Northeast Fisheries Science Center Reference Document 15-15

doi:10.7289/V5HD7SNK

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

August 2015

Northeast Fisheries Science Center Reference Documents

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Information Quality Act Compliance: In accordance with section 515 of Public Law 106-554, the Northeast Fisheries Science Center completed both technical and policy reviews for this report. These predissemination reviews are on file at the NEFSC Editorial Office.

This document may be cited as:

Hatch J, Orphanides C. 2015. Estimates of cetacean and pinniped bycatch in the 2013 New England sink and mid-Atlantic gillnet fisheries. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 15-15; 26 p. Available at: http://www.nefsc.noaa.gov/publications/
doi:10.7289/V5HD7SNK

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ABSTRACT

This report provides estimated bycatch of 8 species of small cetaceans and pinnipeds bycaught in the New England sink (NESG) and mid-Atlantic (MAG) gillnet fisheries. The 2013 serious injuries and total mortalities in the NESG fishery were 399 (coefficient of variation [CV] = 0.33) harbor porpoises (*Phocoena phocoena phocoena*), 104 (CV = 0.47) short-beaked common dolphins (*Delphinus delphis delphis*), 4 (CV = 1.03) Atlantic white-sided dolphins (*Lagenorhynchus acutus*), 27 (CV = 0.95) common bottlenose dophins (*Tursiops truncatus truncatus*), 23 (CV = 0.97) Risso's dolphins (*Grampus griseus*), 22 (CV = 0.75) harp seals (*Pagophilus groenlandicus*), 1127 (CV = 0.20) gray seals (*Halichoerus grypus grypus*), and 147 (CV = 0.30) harbor seals (*Phoca vitulina concolor*). NESG estimates are based on observed bycatch consisting of 20 harbor porpoises, 5 short-beaked common dolphins, 1 Atlantic white-sided dolphin, 1 common bottlenose dolphin, 1 Risso's dolphin, 2 harp seals, 69 gray seals, and 22 harbor seals. The 2013 serious injuries and total mortalities in the MAG fishery were 62 (CV = 0.67) short-beaked common dolphins and 19 (CV = 1.06) harbor porpoises. MAG estimates are based on observed bycatch consisting of 2 short-beaked common dolphins and 1 harbor porpoise. The majority of marine mammal bycatch was observed on hauls targeting monkfish or skate using large-mesh nets that soaked for relatively long durations. For the NESG fishery, full pinger deployment was high in 2013 for times and areas required by the 2010 Harbor Porpoise Take Reduction Plan (HPTRP), ranging from 89 - 100%. Similarly, pinger functionality was found to be high for the 2013 NESG fleet, ranging from 80 - 100%.

INTRODUCTION

The United States (US) Marine Mammal Protection Act (MMPA) of 1972 mandates the annual reporting of serious injury and mortality estimates for marine mammal stocks interacting with US commercial fisheries (Waring et al. 2014). Bycatch is a subset of marine mammal-fisheries interactions, and refers to the direct contact between marine mammals and commercial fishing gear that results in serious injuries or mortalities. Bycatch has been cited as a significant threat to marine mammal populations (Read 2008), with particular concern for the impacts of drift and sink gillnet gear on small cetacean and pinniped stocks (Reeves et al. 2013).

The establishment of the Northeast Fishery Observer Program (NEFOP) was, in part, a response to monitor bycatch of marine mammals in commercial fishing operations within the western Atlantic and has been ongoing since 1989 (Waring et al. 2014; Orphanides 2013). The program was subsequently expanded in 1993 to document marine mammal bycatch in the mid-Atlantic, resulting in observer coverage that ranged from Maine to North Carolina (Waring et al. 2014; Orphanides 2013). In 2010 another observer platform (Northeast Fishery At-Sea Monitoring Program [ASM]) was established to monitor the Northeast multispecies groundfish fishery operating primarily in the Gulf of Maine and southern New England (NMFS 2010).

In US Northwest Atlantic waters, fishing vessels that used drift or sink gillnet gear constituted the New England sink (NESG) or mid-Atlantic (MAG) gillnet fishery. Both fisheries operated year round, with the NESG fishery ranging from Maine to New York and the MAG fishery ranging from New York to North Carolina (NMFS 2014; Waring et al. 2014). Observed fishing hauls were assigned to the NESG or MAG fishery based on the geographic location of fishing activities, with the 72°30'W longitudinal line used to demarcate the 2 fishing fleets (NMFS 2014; Waring et al. 2014).

