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Post-interaction Mortality Determinations for Sea Turtles in US Northeast and Mid-Atlantic Fishing Gear, 2011-2015

US DEPARTMENT OF COMMERCE
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Post-interaction Mortality Determinations for Sea Turtles in US Northeast and Mid-Atlantic Fishing Gear, 2011-2015

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EXECUTIVE SUMMARY

The NMFS Northeast Sea Turtle Injury Workgroup reviewed all sea turtle interactions recorded by the Northeast Fisheries Observer Program (n = 133) and At-Sea Monitoring (n = 20) from 2011 to 2015. The workgroup first determined if the interaction occurred while the turtle was alive (e.g., not a carcass from the seafloor) and whether any injuries or other apparent effects were attributable to the interaction. If so, interactions were assigned 1 of 3 injury categories with associated post-interaction mortality rates or a determination of 100% mortality was applied according to the "Technical Working Guidelines for Assessing Injuries of Sea Turtles Observed in Northeast Region Fishing Gear" (Upite 2011). Sea turtle records were subsequently delineated by major gear type, resulting in 93 trawl records, 44 gillnet records, 3 dredge records, and 1 pot/trap record for which injury determinations were made. In addition, 7 cases had insufficient information to make a determination, and 5 records described moderately to severely decomposed animals deemed to represent capture of carcasses and, therefore, not attributed to the observed fishery. Considering the 141 records with injury determinations, the resulting mortality rate for observable interactions in trawl gear is 50%, gillnet gear is 79%, dredge gear is 67%, and pot/trap gear is 100%. The sample sizes for dredge and pot/trap gear interactions are small, so the mortality rate estimates are uncertain and should be considered accordingly. Additional factors that may influence sea turtle post-interaction mortality were considered, such as seasonality, specific fishery (within an encompassing gear type), geographical area, sea turtle species, and life stage.

NMFS NORTHEAST SEA TURTLE INJURY WORKGROUP
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BACKGROUND

Sea turtles are incidentally captured in fishing activities, and lethal take (mortality) can occur during interaction or after turtles are released alive from fishing gear. The latter is referred to as "post-interaction mortality." A determination of post-interaction mortality is needed to characterize the full impact of federal fisheries on sea turtles, which is necessary under Section 7 of the Endangered Species Act (ESA).

In November 2009, the National Marine Fisheries Service (NMFS), Greater Atlantic Regional Fisheries Office (GARFO), and Northeast Fisheries Science Center (NEFSC) hosted a workshop to discuss sea turtle injuries in Northeast and Mid-Atlantic fishing gear and associated post-interaction mortality. The scope was limited to only fisheries observed by the NEFSC (Maine through North Carolina), excluding the longline fishery, which has a separate post-interaction mortality assessment (Ryder et al. 2006). Workshop participants discussed types of sea turtle injuries and associated survival, turtle behavior, and resuscitation, as well as specific information that should be collected by observers to better assess sea turtle injuries. The information gathered from individual participants at this workshop was then used by NMFS to develop "Technical Working Guidelines for Assessing Injuries of Sea Turtles Observed in Northeast Region Fishing Gear" (Upite 2011). The guidelines were subsequently revised in November 2013 to account for additional release behaviors (Appendix A). The Technical Guidelines have been applied by the NMFS Northeast Sea Turtle Injury Workgroup in review of all sea turtle interactions recorded by the Northeast Fisheries Observer Program (NEFOP) and At-Sea Monitoring (ASM), as available, since 2006.

Insofar as process, the workgroup reviews the latest year of sea turtle observer records annually, determines the injury category for each record, and maintains a rolling 5-year mortality rate by gear type (gillnet, trawl, dredge, pot/trap). The workgroup published the first 5-year assessment for 2006 to 2010 (n = 145 records) in Upite et al. (2013), and the results from 2007 to 2011 (n = 147 records), 2008 to 2012 (n = 144 records), 2009 to 2013 (n = 151 records), and 2010 to 2014 (n = 115 records) are found in previous NMFS memos[1]. GARFO applied these post-interaction mortality results to the anticipated incidental take of sea turtles in 2 recent Biological Opinions covering the operations of 8 federally managed fisheries (NMFS 2012, 2013).

The Northeast Sea Turtle Injury Workgroup applied the post-interaction mortality Technical Guidelines in Upite (2011) to observer records dating back to 2006, as there were no comparable national criteria. To promote consistency among NMFS regions, NMFS recently

[1] September 16, 2013 memo from Upite to Colligan, November 13, 2013 memo from Upite to Colligan, September 23, 2104 memo from Upite to Gouveia, April 6, 2016 memo from Upite to Damon-Randall, respectively.

convened an expert workshop to gather individual input to inform development of national criteria (Stacy et al. 2016). The information obtained at this workshop led to the development of national criteria to assess post-interaction mortality for turtles bycaught in trawl, net, and pot/trap fisheries (NMFS 2017). The national criteria were not available at the time of this review, so the results in this report employ the previous Greater Atlantic Region (GAR) guidelines. The Northeast Sea Turtle Injury Workgroup will use the new national criteria in subsequent reviews (e.g., 2016 on). The national criteria are very similar to the GAR guidelines, with the biggest difference in the national criteria involving different mortality rates for Category I (10 or 20%) depending on the depth of the fishery.

The results of the 2011 to 2015 determinations are provided here. It should also be noted that mortality rates in this report are determined for observable interactions, which are those animals brought on board the fishing vessel or that interact with the gear at the surface (Warden and Murray 2011). Mortality rates may be different for interactions unobservable because of the design of the gear or the behavior of the animal, such as animals that interact with the gear exclusively subsurface or away from view.

METHODS

Workgroup members reviewed available information for each observer record in the NEFOP and ASM databases from 2011 to 2015 and made independent injury determinations. Information available for the review included the turtle capture photos and video (when available) and observer comments on the vessel and trip information logs, incidental take logs, and sea turtle biological sample logs (NEFSC 2016).

Each member first determined whether the turtle was captured while alive (antemortem) and whether any injuries or other apparent effects were attributable to the observed fishery interaction in question according to the guidance in Upite (2011) and expert opinion. The interactions not attributed to the observed haul/tow/set were noted as such in the determination file and excluded from further analysis. For example, a moderately or severely decomposed turtle found in active fishing gear (e.g., trawls or dredges) likely died prior to the interaction, so the mortality was not assigned to the fishery. For antemortem interactions, each member then used the Technical Guidelines to evaluate any injuries and to place the turtle into 1 of the 3 categories with identified post-interaction mortality rates or to provide justification for a 100% mortality determination. In addition, injury category was not assigned if there was insufficient information on which to base the assessment. This could occur if the sea turtle was released from the gear (e.g., during haulback) or vessel before the observer could sample and evaluate the turtle. These cases were also noted in the determination file and excluded from further analysis.

After the individual determinations were made and sent to the GARFO staff contact, the records were reviewed for consistency. For the majority of the cases, the initial injury determinations were consistent among all members. The records with inconsistent determinations between workgroup members were discussed. After workgroup discussion and review occurred, consensus was reached for all cases. Consequently, each record from 2011 to 2015 had an injury determination of Category I, II, III, or dead, with an associated mortality percentage (or noted as “could not be determined” or “not applicable,” as described above).

Percent probability of mortality was calculated based on the Technical Guidelines (Upite 2011) (Appendix A). Briefly, those animals in Category I were considered to have a 20% probability of post-interaction mortality based upon their capture condition and assessment,

animals in Category II had a 50% probability of post-interaction mortality, and animals in Category III had an 80% probability of post-interaction mortality. Turtles believed to be dead after the workgroup's review (based upon observer logs and comments) or released into the water in an unresponsive state were given a 100% mortality rate. For applicability to fishery management actions, the records were organized by major gear type. For each gear type, mortality rates were calculated by determining the number of dead turtles in each category (i.e., total number of interactions multiplied by mortality percentage) and dividing the total number of dead turtles by the total number of interactions.

Additional factors that may influence sea turtle post-interaction mortality were considered; however, substantial uncertainty (e.g., small sample size) in the dataset precluded meaningful statistical comparisons. Nonetheless, key characteristics, such as month, specific fishery (within an encompassing gear type), geographical area, sea turtle species, and life stage, are included here to provide a detailed description of the dataset. It should also be noted that observer effort is not evenly distributed. In some cases, there may have been focused observer effort in a particular area or fishery, which will be noticeable in the results.

