In 64 of the 496 confirmed unique large whale events during 2005 - 2009, positive species identification was not possible. In six of the 64 events, the similarity in body shape and size between fin and sei whales prevented us from distinguishing which of these two species

were involved. In another eight events, the whales could only be identified as balaenopteridae based on the presence of ventral pleats. The taxonomic identity of the whales involved in the remaining 50 events could not be assigned with any certainty. Entanglement was confirmed in five of these 64 events. Forty-five of the 64 events involving unidentified whales were confirmed mortalities (see Table 1).

DISCUSSION

The criteria employed in this report evolved from recommendations of serious injury workshops (Andersen et al. 2008; Angliss and DeMaster 1998) and our experience examining large whale reports collected since 1990. The criteria attempt to encompass all event scenarios and minimize the identification of false positive human-caused mortalities and serious injuries. The resulting values provide a minimum value of confirmed human impact to whale stocks.

Differentiating causal injuries from preexisting ones or postmortem damage is problematic but can be accomplished through examination of necropsy data or parsimonious evaluation of available evidence. In our determinations, fishing line constrictions were considered circumstantial evidence of premortem entanglement, as these constrictions were likely the result of force applied by an active animal. Vessel collisions frequently lack external evidence and may not be detected unless a necropsy is conducted; necropsies frequently identified subdermal hemorrhaging or hematomas, indicating that blood was still circulating at the time of injury. Large lacerations were considered an indication of a premortem vessel collision since only whales at depth would be exposed to the propellers of a ship; floating carcasses would be pushed aside by the ship's bow wave (Knowlton et al. 1995).

Assessment of serious injury was guided by regulation 50 *CFR* 229.2, which defines serious injury as "any injury that will likely result in mortality." Evidence of the whale's deteriorating health was used as confirmation of serious injury. A whale's physiological response to tissue damage includes increased secretion of glucocorticoids, which suppresses lymphocytes, and if sustained (because of chronic destruction of tissue by gear or hydrodynamic forces) compromises the ability of an animal to fight other infections. External indications of poor health, including skin discoloration, lesions near the nares, fat loss, or increased cyamid loads, are part of a cascade of immunological disorders. Cases of constricting entanglements invariably follow this sequence. Removal of constricting gear typically reversed the decline in appearance, and disentanglement was generally considered to prevent serious injury. Whales only loosely entangled in line typically did not have external indications of poor health; some whales carried loose wraps for years.

Over the five year period, 246 of 308 confirmed mortalities (80%) lacked sufficient evidence to determine cause of death (Table 1). Carcasses floating at sea often cannot be examined sufficiently for either internal or external indications, and they generate false negatives if they are not towed ashore and necropsied. Likewise, insufficient documentation precluded determination of fate in 41 of 193 confirmed entanglement events (21%) and 11 of 63 ship strike events (17%).

Perhaps of greater concern is the number of animals never observed. Humpback whale scar evidence suggests that only 6-12% of entanglements are witnessed and reported (Robbins 2009, 2010). Thus, whales may succumb to entanglement before the event can be detected. It is also likely that some number of ship strikes are not detected or reported. Negatively buoyant species are less likely to be detected after death, and positively buoyant species, such as North Atlantic right whales, may become negatively buoyant if an injury precludes effective feeding

for an extended period (Moore et al. 2004). Given the likelihood that some number of entanglement and ship strike serious injuries and mortalities are not observed and that the serious injury and mortality criteria are designed to minimize the identification of false positive human-caused mortalities and serious injuries, the numbers in this report represent the minimum values for human-caused serious injury and mortality to large whale stocks along the Gulf of Mexico and US and Canadian eastern seaboard.

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Table 1. Summary of all unique whale events and mortalities along the Gulf of Mexico Coast, US East Coast and adjacent Canadian Maritimes, 2005-2009. Determinations of human-caused mortality follow the criteria established by the NEFSC.