Observed gillnetters in both the NESG and MAG fisheries predominately used nets made of monofilament twine, with string lengths varying from 300 - 9600 ft (median of 4500 ft) and 120 - 7269 ft (median of 1131 ft), respectively. While the MAG fleet comprised both drift and sink gillnets, the NESG fishery largely comprised anchored and unanchored bottom-tending (i.e., sink) nets. Gillnet mesh sizes often vary with target fish species, but have been observed to range anywhere from 4.5 - 12.5 in (median of 6.5 in) and 2.5 - 12 in (median of 3.5 in) for the NESG and MAG fisheries, respectively.

The Harbor Porpoise Take Reduction Plan (HPTRP) was first implemented on January 1, 1999 to reduce interactions between harbor porpoises and the NESG and MAG fisheries (Orphanides and Palka 2013). Bycatch estimates used to inform the HPTRP were based on stratification schemes that captured the spatial and temporal dynamics of harbor porpoises and commercial fishing vessels using gillnet gear (Rossman and Merrick 1999) (see Figure 1). Those methods were eventually extended to estimate bycatch of other marine mammals that were observed bycaught in the NESG and MAG fisheries (Belden et al. 2006).

For 2013, 8 species of small cetaceans and pinnipeds were observed bycaught in drift and sink gillnet gear from US Northwest Atlantic waters. These include harbor porpoise (*Phocoena phocoena phocoena*), short-beaked common dolphin (*Delphinus delphis delphis*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), common bottlenose dophin (*Tursiops truncatus truncatus*), Risso's dolphin (*Grampus griseus*), harp seal (*Pagophilus groenlandicus*), gray seal (*Halichoerus grypus grypus*), and harbor seal (*Phoca vitulina concolor*). In summary, bycatch was estimated for small cetaceans and pinnipeds in the 2013 NESG and MAG fisheries, bycatch estimates

were compared to previous years, gear characteristics of hauls with and without marine mammal bycatch were investigated, and compliance of observed hauls to pinger regulations was explored.

MATERIALS AND METHODS

Five datasets were used in estimating annual bycatch of small cetaceans and pinnipeds in the NESG and MAG fisheries. These included observer data collected by NEFOP and ASM as well as commercial fishing effort from vessel trip reports (VTR), dealer weigh out slips, and the North Carolina Division of Marine Fisheries (NCDMF) trip ticket program. Observer records (NEFOP and ASM) were used to estimate bycatch rates, defined as the number of animals bycaught per metric ton (mt) of landed catch, for the NESG and MAG fisheries. Estimated bycatch from the entire gillnet fleet was then obtained by applying estimated bycatch rates to commercial fishing effort, defined as the weight of commercial landings in mt.

Data

Observer data

Observer data were recorded under 2 survey platforms, NEFOP and ASM. For 2013, 62% and 38% of all hauls observed were from NEFOP and ASM, respectively. Both survey platforms used complete sampling protocols (or complete trips), for which observers sampled both catch and discard of fishes for biological information (65% of hauls). During complete sampling, observers were not explicitly watching haul backs and may have missed bycatch of marine mammals that fell out of the net prior to being hauled on board. Unlike ASM, NEFOP also used limited sampling protocols (or limited trips) for which the observer explicitly watched the net during haul backs (35% of hauls), reducing the chances of unnoticed bycatch. It should also be noted that both survey platforms collected environmental, gear, haul, and vessel characteristics during observed fishing trips. However, ASM only collected a subset of the data required by NEFOP and only monitored vessels with trip declarations into the Northeast multispecies groundfish fishery. For this reason, ASM data may not be representative of all gillnet fishing effort with the potential for marine mammal bycatch. Any potential bias introduced into the analysis through the use of ASM data was addressed as described in the bycatch estimates section below. Unidentified animals, including 8 unknown seals, were not included in the bycatch estimates.

Commercial fishing effort

Vessel trip reports (VTRs) were considered to be a near census of commercial fishing trips for the NESG and MAG fisheries, except for those landing catch in North Carolina. VTR data were augmented with information from dealer weigh out slips, as self-reported landings on VTRs were assumed to be biased low (Wigley et al. 2008; Murray 2009). For instances where a corresponding dealer weigh out slip(s) could not be located for a VTR, the landings on the VTR were scaled by an adjustment factor derived from stratification of the VTR and dealer weigh out data by state and season. This ensured that unmatched VTR landings in any stratum were equal to the unmatched landings in the dealer weigh out data (Orphanides 2013), which is assumed to be a near census of commercial catch (Wigley et al. 2008).