The workgroup evaluated the post-interaction mortality determinations by fishery to assist with section 7 consultations on federal Fishery Management Plans. That said, the fishery identified here is essentially a proxy for gear characteristics and fishing methods, which have more influence on turtle mortality than the actual species caught. Delineation of fishery within a gear type was based on the greatest quantity of landed fish species by weight for the trip, as recorded by fishery observers. The primary landed species was determined to be a better proxy for the actual fishery instead of trip or haul target, as the target recorded may not reflect the fish species actually caught on the trip or the way the gear is prosecuted (which may affect sea turtle mortality). For the purposes of this report, the primary landed fish species by weight by trip is used synonymously with "fishery."

Geographical distribution of the observed interactions is provided by the latitude and longitude included on the observer logs. The latitude/longitude represents the position at the beginning of the haul for mobile gear or at the end of the haul for fixed gear. The latitude/longitude coordinates were plotted in an ArcMap Geographic Information System (GIS) to provide a geographical depiction of the interactions. The workgroup also referred to the NMFS Northeast Statistical Areas to help describe geographic distribution (Appendix B).

Probability of mortality was considered the same for all sea turtle species based on the Technical Guidelines (Upite 2011); however, this recommendation was based on insufficient data to support species differences. Data for individual species were considered and presented here to detect any differences in injury category that would warrant further consideration of this approach.

The sizes of the observed turtles were evaluated to determine if one life stage was being disproportionately affected or if injury rate varied by life stage. Categorization by size class was largely limited to loggerheads (*Caretta caretta*), given the predominance of this species in the records reviewed. Onboard fishery observers measured curved carapace length[2] (CCL), and the workgroup made the assumption that all of the recorded sizes were accurate. Turtles with estimated (not measured) sizes were not included. Size class categories were developed from the 2008 loggerhead recovery plan (NMFS and USFWS 2008) but were modified so that individuals

[2] Curved carapace length of the turtle was measured as the distance between the center of the nuchal scute at the anterior of the carapace and the posterior tip of the longest marginal scute, following the curvature of the dorsal centerline.

could be assigned into mutually exclusive groups (Table 1). These size class definitions are for the purposes of this report and are not intended to imply alteration to size classes defined in the recovery plan for other purposes. Furthermore, the workgroup recognizes that such definitions inevitably result in misclassification of some individuals given the variability in sea turtle life history. The green (*Chelonia mydas*) and Kemp's ridley (*Lepidochelys kempii*) life stages were also estimated from carapace sizes in the respective recovery plans (NMFS and USFWS 1991; NMFS, USFWS, and SEMARNAT 2011). No leatherback turtles (*Dermochelys coriacea*) had carapace sizes recorded.

RESULTS AND DISCUSSION

All 153 observed sea turtle interactions in the NEFOP (n = 133) and ASM (n = 20) databases from 2011 to 2015 were reviewed, including 101 trawl records, 47 gillnet records, 4 dredge records, and 1 pot/trap record. There were 4 trawl (1 loggerhead, 3 unknown) and 3 gillnet (1 loggerhead, 2 unknown) records with insufficient information to make a determination, and 4 trawl (3 loggerheads, 1 unknown) and 1 dredge (loggerhead) record that consisted of moderately to severely decomposed animals not attributable to the fishery in question. A total of 141 observer records were used to calculate post-interaction mortality.

The workgroup calculated injury determinations and post-interaction mortality rates by gear type (Table 2). Of the total number of records reviewed and for which determinations were made (n = 141), the workgroup determined that 34% of the documented interactions were in Category I, 20% in Category II, 17% in Category III, and 29% had a 100% probability of mortality (Table 2).

Trawl Gear

There were 97 observed interactions in fish bottom otter trawls, 3 interactions in scallop bottom otter trawls, and 1 interaction in a twin trawl from 2011 to 2015. All trawl gear records were combined for applicability to section 7 consultations and are hereby referred to as "trawl gear."

After the records with insufficient information (n = 4) and not attributable to the gear interaction in question (n = 4) were removed, post-interaction mortality determinations were made for 93 interactions involving trawl gear. The resulting mortality rate for observable interactions in trawl gear for 2011-2015 is 50% (Table 3).

To identify any annual biases, injury categories by year were considered (Figure 1). The highest number of observed interactions was in 2012 (n = 25), followed by 2014 (n = 23), and the lowest number was in 2015 (n = 14). The injury category distribution appears relatively consistent, even though most of the 2015 interactions were in Category I. Overall, it does not appear that 1 year biased the overall results based upon our qualitative assessment.

Seasonality was also considered to assess whether warmer months or the beginning or end of turtles' residency in the GAR would influence post-interaction mortality. The number of observed interactions was notably highest in October, followed by September and February (Figure 2). Those interactions with 100% mortality mostly occurred later in the year, from September to November. Other than that, the proportion of post-interaction mortality determinations appear relatively consistent among months. The level of observer coverage by month (largely determined by distribution of fishing effort) and the fisheries prosecuted at

various times of the year should be considered when interpreting these results. For instance, sea turtles are not considered common in the GAR (Maine to Virginia) in February; all February interactions occurred in the Atlantic croaker (*Micropogonias undulatus*) fishery off North Carolina, which is not managed under a federal Fishery Management Plan or covered by an existing GARFO Biological Opinion.

Observers recorded the highest number of sea turtle interactions in the longfin squid (*Loligo pealeii*) fishery (32%), Atlantic croaker fishery (27%), and summer flounder (*Paralichthys dentatus*) fishery (14%) (Table 4). Overall, there did not appear to be any proportional differences in the injury category determinations across fisheries.

Considering the geographic distribution of trawl observations, a few patterns emerge in terms of bycatch location (also see Murray 2015), but there are no clear patterns in terms of post-interaction mortality (Figure 3). For example, a cluster of interactions was found off North Carolina (Statistical Areas 635 and 636 combined; Figure 3, Appendix B), and Category I, II, and III are all represented relatively equally with only 1 turtle determined dead. This same pattern was seen in the concentration of interactions off southern Long Island, NY. Overall, post-interaction mortality determinations did not appear to differ substantially in different geographic regions. Again, for all of these results, the distribution of observer coverage, as well as the relatively small observed sample sizes, should be considered.

The vast majority of trawl records involved loggerheads (88%), followed by Kemp's ridleys (4%), greens (3%), leatherbacks (2%), and unknown species (2%) (Table 3). The small sample size for the non-loggerheads makes it difficult to interpret any post-interaction mortality differences by species. In the trawl gear observer records from 2011 to 2015, there were 69 records with sizes measured for loggerheads. Based on sizes recorded by fishery observers, the life stages assigned are indicative of the turtle life stages presumed to be found in the GAR. That is, most of the trawl gear interactions involved neritic, immature turtles (n = 43; Figure 4). Of these neritic, immature turtles, the records were split relatively equally between Category I (slightly higher), II, and III. Fourteen cases involved adult sized loggerheads, and 12 interactions were with turtles in the transitional phase (immature turtles split between neritic and oceanic environments). Category I determinations ranked the highest in both of these life stages (6 cases each). While the number of adult mortalities in relation to the other injury categories is notable (Figure 4), overall it does not appear that one size class was represented disproportionately among injury categories or mortalities. There were no oceanic immature loggerheads in the 2011-2015 records.

For non-loggerheads, there were 6 animals in trawl gear with carapace sizes recorded. Three Kemp's ridleys were observed with sizes of 22.7, 24.7, and 29.7 cm CCL, all in Category I. One green with a size of 25.6 cm CCL was determined to be in Category I, another green was 27.4 cm CCL and in Category III, and a third green turtle at 31 cm CCL was determined dead. All of these hard-shelled sea turtles are considered immature. The sample sizes are too small to make any assumptions about size classes and injury categories.

Gillnet Gear

For gillnet gear, there were 47 records reviewed from 2011 to 2015. Most records (n = 43) were classified as "sink gillnet, fixed or anchored, other species" in the observer database, and 4 records involved "drift-sink gillnets, fish." All records were combined and are hereby referred to as "gillnet gear." After the records with insufficient information (n = 3) were

removed, injury category determinations were made for 44 interactions involving gillnet gear. The resulting mortality rate for observable interactions in gillnet gear is 79% (Table 5).

As with trawls, injury categories by year were considered to identify if the 5-year injury rate was skewed by interactions in any given year (Figure 5). Three years (2012, 2014, and 2015) had similarly higher number of records (n = 11-14), while 2011 and 2013 only had 4 cases each. Proportionally more dead turtles were observed in 2014 (n = 10), but that is not inconsistent among the 5-year period as half or more cases were recorded as 100% mortality in other years (range 2-8 cases). Considering the relatively small sample size for each year and our qualitative assessment, it does not appear that 1 year biased the overall results.

In terms of month, Category II determinations mostly occurred earlier in the year (March/April), while the rest of the year was mostly split between Category I and dead turtles (Figure 6). No real seasonal trends in post-interaction mortality were apparent. Our interpretation of injury determinations by month assumes that even observer coverage was achieved throughout the year. As with trawls, the level of observer coverage by month and the fisheries prosecuted at various times of the year should be considered when interpreting these results.