Species	Western North Atlantic right whale (*Eubalaena glacialis)*	Gulf of Maine humpback whale *(Megaptera novaeangliae)*	Western North Atlantic fin whale *(Balaenoptera physalus)*	Nova Scotian sei whale (*B.borealis)*	Western North Atlantic blue whale *(B. musculus)*	Canadian East Coast minke whale *(B. acutorostrata)*	Northern Gulf of Mexico Bryde's whale *(B. edeni)*	Unidentified fin/sei whale	Unidentified balaenopterid[c]	Unidentified whale spp.
Total events[a,b] (2005, 2006, 2007, 2008, 2009)	**60** (14, 12, 6, 13, 15)	**202** (30, 48, 35, 47, 42)	**46** (10, 9, 13, 6, 8)	**12** (0, 5, 1, 4, 2)	**0**	**110** (19, 25, 27, 24, 15)	**2** (0, 1, 0, 0, 1)	**6** (3, 2, 1, 0, 0)	**8** (4, 1, 2, 0, 1)	**50** (10, 13, 8, 11, 8)
Total confirmed mortalities	**20** (4, 6, 3, 3, 4)	**115** (13, 33, 21, 27, 21)	**34** (9, 7, 8, 5, 5)	**10** (0, 4, 1, 3, 2)	**0**	**82** (18, 18, 20, 17, 9)	**2** (0, 1, 0, 0, 1)	**4** (2, 1, 1, 0, 0)	**8** (4, 1, 2, 0, 1)	**33** (4, 10, 5, 8, 6)
Confirmed entanglement mortalities	**2** (0, 1, 1, 0, 0)	**6** (0, 1, 1, 2, 2)	**2** (0, 0, 2, 0, 0)	**1** (0, 0, 0, 1, 0)	**0**	**7** (1, 1, 1, 4, 0)	**0**	**0**	**0**	**0**
Confirmed ship strike mortalities	**6** (2, 4, 0, 0, 0)	**7** (0, 3, 3, 1, 0)	**9** (5, 0, 2, 1, 1)	**3** (0, 1, 1, 0, 1)	**0**	**2** (1, 0, 0, 0, 1)	**1** (0, 0, 0, 0, 1)	**0**	**0**	**0**
Confirmed mortalities, NOT ship strike or entanglement	**5** (0, 0, 1, 3, 1)	**2** (1, 1, 0, 0, 0)	**3** (0, 0, 0, 2, 1)	**0**	**0**	**5** (2, 1, 1, 0, 1)	**1** (0, 1, 0, 0, 0)	**0**	**0**	**0**
Confirmed mortalities, IITD[d]	**7** (2, 1, 1, 0, 3)	**100** (12, 28, 17, 24, 19)	**20** (4, 7, 4, 2, 1)	**6** (0, 3, 0, 2, 1)	**0**	**68** (14, 16, 18, 13, 7)	**0**	**4** (2, 1, 1, 0, 0)	**8** (4, 1, 2, 0, 1)	**33** (4, 10, 5, 8, 6)

[a] Includes all types of events : entanglements, ship strikes, natural causes, and unconfirmed origin or fate

[b] Excludes resights of previously reported individuals unless a new injury was documented.

[c] Described as having throat grooves (rorqual pleats).

[d] IITD = insufficient information to determine cause of death or if the injury was serious and likely lethal.

Table 2. Summary of confirmed large whale entanglement events along the Gulf of Mexico Coast, US East Coast and adjacent Canadian Maritimes, 2005-2009. Determinations of human-caused mortality and serious injury follow the criteria established by the NEFSC.