For vessels landing catch in North Carolina, data from the NCDMF trip ticket program were combined with VTRs and dealer's weigh out slips to estimate bycatch from the MAG fishery. Com-

mercial fishing effort for gillnet trips in North Carolina were poorly represented in the VTR and dealer weigh out data, requiring the use of monthly gillnet landings reported by NCDMF (Orphanides 2011). Unfortunately, NCDMF does not collect information on mesh size, soak duration, or geographic location of commercial fishing trips, requiring bycatch in the Southern Mid-Atlantic Management Area to be estimated with a season-state stratification scheme following Orphanides (2011). This approach contrasts with the traditional stratification scheme used by Orphanides (2013), which includes season, portgroup/management area, mesh size, and soak duration.

Data preparation

Data preparation included the conversion of landed to live weights using standardized conversion factors (Palmer 2010) as well as imputing missing fishing locations, mesh sizes, and soak durations when needed, following the methods outlined in Warden and Orphanides (2008).

Missing data imputation

In 2013, 6% of observer records were missing latitude and longitude coordinates, while about 11% of commercial fishing records were missing detailed information on geographic fishing locations. Similarly, <1% of observer records were missing values of mesh size and about 2% of observer records were missing values of soak duration, while <1% of commercial fishing records were missing information on mesh size and about 9% of commercial fishing records were missing information on soak duration. Less than 1% of observed hauls were missing information on pinger usage (none of which had incidental bycatch of marine mammals) and were subsequently removed from the analysis.

For the MAG fishery, bycatch estimates for the Waters off New Jersey Management Area were obtained through data stratification by season, mesh size, and soak duration as outlined in Orphanides (2013). Unfortunately, 1 observed haul with short-beaked common dolphin bycatch was missing soak duration, which could not be imputed using the standard methods documented in Warden and Orphanides (2008). In order to impute the missing value, soak durations in the same time and area as the observed haul with short-beaked common dolphin bycatch were modeled using a Bayesian generalized linear model. The missing soak duration was then estimated from the posterior predictive distribution, defined as:

$$p\left(y^{(mis)}|y\right) = \int p\left(y^{(mis)}|\theta, y\right) p(\theta|y) d\theta \tag{1}$$

where:

$y^{(mis)}$ = missing soak duration

y = observed soak duration

$p(\theta|y)$ = posterior distribution

The posterior predictive distribution captures the predictive probability of seeing new values (or in this case missing values) conditioned on the observed data. The soak durations were assumed to be log-normally distributed, whose median was modeled as a linear combination of several variables (i.e., longitude, longitude^2, latitude, latitude^2, statistical area fished, and mesh size). Vague, uninformative priors were assumed on all parameters and convergence of chains was assessed by monitoring trace plots and computing Gelman and Rubin statistics. More formally,

$$\text{Soak Duration}_i \sim \text{Log-Normal}(\mu_i, \sigma^2) \tag{2}$$

$$\log \mu_i = \beta_0 + \sum_{j=1}^{n} \beta_j x_{i,j}$$

where:

$\mu_i =$ expected value for observation i on the log scale
$x_{i,j} =$ observation i of covariate j
$\beta_0 =$ intercept
$\beta_j =$ coefficient for covariate j
$\sigma^2 =$ variance on the log scale

Included covariates were selected using AIC and best subsets (McLeod and Xu 2011). The posterior predictive distribution for the missing soak duration indicated that there was an 89% chance that the soak duration was ≤ 72 hrs, and as such it was included in the short soak duration stratum.

Bycatch estimates

As in previous years, bycatch rates were estimated with ratio and stratified ratio estimators, with strata defined to reflect the spatial and temporal distributions of marine mammals and commercial gillnetters (Rossman and Merrick 1999; Belden et al. 2006). For the NESG fishery, data were stratified temporally by season and spatially by portgroup or management area. Seasons were defined as "W" (winter; January - May), "S" (summer; June - August), and "F" (fall; September - December). The stratum-specific bycatch rates were then estimated using NEFOP and ASM data, and were weighted by pinger use and NEFOP-observed groundfish/nongroundfish landings. Only NEFOP-observed groundfish/nongroundfish landings were used to ensure that estimated bycatch rates were representative of the entire NESG fishery, and not biased towards the part of the fleet monitored by ASM. In other words,