Observers recorded the highest number of sea turtle interactions in the monkfish (*Lophius americanus*) fishery, with 100% mortality being determined for 75% of those interactions (Table 6). The winter skate (*Leucoraja ocellata*) fishery had 15 observed interactions, and similarly, 80% of those cases were found to be dead. All of the spiny dogfish interactions (n = 5) were of dead turtles.

The highest concentration of gillnet gear interactions occurred in the waters off the tip of Long Island, NY, to Martha's Vineyard, MA, which involved Statistical Areas 537 (n = 17) and 613 (n = 5) (Figure 7, Appendix B). The majority of these interactions resulted in death (77%). The vast majority of turtles were found dead in other notable groupings off Cape Cod, MA (n = 4/5, Statistical Area 521) and off the northern New Jersey coast (n = 4/4, Statistical Area 612). Whereas off the Outer Banks, NC (Statistical Area 635), 4 out of 5 interactions fell into Category I. For all of these results, the representativeness of observer coverage, as well as the small observed sample sizes, should be considered.

Loggerhead turtles had the highest number of observed gillnet interactions (61%), followed by Kemp's ridleys (18%), unknown species (14%), leatherbacks (5%), and green turtles (2%) (Table 5). Again, the small number of non-loggerheads prevents a full species comparison of post-interaction mortality determinations, but there does not appear to be any notable species differences in the results. In the gillnet observer records from 2011 to 2015, there were 15 turtles with carapace sizes recorded. Of the 9 loggerheads with sizes recorded, 6 were in the transitional (oceanic or neritic) immature phase (2 Category II, 1 Category III, 3 dead), while 3 were neritic immature turtles (1 Category I, 2 dead). The 5 immature Kemp's ridleys measured between 29.5 and 39 cm CCL (3 of which were dead, 2 in Category I). The green turtle (Category I) had a measurement of 30 cm CCL. From this limited information, it does not appear that one life stage is disproportionately affected by gillnet fisheries for any of the 3 hard-shelled sea turtle species.

Dredge Gear

For dredge fishing gear, which only involved scallop dredges, 4 records were reviewed from 2011 to 2015. One case involved a severely decomposed loggerhead not related to the gear in question, so that case was removed from the analysis. The resulting mortality rate for observable interactions in dredge gear is 67% (Table 7). However, given the small sample size of

observer records for this gear type, this mortality rate should be treated with caution. No differences in injury category determinations were apparent by month, year, geographical location, or species (Table 7, Figure 8).

The scallop dredge mortality rate calculated by the workgroup is less critical to management than some of the other gear types. Scallop dredge vessels fishing west of 71° W longitude from May 1 through November 30 are required to use a Turtle Deflector Dredge (TDD) and chain mats (50 CFR 223.206(d)(11); 50 CFR 648.51(b)(5)(ii)(A)). Previously, the TDD dredge with chain mats was estimated to have a maximum estimated serious injury rate of 28% (Smolowitz et al. 2010; NEFMC 2011; NMFS 2012). This mortality rate is applied to scallop dredge gear west of 71° W longitude in the Atlantic Sea Scallop Biological Opinion (NMFS 2012). As the gear modifications are only required in certain areas and times, the post-interaction mortality rate calculated by the Northeast Sea Turtle Injury Workgroup could be considered for scallop dredges fishing from December 1 to April 30 as well as those vessels fishing east of 71° W longitude. From 2011 to 2015, 2 of the dredge interactions were outside the time period of the gear modification requirements, and the third interaction involved a small Kemp's ridley (29 cm CCL) that likely passed through the chain mat configuration (Table 7).

Pot/Trap Gear

There was 1 pot/trap record in 2014 (a dead leatherback in statistical area 539 off Rhode Island). This was the first NEFOP/ASM reported interaction in this gear type, and thus the resulting mortality for observable interactions in pot/trap gear is 100% (Table 2). However, given the extremely small sample size of observer records for this gear type, this mortality rate should be treated with caution.

COMPARISON TO PREVIOUS DETERMINATIONS

The workgroup started reviewing observed sea turtle interaction cases for post-interaction mortality in 2011, with the first assessment review going back 5 years to 2006-2010. Those results are published in Upite et al. (2013). Since that time, the workgroup has reviewed the most current year of observer records annually and calculated an updated rolling 5-year post-interaction mortality rate for trawl, gillnet, and dredge gear. Those mortality rates have been shared through internal memos and used in section 7 consultations and Biological Opinion monitoring when needed.

There are some consistent patterns in mortality percentages for the six 5-year time periods for which post-interaction mortality has been calculated (2006-2015) (Figure 9). Pot/trap gear is not included as there is only 1 record for that gear type. Considering the different gear types, trawl gear has consistently had the lowest post-interaction mortality of all gear types (average 48.5%). Gillnet gear has had the next lowest mortality rate, with an average of 67.5%. Dredge gear has had a higher overall mortality percentage (79.8%) compared to gillnet and trawl gear. This trend is not surprising given the nature of the gear (e.g., heavy, bottom dragging gear). However, the number of observed interactions (and presumed overall fishery mortality rate) in dredge gear has decreased since the TDD and chain mat gear modifications described earlier were enacted because the gear modifications were intended to minimize the number of turtles injured and caught in the dredge bag. As such, the mortality rates for the 5-year periods with

only a few turtle observations in dredge gear are uncertain and should be considered accordingly.

In terms of variability within gear types over the time period assessed, the post-interaction mortality percentage for trawl gear has been most consistent. The overall mortality rate for trawl gear has ranged from 46 - 52%, whereas gillnet mortality rates ranged from 57 - 84% (Figure 9). Greater interperiod variability in mortality assigned to gillnet interactions may reflect a smaller sample size, which averaged 37 records per 5-year period as compared to 96 per 5-year period for trawl interactions. Inconsistency in mortality rates in gillnet gear could also be a function of the nature of the gear interaction because turtles found in gillnet gear are often either alive and uninjured (Category I) or dead. If more or fewer dead turtles are found in 1 year, that difference has a strong effect on the 5-year mortality rate, which would be exacerbated by a small sample size. For example, in the 2010-2014 and 2011-2015 time periods, there were large numbers of dead turtles found on gillnet trips in 2012-2014, which resulted in higher overall mortality rates. For all gear types, biologists should be aware of the potential variability between 5-year periods when using these results during section 7 consultations and monitoring.

To evaluate patterns in post-interaction mortality, the workgroup reviewed the location, injury category, and gear type for all observed sea turtle interactions for which post-interaction mortality determinations were made (Figure 10). The frequency of Category I, II, III, and dead turtles appears relatively consistent throughout the region. The only patterns that stand out are a concentration of dead gillnet interactions in the waters between Long Island, NY, and Martha's Vineyard, MA, (offshore Rhode Island/Massachusetts) and a cluster of Category I cases in North Carolina in both trawl (offshore Cape Hatteras) and gillnet gear (by Cape Lookout). Overall, by qualitatively considering the patterns seen in Figure 10, it appears that post-interaction mortality results are not necessarily a function of location, but rather gear type, operational procedures, and possibly fishery. These distributional conclusions should be treated with caution, as observer effort is not evenly distributed. Further, protected species and fishing regulations dictate differences in the way gear is fished in different times and areas, which could influence the probability and severity of a sea turtle interaction.

The mortality rates presented here are indicators of the impacts certain gear types have on sea turtle survival. As noted in earlier documents, it is the workgroup's recommendation that the calculated mortality percentages be applied to the observable portion of the total estimated incidental take for the respective gear types in each Fishery Management Plan managed by the GARFO, in order to develop a lethal incidental take estimate by gear type.

The workgroup has used the best available information over time to consistently develop post-interaction mortality determinations since 2006. In future years, the new national guidance (NMFS 2017) will be applied, and subsequent assessments will evaluate if previous results (for the 5-year period in question) need to be modified given those changes in the guidance.

ACKNOWLEDGEMENTS

This analysis would not be possible without the diligent collection of data by NEFOP and ASM observers, in particular the collection of photos and video. The workgroup also appreciates the work of the NEFSC Fishery Sampling Branch staff to clarify and elaborate upon the observer logs and comments. Thank you to David Hiltz, NEFSC, for photo tech support and Ellen Keane, GARFO, for preparing the maps.

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Table 1. Loggerhead (*Caretta caretta*) size classes used for injury category determinations (based on NMFS and USFWS 2008).