Species	Western North Atlantic right whale (*Eubalaena glacialis)*	Gulf of Maine humpback whale *(Megaptera novaeangliae)*	Western North Atlantic fin whale *(Balaenoptera physalus)*	Nova Scotian sei whale (*B.borealis)*	Western North Atlantic blue whale *(B. musculus)*	Canadian East Coast minke whale *(B. acutorostrata)*	Northern Gulf of Mexico Bryde's whale *(B. edeni)*	Unidentified fin/sei whale	Unidentified balaenopterid	Unidentified whale spp.
Confirmed entanglement events[a] (2005, 2006, 2007, 2008, 2009)	**29** (2, 5, 4, 10, 8)	**94** (13, 20, 15, 22, 24)	**14** (0, 2, 6, 2, 4)	**3** (0, 1, 0, 2, 0)	**0**	**48** (6, 8, 12, 15, 7)	**0**	**2** (1, 1, 0, 0, 0)	**0**	**3** (1, 1, 0, 1, 0)
Confirmed entanglement mortalities	**2** (0, 1, 1, 0, 0)	**6** (0, 1, 1, 2, 2)	**2** (0, 0, 2, 0, 0)	**1** (0, 0, 0, 1, 0)	**0**	**7** (1, 1, 1, 4, 0)	**0**	**0**	**0**	**0**
Confirmed entanglement serious injuries	**3** (0, 0, 0, 1, 2)	**12** (0, 3, 2, 4, 3)	**2** (0, 1, 1, 0, 0)	**2** (0, 1, 0, 1, 0)	**0**	**3** (0, 0, 1, 0, 2)	**0**	**0**	**0**	**0**
Confirmed entanglement events, NOT serious injury/mortality[b]	**20** (2, 3, 2, 8, 5)	**45** (12, 10, 7, 7, 9)	**2** (0, 0, 1, 1, 0)	**0**	**0**	**11** (1, 4, 3, 1, 2)	**0**	**0**	**0**	**0**
Confirmed entanglement events, IITD[c]	**2** (0, 1, 0, 0, 1)	**16** (1, 2, 3, 5, 5)	**6** (0, 1, 2, 0, 3)	**0**	**0**	**13** (0, 2, 3, 6, 2)	**0**	**2** (1, 1, 0, 0, 0)	**0**	**2** (1, 1, 0, 0, 0)
Mortality with evidence of entanglement, but not confirmed as COD[d]	**1** (0, 0, 1, 0, 0)	**13** (0, 3, 1, 4, 5)	**2** (0, 0, 0, 1, 1)	**0**	**0**	**14** (4, 1, 4, 4, 1)	**0**	**0**	**0**	**1** (0, 0, 0, 1, 0)

[a] Includes 3 events where evidence of entanglement was present, but was not determined to be the primary cause of fate.

[b] Includes cases where animal was disentangled or shed gear.

[c] IITD = insufficient information to determine cause of death or if the injury was serious and likely lethal.

[d] COD = cause of death

Table 3. Summary of confirmed large whale ship strike events along the Gulf of Mexico Coast, US East Coast and adjacent Canadian Maritimes, 2005-2009. Determinations of human-caused mortality and serious injury follow the criteria established by the NEFSC.

Species	Western North Atlantic right whale (*Eubalaena glacialis)*	Gulf of Maine humpback whale *(Megaptera novaeangliae)*	Western North Atlantic fin whale *(Balaenoptera physalus)*	Nova Scotian sei whale (*B.borealis)*	Western North Atlantic blue whale *(B. musculus)*	Canadian East Coast minke whale *(B. acutorostrata)*	Northern Gulf of Mexico Bryde's whale *(B. edeni)*	Unidentified fin/sei whale	Unidentified balaenopterid	Unidentified whale spp.
Confirmed ship strike events[a] (2005, 2006, 2007, 2008, 2009)	**17** (6, 6, 1, 1, 3)	**18** (1, 3, 5, 5, 4)	**12** (7, 0, 3, 1, 1)	**3** (0, 1, 1, 0, 1)	**0**	**2** (1, 0, 0, 0, 1)	**1** (0, 0, 0, 0, 1)	**0**	**0**	**10** (2, 3, 2, 1, 2)
Confirmed ship strike mortalities	**6** (2, 4, 0, 0, 0)	**7** (0, 3, 3, 1, 0)	**9** (5, 0, 2, 1, 1)	**3** (0, 1, 1, 0, 1)	**0**	**2** (1, 0, 0, 0, 1)	**1** (0, 0, 0, 0, 1)	**0**	**0**	**0**
Confirmed ship strike serious injuries	**2** (1, 1, 0, 0, 0)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Confirmed ship strike events, NOT serious injury/mortality	**6** (2, 1, 1, 0, 2)	**10** (1, 0, 1, 4, 4)	**2** (1, 0, 1, 0, 0)	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Confirmed ship strike events, IITD[b]	**2** (1, 0, 0, 0, 1)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**9** (2, 2, 2, 1, 2)
Mortality with evidence of ship strike, but not confirmed as COD[c]	**0**	**0**	**1** (1, 0, 0, 0, 0)	**0**	**0**	**0**	**0**	**0**	**0**	**1** (0, 1, 0, 0, 0)

[a] Includes 2 events where evidence of ship strike was present but was not determined to be the primary cause of fate.