$$\hat{R}_{s,m} = \left(\frac{W_{s,m,g}}{W_{s,m}}\right)\left[\left(\frac{N_{s,m,g,p}}{N_{s,m,g}}\right)\frac{y_{s,m,g,p}}{x_{s,m,g,p}} + \left(\frac{N_{s,m,g,np}}{N_{s,m,g}}\right)\frac{y_{s,m,g,np}}{x_{s,m,g,np}}\right] \tag{3}$$
$$+ \left(\frac{W_{s,m,ng}}{W_{s,m}}\right)\left[\left(\frac{N_{s,m,ng,p}}{N_{s,m,ng}}\right)\frac{y_{s,m,ng,p}}{x_{s,m,ng,p}} + \left(\frac{N_{s,m,ng,np}}{N_{s,m,ng}}\right)\frac{y_{s,m,ng,np}}{x_{s,m,ng,np}}\right]$$

where:

$N_{s,m,g} = N_{s,m,g,p} + N_{s,m,g,np}$

$N_{s,m,ng} = N_{s,m,ng,p} + N_{s,m,ng,np}$

$W_{s,m} = W_{s,m,g} + W_{s,m,ng}$

$s =$ season

$m =$ portgroup or management area

$g =$ groundfish and $ng =$ nongroundfish

$p =$ pingers and $np =$ no pingers

$\hat{R} =$ stratum-specific bycatch rate

$W =$ NEFOP-observed weight of landed catch (mt)

$N =$ observed number of hauls

$y =$ observed number of bycaught animals

$x =$ observed weight of landed catch (mt)

The weighted bycatch rate explicitly accounts for observed fishing effort targeting groundfish versus nongroundfish and the use of pingers on gillnet strings (Palka et al. 2008). The Cape Cod South Management Area was not retained for the purposes of estimating bycatch during the 2013 winter season, to address concerns with overstratification.

For the MAG fishery, data in the Waters off New Jersey Management Area were stratified temporally by season as well as by mesh size (i.e., ≥ 7 in or < 7 in) and soak duration (i.e., > 72 hours or ≤ 72 hours) (Orphanides 2013). Data in the Southern Mid-Atlantic Management Area were stratified temporally by season and spatially by state, due mainly to limitations in the NCDMF data (Orphanides 2011). More formally this can be expressed as:

$$\hat{R} = \frac{y}{x} \tag{4}$$

where:

$\hat{R} =$ stratum-specific bycatch rate

$y =$ observed, stratum-specific number of bycaught animals

$x =$ observed, stratum-specific weight of landed catch (mt)

For a more in-depth treatment of the rationale behind the data stratification presented in this report, refer to Orphanides (2011, 2013).

Estimates of bycatch in any stratum ($\hat{B}$) were then obtained through the product of stratum-specific bycatch rates ($\hat{R}$) and the total commercial fishing effort (E) associated with that stratum. More formally this can be expressed as:

$$\hat{B} = \hat{R}E \tag{5}$$

Seasonal subtotal and total bycatch estimates were then obtained through the summation of stratum-specific bycatch estimates. Uncertainty around seasonal subtotal, total, and stratum-specific bycatch estimates were obtained through nonparametric stratified bootstrapping techniques, with $(1-\alpha)$% confidence intervals constructed through the bias-corrected and accelerated (BCa) method using 10,000 iterations with the R "boot" library (Canty and Ripley 2012; Efron and Tibshirani 1993). The resampling unit used for bootstrapping was an entire fishing trip, to account for interdependence among hauls nested within trips (Bisack 2003).

For strata with high observer coverage (i.e., $\geq 10\%$) the finite population correction factor (fpc) was applied to the bootstrapped estimate of the standard error used in calculating the coefficient of variation (CV), where the fpc for each stratum was defined as:

$$fpc = \sqrt{\frac{W - w}{W - 1}} \tag{6}$$

where:

W = stratum-specific weight of commercial landings

w = observed, stratum-specific weight of landed catch

Observer coverage was defined as the percentage of commercial landings observed by NEFOP and ASM for each stratum (i.e., $w/W \times 100\%$).

Gear characteristics

Gear characteristics of the 2013 NESG fishery were investigated, focusing on those factors previously shown to influence marine mammal bycatch (i.e., mesh size and soak duration; Orphanides 2013). Distributions of mesh size and soak duration were compared for observed hauls with and without marine mammal bycatch, also highlighting the target fish species associated with those distributions (see Figures 5 and 6). Because mesh size and soak duration were incorporated into the data stratification process for bycatch estimates from the mid-Atlantic, a comparison was not conducted for the MAG fishery.