Size class for categorization by injury workgroup	Curved carapace length (cm)
Oceanic phase, immature	8.5-46.0
Transitional phase (oceanic or neritic), immature	46.01-64.0
Neritic phase, immature	64.01-87.0
Adult[1]	>87.0

Table 2. The number of sea turtle observer records from 2011 - 2015 in each injury category by gear type, as well as the overall post-release mortality percentage by gear type.

	Category I (20% mortality)	Category II (50% mortality)	Category III (80% mortality)	100% mortality	TOTAL	Overall mortality percentage
Trawl	38	24	22	9	**93**	**50%**
Gillnet	9	4	1	30	**44**	**79%**
Dredge	1	0	1	1	**3**	**67%***
Pot/trap	0	0	0	1	**1**	**100%***
TOTAL	**48**	**28**	**24**	**41**	**141**	

*While this represents the calculated mortality percentage for turtles observed in these gear types, the small sample size should be considered when interpreting the results.

[1] The recovery plan has an additional category for adult males (>83 cm CCL), which overlaps with the size range for neritic immature loggerheads (46-87 cm CCL). The workgroup reviewed the available tail photographs of those loggerheads between 83-87 cm CCL (n = 3) to ensure that they should be included in the immature neritic phase. (In sea turtles, tail length is a secondary sex characteristic; adult males have long tails while females have short tails. Tail length does not indicate an individual's sex for juvenile sea turtles.)

Table 3. The number and corresponding injury category of sea turtles observed captured in trawl gear, 2011 - 2015.

	Category I (20% mortality)	**Category II (50% mortality)**	**Category III (80% mortality)**	**100% mortality**	**TOTAL**	**Mortality Percentage**
Loggerhead *(Caretta caretta)*	32	22	20	8	**82**	
Leatherback *(Dermochelys coriacea)*	0	2	0	0	**2**	
Kemp's ridley *(Lepidochelys kempii)*	3	0	1	0	**4**	
Green *(Chelonia mydas)*	1	0	1	1	**3**	
Unknown	2	0	0	0	**2**	
TOTAL	**38**	**24**	**22**	**9**	**93**	
Percentage of turtles in each category[1]	41%	26%	24%	10%		
Dead turtles *(total * mortality %)*	**7.6**	**12**	**17.8**	**9**	**46.4**	**50%**

[1] The combined percentages do not equal 100% because of rounding.

Table 4. The number and corresponding injury category of sea turtles observed captured in trawl gear by fishery, 2011 - 2015.

		Category I (20% mortality)	Category II (50% mortality)	Category III (80% mortality)	100% mortality	TOTAL
Fishery	Atlantic cod (*Gadus morhua)*	1	0	0	0	1
	Atlantic croaker *(Micropogonias undulatus)*	9	10	5	1	25
	Atlantic sea scallop *(Placopecten magellanicus)*	1	0	1	0	2
	Butterfish *(Peprilus triacanthus)*	1	0	1	2	4
	Horseshoe crab *(Limulus polyphemus)*	3	0	0	0	3
	Little skate *(Leucoraja erinacea)*	2	0	0	0	2
	Longfin squid *(Loligo pealeii)*	7	8	11	4	30
	Monkfish *(Lophius americanus)*	1	0	1	0	2
	Northern shortfin squid *(Illex illecebrosus)*	0	1	0	0	1
	Scup *(Stenotomus chrysops)*	2	1	1	0	4
	Skate *(specific species not known)*	0	1	0	0	1
	Summer flounder *(Paralichthys dentatus)*	9	1	1	2	13
	Silver hake *(Merluccius bilinearis)*	1	0	0	0	1
	Winter flounder *(Pseudopleuronectes americanus)*	1	1	0	0	2
	Winter skate *(Leucoraja ocellata)*	0	1	0	0	1
	Yellowtail flounder *(Limanda ferruginea)*	0	0	1	0	1
	TOTAL	**38**	**24**	**22**	**9**	**93**

Table 5. The number and corresponding injury category of sea turtles observed captured in gillnet gear, 2011 - 2015.

	Category I (20% mortality)	**Category II (50% mortality)**	**Category III (80% mortality)**	**100% mortality**	**TOTAL**	**Mortality Percentage**
Loggerhead *(Caretta caretta)*	5	4	1	17	**27**	
Leatherback *(Dermochelys coriacea)*	0	0	0	2	**2**	
Kemp's ridley *(Lepidochelys kempii)*	3	0	0	5	**8**	
Green *(Chelonia mydas)*	1	0	0	0	**1**	
Unknown	0	0	0	6	**6**	
TOTAL	**9**	**4**	**1**	**30**	**44**	
Percentage of turtles in each category[1]	20%	9%	2%	68%		
Dead turtles *(total * mortality %)*	**1.8**	**2**	**0.8**	**30**	**34.6**	**79%**

[1]The combined percentages do not equal 100% because of rounding.

Table 6. The number and corresponding injury category of sea turtles observed captured in gillnet gear by fishery, 2011 - 2015.

		Category I (20% mortality)	Category II (50% mortality)	Category III (80% mortality)	100% mortality	TOTAL
Fishery	Atlantic menhaden *(Brevoortia tyrannus)*	1	0	0	0	1
	Clearnose skate *(Raja eglanteria)*	0	1	0	0	1
	King mackerel *(Scomberomorus cavalla)*	1	0	0	0	1
	Monkfish *(Lophius americanus)*	0	3	1	12	16
	Skate *(specific species not known)*	1	0	0	0	1
	Southern flounder *(Paralichthys lethostigma)*	1	0	0	0	1
	Spanish mackerel *(Scomberomorus maculatus)*	2	0	0	0	2
	Spiny dogfish *(Squalus acanthias)*	0	0	0	5	5
	Summer flounder *(Paralichthys dentatus)*	0	0	0	1	1
	Winter skate *(Leucoraja ocellata)*	3	0	0	12	15
	TOTAL	**9**	**4**	**1**	**30**	**44**

Table 7. The number and corresponding injury category of sea turtles observed captured in dredge gear, 2011 - 2015.

	Category I (20% mortality)	Category II (50% mortality)	Category III (80% mortality)	100% mortality	DATE	TOTAL	Mortality Percentage
Loggerhead *(Caretta caretta)*	0	0	0	1	12/2011		
Loggerhead *(Caretta caretta)*	1	0	0	0	12/2015		
Kemp's ridley *(Lepidochelys kempii)*	0	0	1	0	10/2015		
TOTAL	**1**	**0**	**1**	**1**		**3**	
Percentage of turtles in each category[1]	33%	0%	33%	33%			
Dead turtles *(total * mortality %)*	**0.2**	**0**	**0.8**	**1**		**2**	**67%**

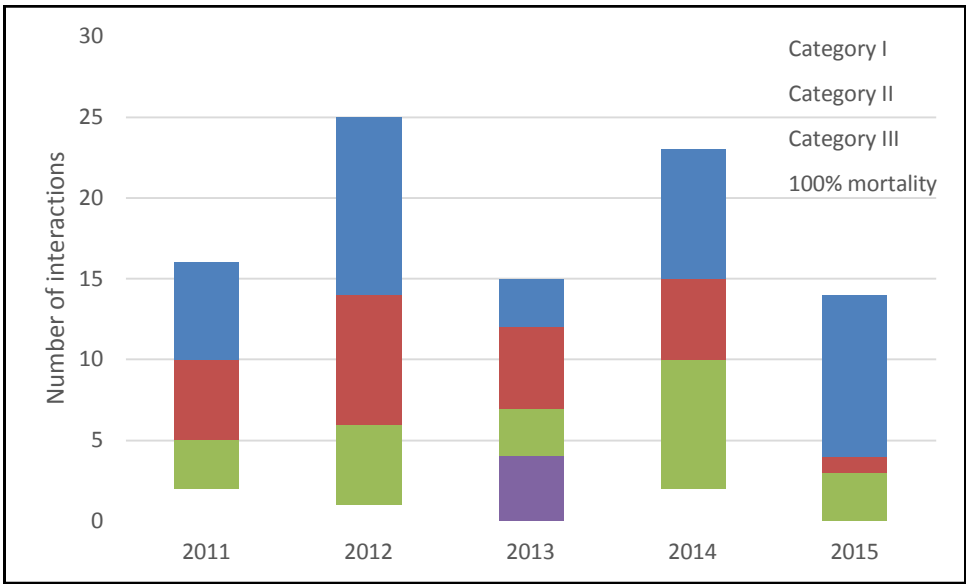


Figure 1. The number and corresponding injury category of sea turtles observed captured in trawl gear by year. Category I is defined as those turtles with a 20% probability of post-release mortality, Category II cases have a 50% probability of post-release mortality, and Category III cases have an 80% probability of post-release mortality.

[1] The combined percentages do not equal 100% because of rounding.