[b] IITD = insufficient information to determine cause of death or if the injury was serious and likely lethal.

[c] COD = cause of death

Table 4. Summary of the confirmed human-caused mortality and serious injury (SI) events involving baleen whale stocks along the Gulf of Mexico Coast, US East Coast, and adjacent Canadian Maritimes, 2005-2009, with number of events attributed to entanglements or vessel collisions by year.

Stock	Mean annual mortality and SI rate (PBR[1] for reference)	Entanglements			Vessel Collisions		
		Annual rate (US waters / Canadian waters)	Confirmed mortalities (2005, 2006, 2007, 2008, 2009)	Confirmed SIs (2005, 2006, 2007, 2008, 2009)	Annual rate (US waters / Canadian waters)	Confirmed mortalities (2005, 2006, 2007, 2008, 2009)	Confirmed SIs (2005, 2006, 2007, 2008, 2009)
Western North Atlantic right whale *(Eubalaena glacialis)*	**2.6** (0.5)	**1.0** (1.0/ 0)[2]	(0, 1, 1, 0, 0)	(0, 0, 0, 1, 2)	**1.6** (1.2 / 0.4)	(2, 4, 0, 0, 0)	(1, 1, 0, 0, 0)
Gulf of Maine humpback whale *(Megaptera novaeangliae)*	**5.0** (1.1)	**3.6** (3.6 / 0)	(0, 1, 1, 2, 2)	(0, 3, 2, 4, 3)	**1.4** (1.4 / 0)	(0, 3, 3, 1, 0)	**0**
Western North Atlantic fin whale *(Balaenoptera physalus)*	**2.6** (6.5)	**0.8** (0.6 / 0.2)	(0, 0, 2, 0, 0)	(0, 1, 1, 0, 0)	**1.8** (1.4 / 0.4)	(5, 0, 2, 1, 1)	**0**
Nova Scotian sei whale *(B. borealis)*	**1.2** (0.4)	**0.6** (0.4 / 0.2)	(0, 0, 0, 1, 0)	(0, 1, 0, 1, 0)	**0.6** (0.6 / 0)	(0, 1, 1, 0, 1)	**0**
Western North Atlantic blue whale *(B. musculus)*	**0** (–)[3]	**0**	**0**	**0**	**0**	**0**	**0**
Canadian East Coast minke whale *(B. acutorostrata)*	**2.4** (69)	**2.0** (0.6 / 1.4)	(1, 1, 1, 4, 0)	(0, 0, 1, 0, 2)	**0.4** (0.4 / 0)	(1, 0, 0, 0, 1)	**0**
Northern Gulf of Mexico Bryde's whale *(B. edeni)*	**0.2** (–)[3]	**0**	**0**	**0**	**0.2** (0.2 / 0)	(0, 0, 0, 0, 1)	**0**

1 Potential Biological Removal (PBR)

2 CORRECTION: In the first edition of this report, published October 21, 2011, Table 4 incorrectly listed the annual entanglement rate (US/CAN waters) for right whales as 1.0 (0.4/0.6). It was corrected to read 1.0 (1.0/0) on January 20, 2012.

3 Stock abundance estimates outdated; no PBR established for this stock.

Table 5. Confirmed human-caused mortality and serious injury records of Western North Atlantic right whales *(Eubalaena glacialis)*, 2005 - 2009.

Date[a]	Report Type	Age, Sex, ID, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship Strike	Entanglement/ Fishery interaction	
1/12/2005	mortality	Adult Female #2143 13.1m	Cumberland Island, GA	P		Healed propeller wounds from strike as a calf reopened as a result of pregnancy
3/10/2005	serious injury	Adult[b] Female[b] #2425	Cumberland Island, GA	P		43 ft power yacht partially severed left fluke; resighted 9/4/05 in extremely poor condition
4/28/2005	mortality	Adult Female #2617 14.7m	Monomoy Island, MA	P		Significant bruising and multiple vertebral fractures
1/10/2006	mortality	Calf Male 5.4m w/out fluke	Jacksonville, FL	P		Propeller lacerations associated with hemorrhaging and edema; flukes completely severed
1/22/2006	mortality	Calf Female[b] 5.6m	off Ponte Vedra Beach, FL		P	Significant premortem lesions from entanglement in apparent monofilament netting; no gear present
3/11/2006	serious injury	Yearling Male #3522	Off Cumberland Island, GA	P		11 propeller lacerations across dorsal surface

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. Additional information on previous event that was not included in previous reports.