Pinger deployment

In an effort to monitor the compliance of observed hauls to pinger regulations in the 2013 NESG fishery, pinger deployment was calculated by season and portgroup for times and areas where pingers were required (Figure 1). According to the 2010 HPTRP, pingers were required to be placed on the bridle of each net panel (or every 300 ft if a net panel should exceed 300 ft) and on each end of the gillnet string. For example, if a gillnet string has 2 net panels, then it is required to have 3 functioning pingers. Pinger deployment (% pingers) was then calculated as:

$$\%\ \text{pingers} = \frac{\text{NACTMMDHAUL}}{\text{NNETS} + 1} \tag{7}$$

where:

NACTMMDHAUL = total number of pingers on the gear when it was hauled

NNETS = total number of net panels used

Full pinger deployment was then defined as 1 if % pingers ≥ 1; otherwise it was defined as 0. If NACTMMDHAUL was missing, then the number of pingers on the gear when it was set (NACTMMD) was used. If both NACTMMDHAUL and NACTMMD were missing, then the observed haul was removed from the analysis. Only observations from NEFOP were used in calculating full pinger deployment, which only reflects whether or not the correct number of pingers were used and not functionality.

Pinger functionality for a limited number of NEFOP-observed hauls was also summarized for times and areas where pingers were required (Figure 1). Since 2011, NEFOP has deployed pinger testers on a limited number of commercial fishing trips, with observers evaluating all pingers on a gillnet string for functionality.

RESULTS

The overall annual observer coverages for the 2013 NESG and MAG fisheries were 11% and 3%, respectively (Table 1, Figure 2). Observer coverage of the NESG fishery has declined slightly since 2012, while observer coverage of the MAG fishery has increased (Figure 2). Stratum-specific observer coverage rates for the NESG fishery ranged between 0% and 42% (Table 1). Stratum-specific observer coverage rates for the MAG fishery ranged between 3% and 5% (Table 2).

There were 121 marine mammals observed bycaught in the NESG fishery for 2013, of which 20 were harbor porpoises, 5 were short-beaked common dolphins, 1 was an Atlantic white-sided dolphin, 1 was a common bottlenose dolphin, 1 was a Risso's dolphin, 2 were harp seals, 69 were gray seals, and 22 were harbor seals (Tables 3 - 10). There were 3 marine mammals observed bycaught in the MAG fishery for 2013, of which 1 was a harbor porpoise and 2 were short-beaked common dolphins (Table 11). All observed bycatch of marine mammals in the 2013 NESG and MAG fisheries were serious injuries or mortalities, with no observed nonserious injuries. Geographic locations of observed bycatch can be found in Figure 3.

For 2013, it was estimated that there were 399 (CV = 0.33) harbor porpoises, 104 (CV = 0.47) short-beaked common dolphins, 4 (CV = 1.03) Atlantic white-sided dolphins, 27 (CV = 0.95) common bottlenose dophins, 23 (CV = 0.97) Risso's dolphins, 22 (CV = 0.75) harp seals, 1127 (CV = 0.20) gray seals, and 147 (CV = 0.30) harbor seals with serious injuries or mortalities from the NESG fishery (Tables 3 - 10). For the 2013 MAG fishery, it was estimated that there were 62 (CV = 0.67) short-beaked common dolphins and 19 (CV = 1.06) harbor porpoises with serious injuries or mortalities (Table 11). Patterns in marine mammal bycatch within the NESG and MAG fisheries can be difficult to ascertain given the high uncertainty around estimated bycatch, which results in substantial overlap in confidence intervals across years (Figure 4).

Full pinger deployment was high for 2013, ranging from 89 - 100% (Table 12). The lowest compliance was observed in the Southern New England Management Area during the winter season, while the highest compliance was observed in the Stellwagen Bank Management Area during the fall (Table 12). Only 1 stratum had 100% compliance in terms of the number of pingers required per gillnet string (Table 12). In 2013, 190 NEFOP-observed hauls were also evaluated for pinger functionality. Of the 2657 pingers tested, only 78 were found to be nonfunctioning (5%) and 19 were of unknown condition (Table 13).

The majority of small cetacean and pinniped bycatch occurred on hauls targeting monkfish (*Lophius americanus*) or skate (primarily *Raja ocellata*), with mesh sizes ranging from 7 - 12 in (Figure 5). The majority of observed hauls targeting monkfish or skate with marine mammal bycatch used gillnets with mesh sizes $\geq$11 in (Figure 5). Soak durations for hauls targeting monkfish or skate with marine mammal bycatch were the longest observed and averaged roughly 140 and 66 hrs, respectively (Figure 6).