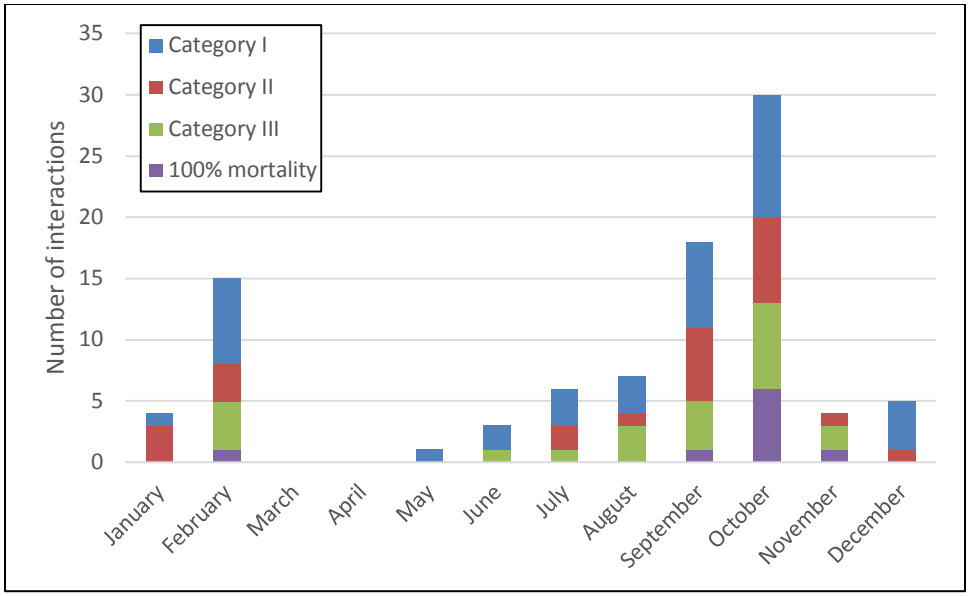


Figure 2. The number and corresponding injury category of sea turtles observed captured in trawl gear by month, 2011 - 2015. Category I is defined as those turtles with a 20% probability of post-release mortality, Category II cases have a 50% probability of post-release mortality, and Category III cases have an 80% probability of post-release mortality.

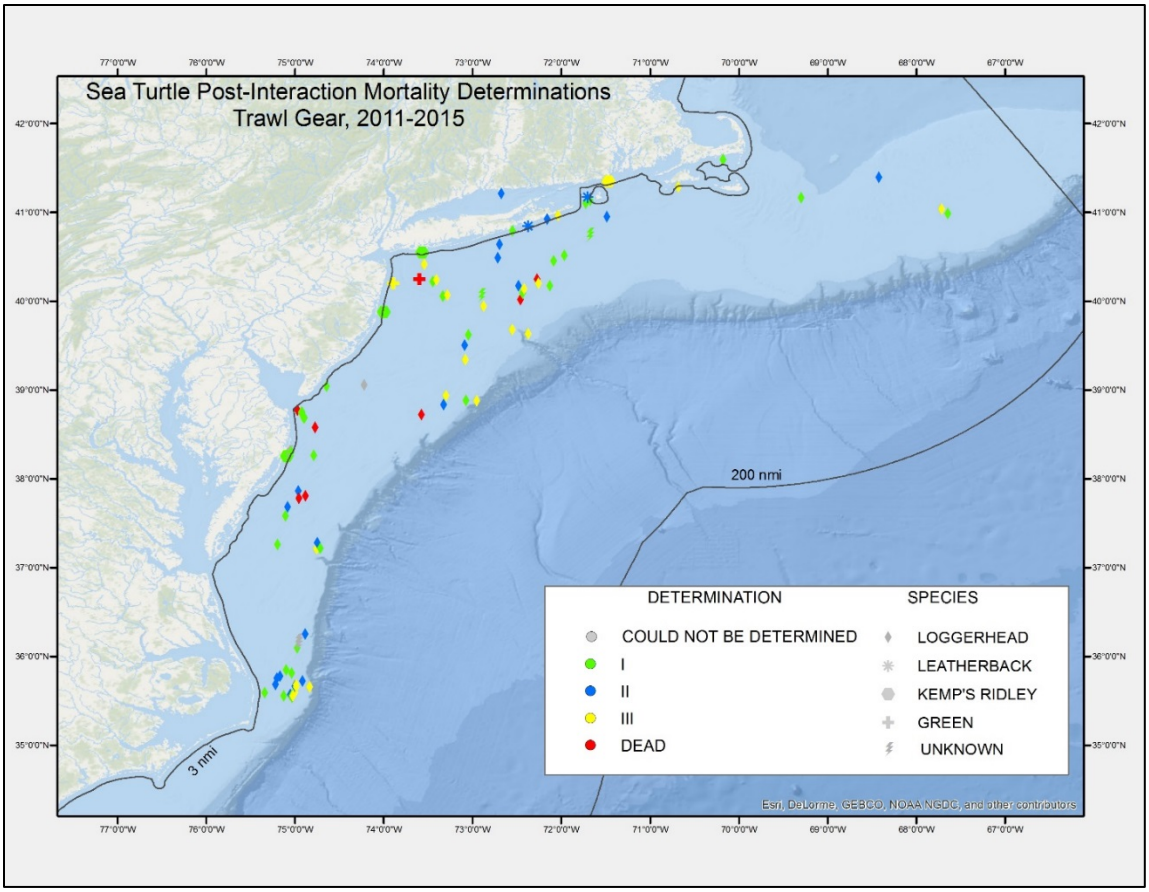


Figure 3. The location and corresponding injury category of observed sea turtle interactions in trawl gear, 2011 - 2015. Category I is defined as those turtles with a 20% probability of post-release mortality, Category II cases have a 50% probability of post-release mortality, and Category III cases have an 80% probability of post-release mortality. Species presented include loggerhead (*Caretta caretta)*, leatherback (*Dermochelys coriacea*), Kemp's ridley (*Lepidochelys kempii*), and green (*Chelonia mydas*) turtles.

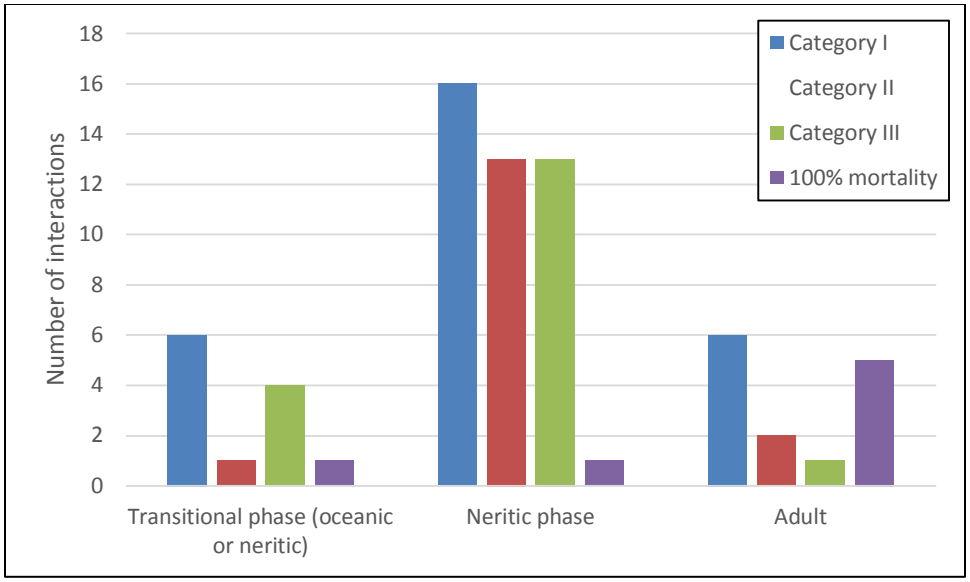


Figure 4. Life stage and injury determinations for loggerheads (*Caretta caretta*) captured in trawl gear, 2011 - 2015. Transitional phase (oceanic or neritic) indicates immature loggerheads (46.01 - 64.0 cm CCL); neritic phase indicates immature loggerheads (64.01 - 87.0 cm CCL); adult indicates mature loggerheads (>87.0 cm CCL). Category I is defined as those turtles with a 20% probability of post-release mortality, Category II cases have a 50% probability of post-release mortality, and Category III cases have an 80% probability of post-release mortality.