Table 5, continued. Confirmed human-caused mortality and serious injury records of Western North Atlantic right whales *(Eubalaena glacialis)*, 2005 - 2009.

Date[a]	Report Type	Age, Sex, ID, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship Strike	Entanglement/ Fishery interaction	
7/24/2006	mortality	age unknown Female 9.6m	Campobello Island, NB	P		Propeller lacerations through blubber, into muscle and ribs
8/24/2006	mortality	Adult Female 14.7m	Roseway Basin, NS	P		16 fractured vertebrae; dorsal blubber bruise from head to genital region
12/30/2006	mortality	Yearling Male #3508 12.6m	off Brunswick, GA	P		20 propeller lacerations along right side of head and back with associated hemorrhaging
3/31/2007	mortality	Calf Male 7.7m	Outer Banks, NC		P	Edema associated with flipper and dorsal & ventral thoracic musculature; epidermal abrasion indicated entangling body and flipper wraps; no gear recovered
2/3/2008	serious injury	Adult Male #1980	Cape Hatteras, NC		P	Embedded wrap in rostrum; decline in health; no gear recovered
1/14/2009	serious injury	Juvenile sex unknown #3311	off Brunswick, GA		P	Partial disentanglement; embedded wrap in rostrum & lip removed; decline in health; gear analysis pending
1/27/2009	serious injury	Juvenile Male #3710 9.8m	Cape Lookout Shoals, NC		P	Live stranded w/ spinal scoliosis; euthanized; necropsy determined scoliosis due to entanglement and not congenital; entanglement wounds chronically infected; 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. Additional information on previous event that was not included in previous reports.

Table 6. Confirmed human-caused mortality and serious injury records of Gulf of Maine humpback whales *(Megaptera novaeangliae)*, 2005 - 2009.

Date[a]	Report Type	Age, Sex, ID, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entanglement/ Fishery interaction	
1/9/2006	mortality	Adult Female #8667 14.0m	off Charleston, SC	P		Extensive muscle hemorrhaging; rib fractures; dislocated flipper on left side of animal
3/17/2006	mortality	Juvenile Female 10.0m	Virginia Beach, VA	P		Crushed cranium and fractured mandible; hemorrhaging associated with fractures; ventral lacerations consistent with propeller wounds
3/25/2006	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
8/6/2006	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
8/23/2006	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[b]	mortality	age & sex unknown	East of Cape Cod, MA		P	Whale entangled through mouth, continuing back to multiple wraps around peduncle; 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. 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 caused by entanglement.

Table 6. Confirmed human-caused mortality and serious injury records of Gulf of Maine humpback whales *(Megaptera novaeangliae)*, 2005 - 2009.

Date[a]	Report Type	Age, Sex, ID, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entanglement/ Fishery interaction	
10/15/2006	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
1/27/2007	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
5/10/2007	mortality	Adult Female 12.5m	off Wachapreague, VA	P		Cranium shattered, hemorrhaging on left lateral side midway between flippers & fluke
5/13/2007	mortality	Juvenile Male 9.3m	Rockport, MA	P		Areas of hemorrhaging indicate major blunt trauma to chest, neck, & head
6/23/2007	serious injury	age unknown Male "Egg Toss"	Wildcat Knoll		P	Body wrap of gear imbedded; no gear recovered
6/24/2007	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

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. 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 caused by entanglement.

Table 6, continued. Confirmed human-caused mortality and serious injury records of Gulf of Maine humpback whales *(Megaptera novaeangliae)*, 2005 - 2009.