DISCUSSION

The status of small cetacean and pinniped stocks is currently determined by comparing mean annual bycatch estimates to a threshold beyond which removals from the population are deemed unsustainable. The MMPA defines this threshold as the Potential Biological Removal (PBR), which is a function of population size and growth rate, and a factor that ensures sufficient recovery (Wade 1998). Annual bycatch estimates of small cetaceans and pinnipeds are typically approximated by 5-yr averages (NMFS 2005), and often include estimates from multiple fisheries (Waring et al. 2014). The majority of small cetacean and pinniped bycatch occurring in US waters is from gillnet gear (Read et al. 2006), and comparing annual gillnet bycatch estimates to PBR may serve as a preliminary indication of bycatch severity. A more comprehensive approach that includes serious injury and mortality estimates from other gear types can be found in the annual US Atlantic and Gulf of Mexico Marine Mammal Stock Assessment reports (Waring et al. 2014).

For 2013, most species of small cetacean and pinniped had estimated gillnet bycatch that was under PBR (Figure 4). Harbor porpoise and Risso's dolphin were the only species of small cetacean that had 95% confidence intervals around gillnet bycatch estimates that included PBR, although point estimates were well below the PBR threshold (Figure 4). PBR for harp and gray seals cannot be estimated for US waters due to insufficient information on population sizes (Waring et al. 2014), with impacts from gillnet bycatch on those pinniped stocks currently unknown. Using point estimates, 2013 gillnet bycatch for common bottlenose dolphin (PBR = 561), short-beaked common dolphin (PBR = 1125), harbor porpoise (PBR = 706), harbor seal (PBR = 1662), Risso's dolphin (PBR = 126), and Atlantic white-sided dolphin (PBR = 304) were at 5%, 15%, 59%, 9%, 18%, and 1% of their PBR values, respectively.

While compliance to pinger regulations was high for 2013 (see Tables 12 and 13), estimated harbor porpoise bycatch for the NESG fishery was not trivial (i.e., 399, 95% CI: 197 - 802). In fact, roughly 95% of the point estimate can be attributed to bycatch in the Southern New England Management Area during the winter season, with factors other than noncompliance possibly contributing to the high levels of estimated bycatch in that time and area. Those factors may include the use of large mesh sizes (Figure 5), long soak durations (Figure 6), and/or general shifts in commercial fishing effort (Figure 7) and harbor porpoise distribution. This is further complicated by the low observer coverage achieved in the Southern New England Management Area during the 2013 winter season (Table 1).

For the 2013 NESG fishery, the majority of observed marine mammal bycatch occurred on gillnets targeting skate or monkfish, using relatively large mesh sizes and long soak durations (see Figures 5 and 6). Previous studies have shown that larger mesh sizes positively correlate with marine mammal and sea turtle bycatch (Palka and Rossman 2001; Murray 2009; Orphanides 2009), and longer soak durations increase the amount of time gillnets are available to interact with marine mammals (Orphanides 2009). Unfortunately, the effects of mesh size and soak duration may be unclear due to the complicating effects of a general shift in commercial fishing effort southwards (Figure 7; Orphanides 2013). Additional research should explore the relative influences of mesh size and soak duration on estimates of marine mammal bycatch, in hopes of teasing out observed associations from statistical artifacts.

Assessing the status of marine mammal stocks is fraught with uncertainty (Williams et al. 2008), which is usually compounded by inadequate funds to achieve necessary observer coverage of relevant fisheries with historical bycatch. Coupled with the rarity of marine mammal interactions with

gillnetters, estimates of incidental bycatch often do not differ significantly across years, resulting in ambiguous bycatch trends. Since increased observer coverage in the NESG or MAG fishery is unlikely, other estimators or stratification schemes could be explored to improve the precision of marine mammal bycatch estimates for future years.

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Table 1. Summaries of observed hauls, observed trips, observed landings, prorated commercial landings, and observer coverage by season and portgroup/management area for the 2013 New England sink gillnet fishery. Light gray rows indicate strata with marine mammal bycatch. Seasons were defined as "W" (winter; January - May), "S" (summer; June - August), and "F" (fall; September - December).