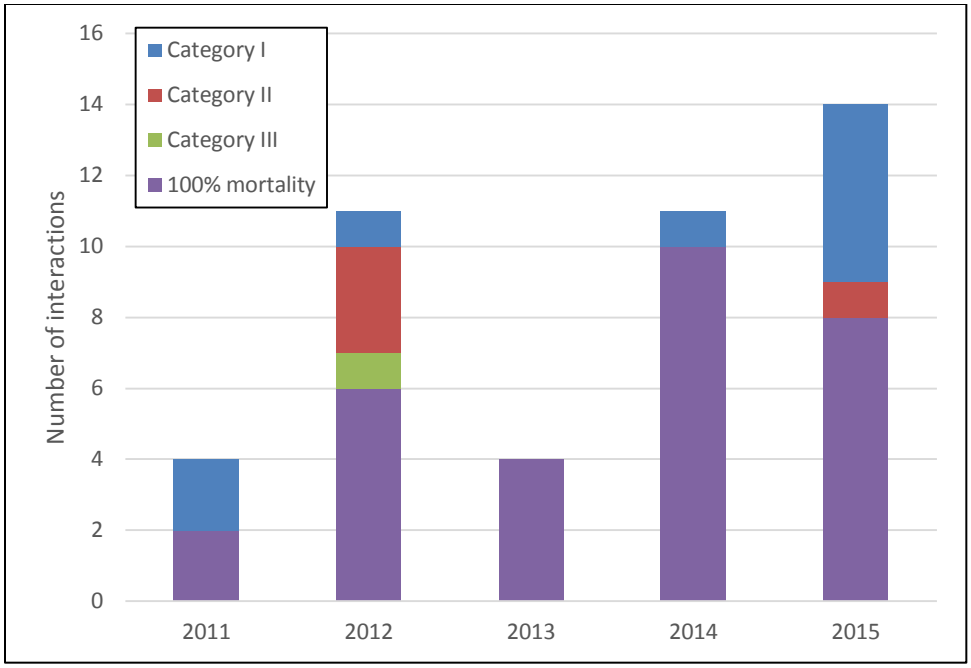


Figure 5. The number and corresponding injury category of sea turtles observed captured in gillnet gear by year. Category I is defined as those turtles with a 20% probability of post-release mortality, Category II cases have a 50% probability of post-release mortality, and Category III cases have an 80% probability of post-release mortality.

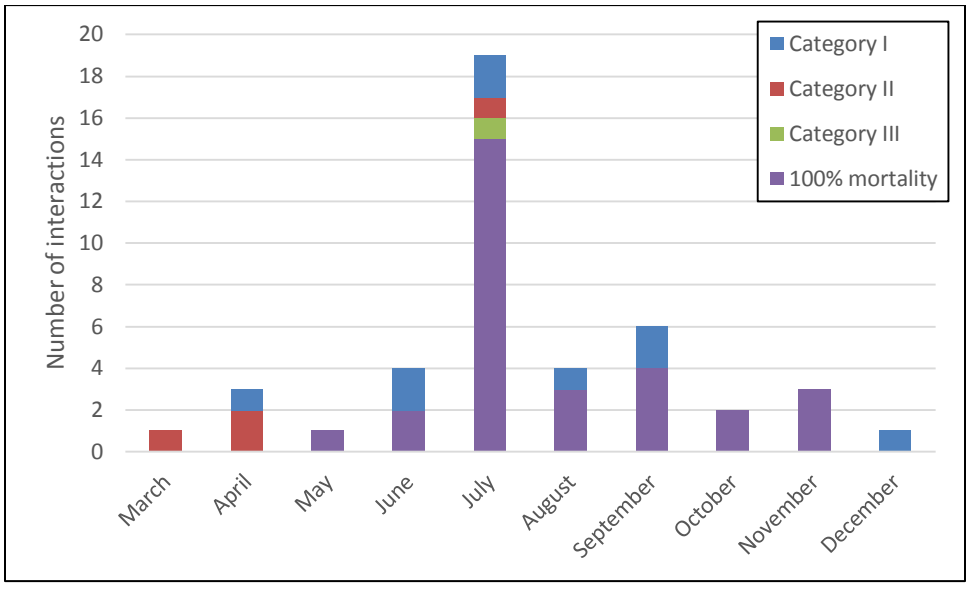


Figure 6. The number and corresponding injury category of sea turtles observed captured in gillnet gear by month, 2011 - 2015. Category I is defined as those turtles with a 20% probability of post-release mortality, Category II cases have a 50% probability of post-release mortality, and Category III cases have an 80% probability of post-release mortality.

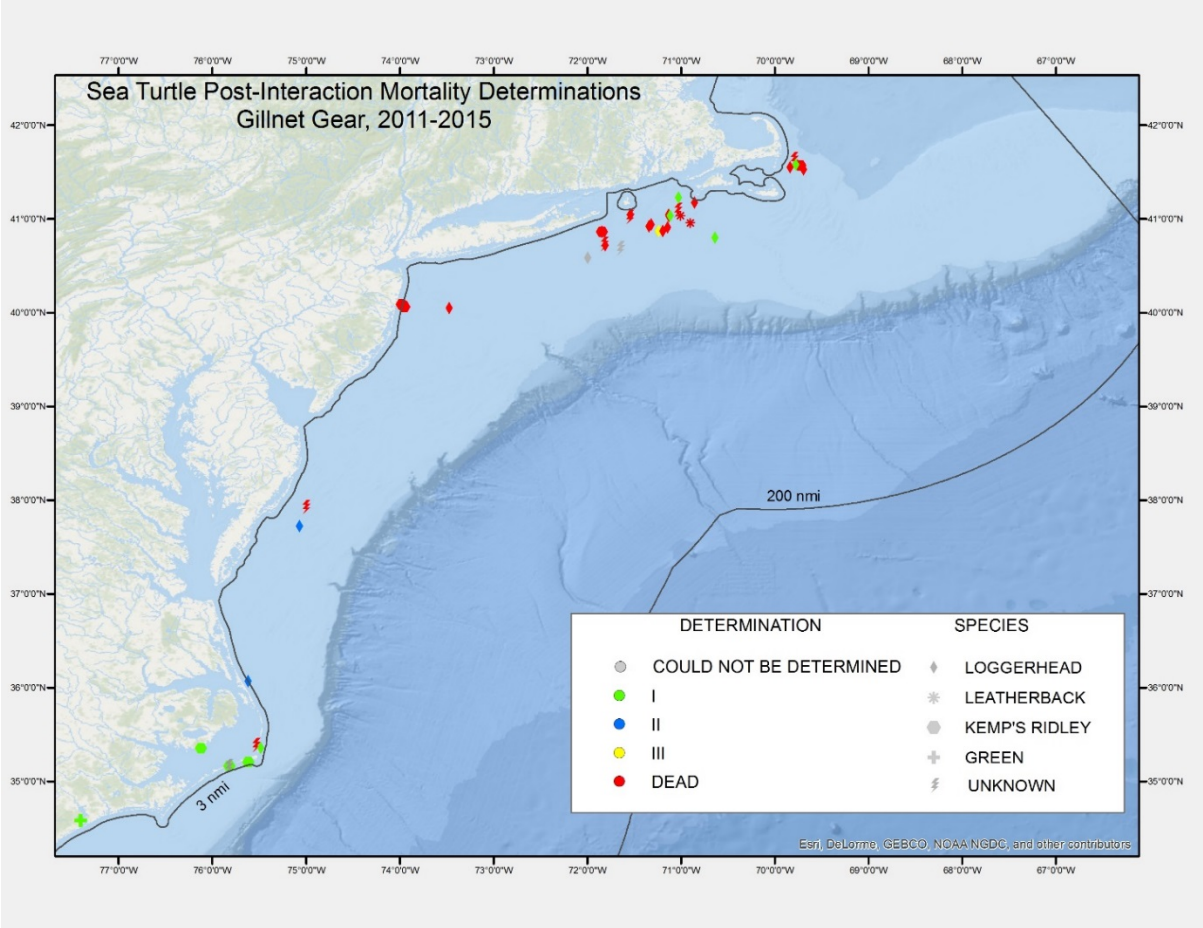


Figure 7. The location and corresponding injury category of observed sea turtle interactions in gillnet gear, 2011 - 2015. Category I is defined as those turtles with a 20% probability of post-release mortality, Category II cases have a 50% probability of post-release mortality, and Category III cases have an 80% probability of post-release mortality. Species presented include loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*), Kemp's ridley (*Lepidochelys kempii*), and green (*Chelonia mydas*) turtles.