Date[a]	Report Type	Age, Sex, ID, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entanglement/ Fishery interaction	
12/21/2007	mortality	age unknown Male 9.4m	Ocean Sands, Corolla, 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
1/6/2008	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
5/30/2008	mortality	age & sex unknown	Georges Bank		P	Constricting body wraps, one wrap under lower jaw; open wound on right flipper; no gear recovered
6/9/2008	mortality	age & sex unknown	Georges Bank		P	Constricting body wrap; gear analysis pending
7/8/2008	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
8/13/2008	serious injury	age & sex unknown 10m (est)	off NJ		P	Partial disentanglement; emaciated; lethargic; heavy cyamid load; gear analysis pending

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. 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 caused by entanglement.

Table 6, continued. Confirmed human-caused mortality and serious injury records of Gulf of Maine humpback whales *(Megaptera novaeangliae)*, 2005 - 2009.

Date[a]	Report Type	Age, Sex, ID, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entanglement/ Fishery interaction	
8/21/2008	serious injury	age & sex unknown	off Chatham, MA		P	Evidence of decline in health; no gear recovered
11/4/2008	mortality	Juvenile Male 10.1m	Assateague Island, MD	P		Cranial fractures with associated hemorrhaging
2/8/2009	mortality	age unknown Male 9.7m	Cape Fear, NC		P	Evidence of entanglement at mouthline, peduncle, and flipper with associated hemorrhaging; emaciated; no gear present
2/16/2009	mortality	Juvenile Male 10.0m	Nags Head, NC		P	Evidence of entanglement involving anchoring or heavily weighted gear with associated hemorrhaging; no gear present
2/25/2009	serious injury	Juvenile sex unknown	off Sandy Hook, NJ		P	Disentangled from anchoring pot gear; maintained hunched body position post-disentanglement; gear analysis pending
6/9/2009	serious injury	age & sex unknown	Stellwagen Bank		P	Constricting body wrap just forward of the flippers; no gear recovered
12/9/2009	serious injury	age & sex unknown	off Jacksonville, FL		P	Disentangled; evidence of health decline; gear analysis pending

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. 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 caused by entanglement.

Table 7. Confirmed human-caused mortality and serious injury records of Western North Atlantic fin whales *(Balaenoptera physalus)*, 2005 - 2009.

Date[a]	Report Type	Age, Sex, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entanglement/ Fishery interaction	
03/26/05	mortality	Adult[b] Female 16.3m	off Virginia Beach, VA	P		Extensive hemorrhaging and vertebral fractures
04/03/05	mortality	Adult[b] Female 18.8m	Southampton, NY	P		Subdermal hemorrhaging
08/23/05	mortality	Juvenile[b] Male 13.7m	Port Elizabeth, NJ	P		Fresh carcass on bow of ship; extensive hemorrhaging along right side
09/11/05	mortality	Juvenile[b] Male 11.0m	Bonne-Esperance, QC	P		Bottom jaw completely severed/broken
09/13/05[c]	mortality	age & sex unknown	Blanc Sablon, NL	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, 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
08/11/07	mortality	age & sex unknown	Cabot Strait, NS		P	Constricting wrap around body, between the head and flippers; 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. The gender and length were misreported in the 2006 Stock Assessment Report. This table shows the correct values.
c. Additional record which was not included in previous reports.

Table 7,continued. Confirmed human-caused mortality and serious injury records of Western North Atlantic fin whales *(Balaenoptera physalus)*, 2005 - 2009.

Date[a]	Report Type	Age, Sex, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entanglement/ Fishery interaction	
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
10/01/09	mortality	age & sex unknown	Port Elizabeth, NJ	P		Fresh carcass with broken flipper, hematomas, and abrasions

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. The gender and length were misreported in the 2006 Stock Assessment Report. This table shows the correct values.
c. Additional record which was not included in previous reports.

Table 8. Confirmed human-caused mortality and serious injury records of Nova Scotian sei whales *(Balaenoptera borealis)*, 2005 - 2009.

Date[a]	Report Type	Age, Sex, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entanglement/ Fishery interaction	
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)	Slack's Cove, NB		P	Extensive entanglement evident; no gear present
05/19/09	mortality	Juvenile Male 12.7 m	off Rehobeth Beach, DE	P		Posterior portion of skull & right mandible fractured; hemorrhaging dorsal to left pectoral

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.