Season	Portgroup/ Management Area (MA)	Observed Hauls[a]	Observed Trips	Observed Landings (mt)	Commercial Landings (mt)	Observer Coverage (%)
F	Cape Cod South MA	30 (8)	6	15.64	383.15	0.04
F	East of Cape Cod	240 (4)	65	121.10	1213.28	0.10
F	Mass Bay MA	48 (1)	26	17.01	40.87	0.42
F	Midcoast MA	511 (9)	129	149.90	604.19	0.25
F	North of Boston	124 (0)	38	16.99	82.5	0.21
F	New Hampshire	12 (0)	2	1.97	38.72	0.05
F	Offshore MA	32 (0)	3	4.22	85.16	0.05
F	Offshore	82 (0)	6	20.19	237.74	0.08
F	Southern Maine	32 (0)	6	9.85	119.24	0.08
F	South of Boston	52 (0)	12	14.16	89.55	0.16
F	South of Cape Cod	144 (123)	24	46.75	1213.59	0.04
F	Southern New England MA	11 (6)	3	5.86	241.89	0.02
F	Stellwagen Bank MA	58 (5)	22	11.01	92.53	0.12
F	Subtotal	1376 (156)	342	434.65	4442.41	0.10
S	East of Cape Cod	528 (0)	162	463.20	2372.14	0.20
S	Great South Channel MA	1 (0)	1	0.78	6.18	0.13
S	Northern Maine	0 (0)	0	0	1.79	0
S	North of Boston	199 (0)	39	54.45	301.31	0.18
S	New Hampshire	364 (0)	99	85.65	478.55	0.18
S	Offshore	139 (0)	11	41.13	185.98	0.22
S	Southern Maine	390 (0)	80	92.72	395.81	0.23
S	South of Boston	56 (0)	19	16.04	184.61	0.09
S	South of Cape Cod	178 (108)	32	56.12	1774.49	0.03
S	Subtotal	1855 (108)	443	810.09	5700.86	0.14
W	East of Cape Cod	16 (0)	4	12.73	66.2	0.19
W	Mass Bay MA	80 (27)	24	8.87	35.87	0.25
W	Midcoast MA	91 (15)	25	10.82	43.25	0.25
W	Northern Maine	5 (5)	1	0.51	0	-
W	North of Boston	11 (0)	6	6.54	73.03	0.09
W	New Hampshire	0 (0)	0	0	3.41	0
W	Offshore MA	181 (0)	15	40.74	191.82	0.21
W	Offshore	12 (0)	1	1.93	38.93	0.05
W	Southern Maine	49 (0)	7	9.37	44.75	0.21
W	South of Boston	0 (0)	0	0	2.13	0
W	South of Cape Cod	4 (0)	1	2.62	155.48	0.02
W	Southern New England MA	273 (106)	52	117.17	2412.04	0.05
W	Stellwagen Bank MA	190 (47)	48	28.21	140.96	0.20
W	Subtotal	912 (200)	184	239.51	3207.87	0.07
	Total	4143 (464)	969	1484.25	13351.14	0.11

[a] Parentheses indicate number of limited hauls out of the total (i.e., complete + limited) number of hauls.

Table 2. Summaries of observed hauls, observed trips, observed landings, prorated commercial landings, and observer coverage by season, portgroup/management area, mesh size, and soak duration for strata with bycatch in the 2013 mid-Atlantic gillnet fishery.

Season	Portgroup/ Management Area (MA)	Mesh Size (in)	Soak Duration (hrs)	Observed Hauls[a]	Observed Trips	Observed Landings (mt)	Commercial Landings (mt)	Observer Coverage
Dec-Jan	Waters off New Jersey	≥ 7	> 72	18 (3)	7	6.85	173.49	0.04
Dec-Jan	Waters off New Jersey	≥ 7	≤ 72	33 (31)	14	13.11	478.58	0.03
Feb-Mar	North Carolina	-[b]	-[b]	255 (245)[c]	34	47.06	911.04	0.05

[a] Parentheses indicate number of limited hauls out of the total (i.e., complete + limited) number of hauls.

[b] NCDMF data do not include mesh size (in) or soak duration (hrs).

[c] 2 hauls in this stratum could not be assigned to complete or limited.

Table 3. Observed number of bycatch, estimated bycatch rates, estimated bycatch, coefficient of variation (CV), and lower (L) and upper (U) bounds on 95% confidence intervals (CI) of harbor porpoise (*Phocoena phocoena phocoena*) bycatch in the New England sink gillnet fishery for 2013, by season and portgroup/management area. Seasons were defined as "W" (winter; January - May), "S" (summer; June - August), and "F" (fall; September - December).