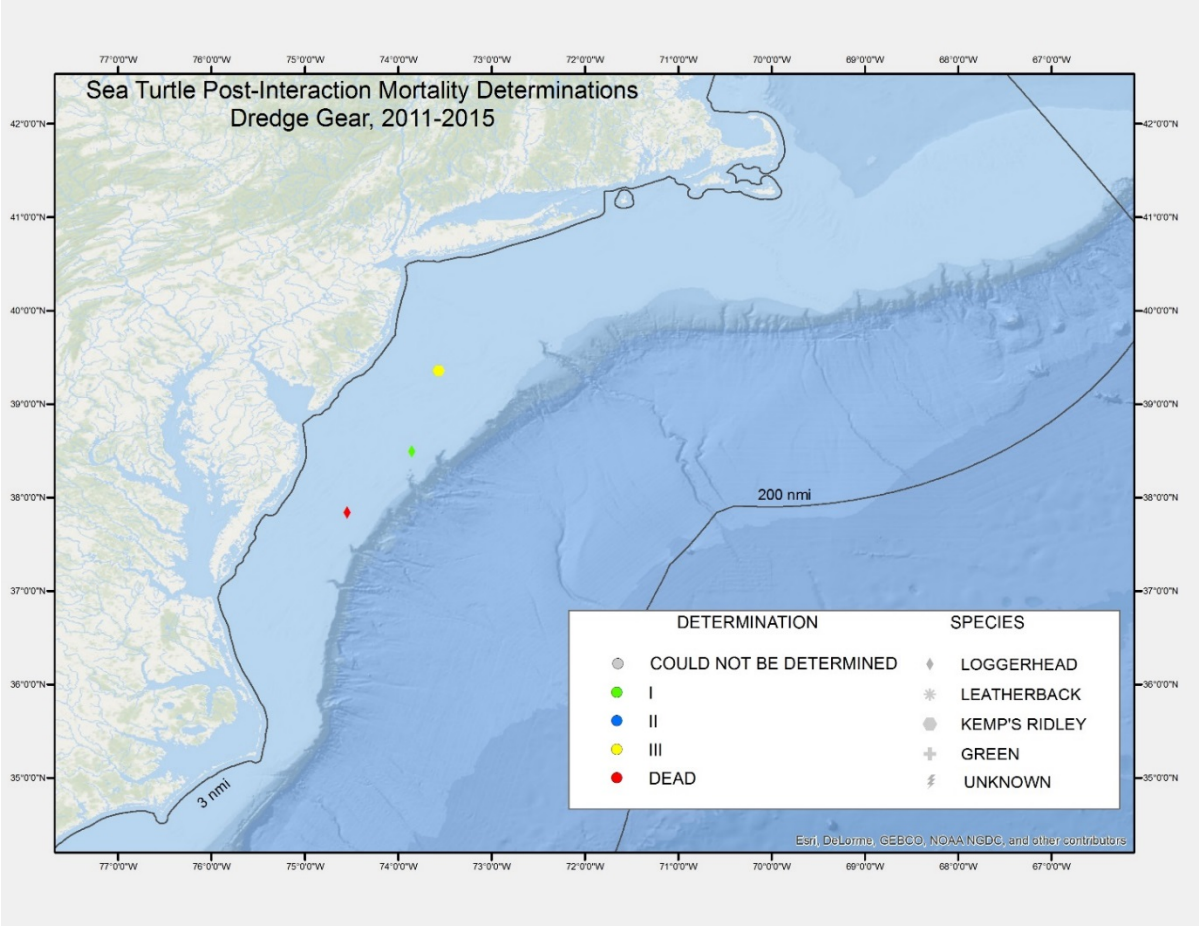


Figure 8. The location and corresponding injury category of observed sea turtle interactions in dredge gear, 2011 - 2015. Category I is defined as those turtles with a 20% probability of post-release mortality, Category II cases have a 50% probability of post-release mortality, and Category III cases have an 80% probability of post-release mortality. Species presented include loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*), Kemp's ridley (*Lepidochelys kempii*), and green (*Chelonia mydas*) turtles.

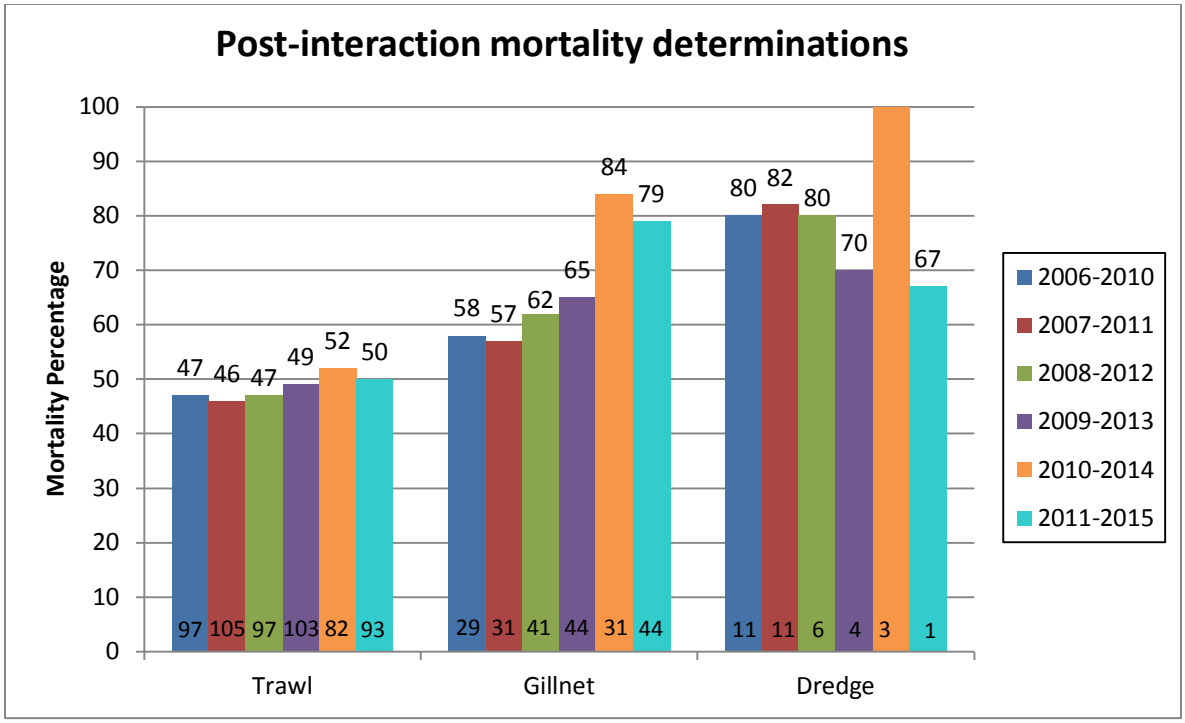


Figure 9. Post-interaction mortality determinations by gear type for each 5-year period reviewed. The number of records reviewed is contained inside the bars, and 5-year mortality rate is at top of bar.