Table 9. Confirmed human-caused mortality and serious injury records of Canadian East Coast minke whales *(Balaenoptera acutorostrata)*, 2005 - 2009.

Date[a]	Report Type	Age, Sex, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entanglement/ Fish interaction	
05/23/05	mortality	Juvenile Male 5.9m	Port Elizabeth, NJ	P		Ribs shattered; liver ruptured; evidence of internal hemorrhaging
08/24/05[b]	mortality	age & sex unknown	Bridgeport, New World Island, NL		P	Constricting gear through mouth with flipper and tail wraps; toad crab pots
09/22/06[b]	mortality	age & sex unknown	Woods Cove, Great Northern Peninsula, NL		P	Anchored by tail in doorways of the gear; mackerel trap
07/16/07	serious injury	age & sex unknown 10m (est)	Trescott, ME		P	Wrapped in gear and anchored; no gear recovered
08/05/07	mortality	Juvenile Female 4.3m	Cape Cod Bay, MA		P	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 11/16" diameter floating rope
06/14/08	mortality	Juvenile Female 4.7m	Orleans, MA		P	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, NL		P	Constricting wraps of gear on caudal peduncle; 5/8" polypropylene rope
07/26/08	mortality	age & sex unknown	Conception Bay, NL		P	Constricting wraps of gear through mouth and around tail; blackback flounder nets

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. Additional record which was not included in previous reports.

Table 9. Confirmed human-caused mortality and serious injury records of Canadian East Coast minke whales *(Balaenoptera acutorostrata)*, 2005 - 2009.

Date[a]	Report Type	Age, Sex, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entanglement/ Fish interaction	
08/25/08	mortality	age & gender unknown 8m (est)	off Richibucto Cape, NB		P	Evidence of constricting body wraps; gear not recovered
05/20/09	mortality	Adult sex unknown 8m (est)	off Point Pleasant, NJ	P		Large hemorrhage at right pectoral
06/03/09	serious injury	age & sex unknown	off Tadoussac, Quebec		P	Free-swimming with tight rostrum wrap; no gear recovered
08/11/09	serious injury	age & sex unknown	off Plymouth, MA		P	Constricting wrap on rostrum & poor skin condition; 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. Additional record which was not included in previous reports.

Table 10. Confirmed human-caused mortality and serious injury records of Northern Gulf of Mexico Bryde's whales *(Balaenoptera edeni)*, 2005 - 2009.

Date[a]	Report Type	Age, Sex, Length	Location[a]	Assigned Cause: P=primary, S=secondary		Notes/Observations
				Ship strike	Entanglement/ Fish interaction	
10/04/09	mortality	Adult Female 12.7m	Tampa, FL	P		Vertebral separation; lung damage; subdermal contusions

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.

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The mission of NOAA's National Marine Fisheries Service (NMFS) is "stewardship of living marine resources for the benefit of the nation through their science-based conservation and management and promotion of the health of their environment." As the research arm of the NMFS's Northeast Region, the Northeast Fisheries Science Center (NEFSC) supports the NMFS mission by "conducting ecosystem-based research and assessments of living marine resources, with a focus on the Northeast Shelf, to promote the recovery and long-term sustainability of these resources and to generate social and economic opportunities and benefits from their use." Results of NEFSC research are largely reported in primary scientific media (*e.g.*, anonymously-peer-reviewed scientific journals). However, to assist itself in providing data, information, and advice to its constituents, the NEFSC occasionally releases its results in its own media. Currently, there are three such media:

NOAA Technical Memorandum NMFS-NE -- This series is issued irregularly. The series typically includes: data reports of long-term field or lab studies of important species or habitats; synthesis reports for important species or habitats; annual reports of overall assessment or monitoring programs; manuals describing program-wide surveying or experimental techniques; literature surveys of important species or habitat topics; proceedings and collected papers of scientific meetings; and indexed and/or annotated bibliographies. All issues receive internal scientific review and most issues receive technical and copy editing.

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Resource Survey Report (formerly *Fishermen's Report*) -- This information report is a regularly-issued, quick-turnaround report on the distribution and relative abundance of selected living marine resources as derived from each of the NEFSC's periodic research vessel surveys of the Northeast's continental shelf. This report undergoes internal review, but receives no technical or copy editing.

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