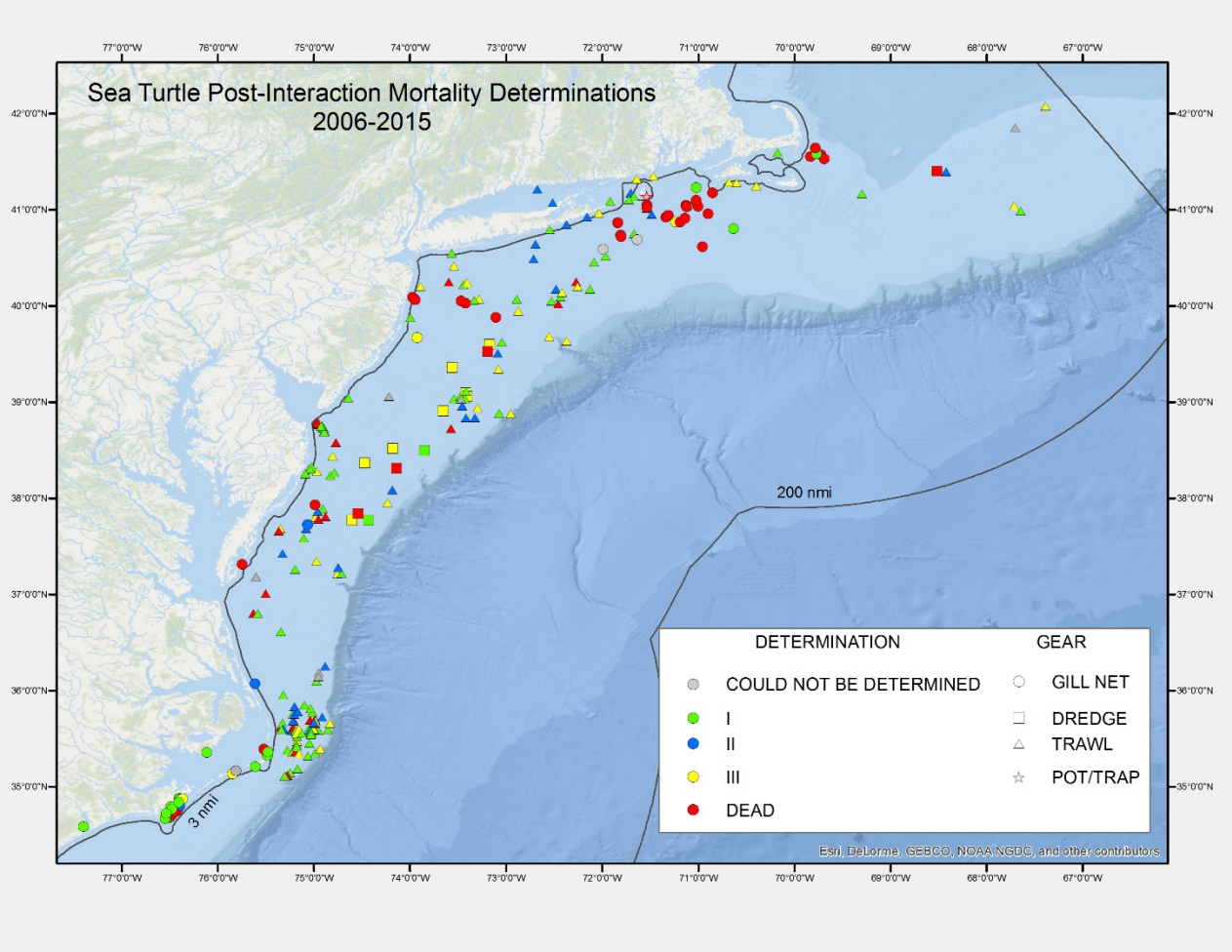


Figure 10. The location and corresponding injury category of observed sea turtle interactions in all trawl, gillnet, dredge and pot/trap gear, 2006 - 2015. Note 3 additional records in other fishing gear types from 2006 - 2010 were reviewed and determinations were made, but the results are excluded here because of confidentiality requirements. Category I is defined as those turtles with a 20% probability of post-release mortality, Category II cases have a 50% probability of post-release mortality, and Category III cases have an 80% probability of post-release mortality.

APPENDIX A. TECHNICAL WORKING GUIDELINES

November 2013

TECHNICAL WORKING GUIDELINES
FOR ASSESSING INJURIES OF SEA TURTLES
OBSERVED IN NORTHEAST REGION FISHING GEAR[1]

Category I – Low probability of mortality (20% mortality rate)

- Any shell fractures of the area of the marginal scutes, involving less than 50% of width of the underlying peripheral bone
- Superficial abrasions, chips, or scuffs to carapace or plastron
- Minor or superficial injuries to skin
- Animals with no apparent injuries and active normal behavior (including diving after release)

Category II – Intermediate probability of mortality (50% mortality rate)

- Any shell fractures of the area of the marginal scutes, involving 50% or more of width of the underlying peripheral bone
- Injuries to flippers (including ligature wounds), which may impair movement or function
- Injuries to one eye
- Lethargic, but becomes active before release
- Observed for at least two minutes after release and remains at surface

Category III – High probability of mortality (80% mortality rate)

- Any shell fracture, excluding marginals
- Fractures or wounds penetrating the body cavity
- Evidence of bleeding from cloaca, nares, eyes, or oral cavity, unrelated to superficial wounds
- Skull or mandibular fracture
- Injuries to both eyes
- Injuries to neck (including ligature wounds) which affects the spinal cord, major blood vessels, or airway
- Amputation of half or more of one or more flippers
- Any open fracture of major long bones
- Behavioral abnormality, including circling, not using all four flippers appropriately, head tilting, not raising head, not breathing, eyes closed, listing/rolling, lethargic at release, inability to right itself in the water
- Unresponsive[2], revived, and released
- Any remaining gear left on the animal at release

If an animal is found with multiple injuries in different categories, the animal should be placed in the category encompassing the most severe of the injuries.

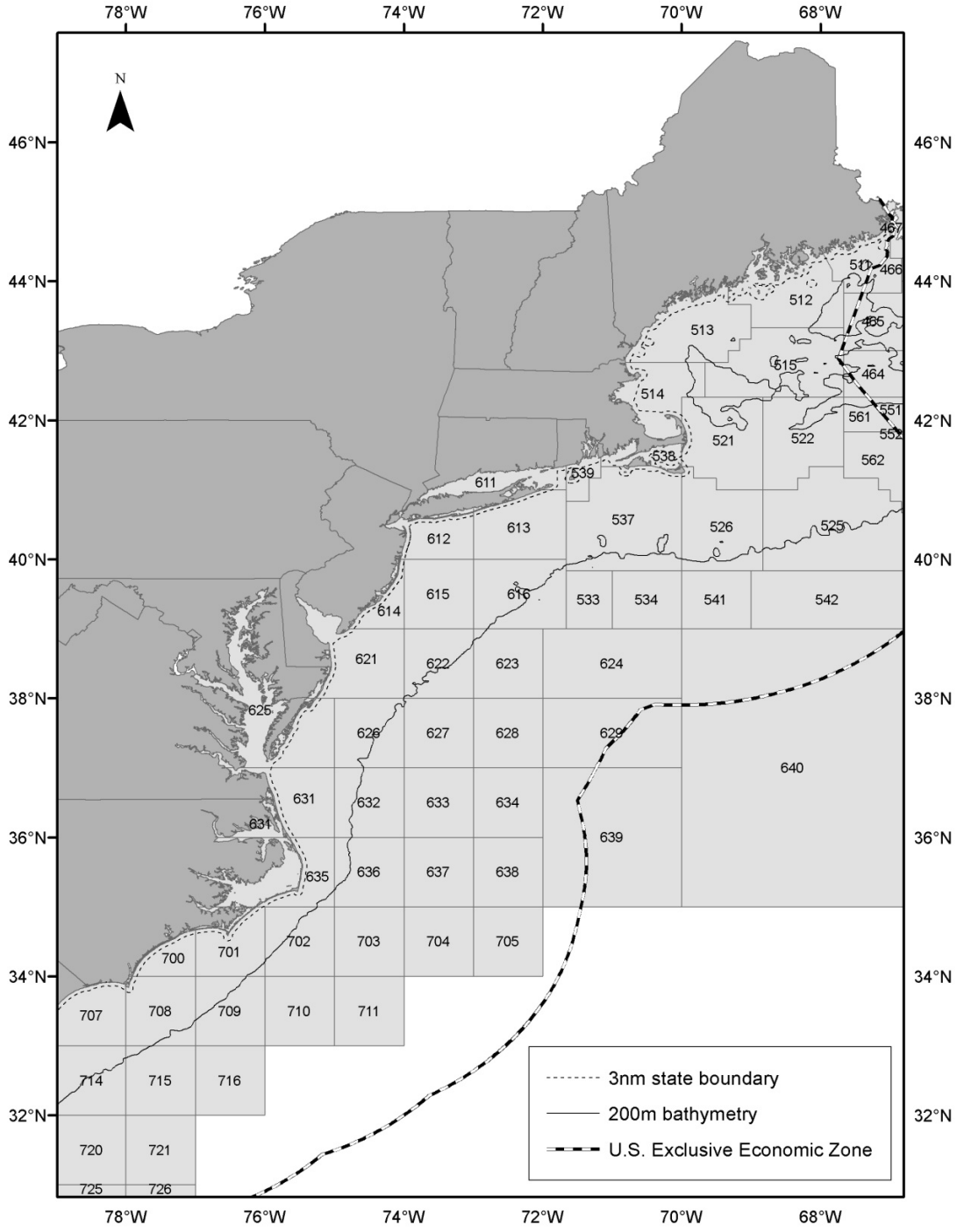
Animals observed for less than two minutes after release should be addressed case by case and typically will only consider observations prior to release.

A 100% mortality rate will be assigned to any animal released into the water in a dead or unresponsive state regardless of its condition at first encounter.

Old injuries determined to be unrelated to the current gear interaction or animals subject to adverse environmental conditions will be considered in the overall health assessment/survivability determination of the animal.

[1] For the purposes of this guidance, Northeast Region fishing gear excludes longline gear.
[2] Unresponsive refers to an episode of lack of response to external stimuli at any time. Lack of response criteria may include bilateral eye reflex, bilateral front and rear flipper pinch, corneal reflex, or cloacal clasp.

APPENDIX B. NMFS NORTHEAST STATISTICAL AREAS



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Tables should be prepared with a table formatting function. Each figure should be supplied in digital format (preferably GIF or JPG), unless there is no digital file of a given figure. Except under extraordinary circumstances, color will not be used in illustrations.

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Authors must submit separate digital files of the manuscript text, tables, and figures. The manuscript must have cleared NEFSC's online internal review system. Non-NEFSC authors who are not federal employees will be required to sign a "Release of Copyright" form.

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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:

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