Season	Portgroup/ Management Area (MA)	Observed Takes	Bycatch Rate	Estimated Takes	CV	95% CI L	95% CI U
F	Midcoast MA	1	0.007	4.23	0.83	1	21
F	Subtotal	1	-	4.23	0.91	1	21
W	Midcoast MA	1	0.092	3.98	0.80	1	17
W	Southern New England MA	16	0.158	381.10	0.36	178	779
W	Stellwagen Bank MA	2	0.071	10.01	0.63	2	34
W	Subtotal	19	-	395.09	0.35	193	794
	Total	20	-	399.32	0.33	197	802

Table 4. Observed number of bycatch, estimated bycatch rates, estimated bycatch, coefficient of variation (CV), and lower (L) and upper (U) bounds on 95% confidence intervals (CI) of short-beaked common dolphin (*Delphinus delphis delphis*) bycatch in the New England sink gillnet fishery for 2013, by season and portgroup/management area. Seasons were defined as "W" (winter; January - May), "S" (summer; June - August), and "F" (fall; September - December).

Season	Portgroup/ Management Area (MA)	Observed Takes	Bycatch Rate	Estimated Takes	CV	95% CI L	95% CI U
W	Southern New England MA	5	0.043	103.72	0.49	27	248
W	Subtotal	5	-	103.72	0.48	27	248
	Total	5	-	103.72	0.47	27	248

Table 5. Observed number of bycatch, estimated bycatch rates, estimated bycatch, coefficient of variation (CV), and lower (L) and upper (U) bounds on 95% confidence intervals (CI) of Atlantic white-sided dolphin (*Lagenorhynchus acutus*) bycatch in the New England sink gillnet fishery for 2013, by season and portgroup/management area. Seasons were defined as "W" (winter; January - May), "S" (summer; June - August), and "F" (fall; September - December).

Season	Portgroup/ Management Area (MA)	Observed Takes	Bycatch Rate	Estimated Takes	CV	95% CI L	95% CI U
W	Midcoast MA	1	0.092	3.98	0.95	1	25
W	Subtotal	1	-	3.98	1.05	1	25
	Total	1	-	3.98	1.03	1	25

Table 6. Observed number of bycatch, estimated bycatch rates, estimated bycatch, coefficient of variation (CV), and lower (L) and upper (U) bounds on 95% confidence intervals (CI) of common bottlenose dolphin (*Tursiops truncatus truncatus*) bycatch in the New England sink gillnet fishery for 2013, by season and portgroup/management area. Seasons were defined as "W" (winter; January - May), "S" (summer; June - August), and "F" (fall; September - December).

Season	Portgroup/ Management Area (MA)	Observed Takes	Bycatch Rate	Estimated Takes	CV	95% CI L	95% CI U
W	Southern New England MA	1	0.011	26.53	0.99	1	121
W	Subtotal	1	-	26.53	0.97	1	121
	Total	1	-	26.53	0.95	1	121

Table 7. Observed number of bycatch, estimated bycatch rates, estimated bycatch, coefficient of variation (CV), and lower (L) and upper (U) bounds on 95% confidence intervals (CI) of Risso's dolphin (*Grampus griseus*) bycatch in the New England sink gillnet fishery for 2013, by season and portgroup/management area. Seasons were defined as "W" (winter; January - May), "S" (summer; June - August), and "F" (fall; September - December).

Season	Portgroup/ Management Area (MA)	Observed Takes	Bycatch Rate	Estimated Takes	CV	95% CI L	95% CI U
S	South of Cape Cod	1	0.013	23.07	1.01	1	133
S	Subtotal	1	-	23.07	0.95	1	133
	Total	1	-	23.07	0.97	1	133

Table 8. Observed number of bycatch, estimated bycatch rates, estimated bycatch, coefficient of variation (CV), and lower (L) and upper (U) bounds on 95% confidence intervals (CI) of harp seal (*Pagophilus groenlandicus*) bycatch in the New England sink gillnet fishery for 2013, by season and portgroup/management area. Seasons were defined as "W" (winter; January - May), "S" (summer; June - August), and "F" (fall; September - December).

Season	Portgroup/ Management Area (MA)	Observed Takes	Bycatch Rate	Estimated Takes	CV	95% CI L	95% CI U
W	East of Cape Cod	1	0.079	5.23	0.62	1	11
W	Southern New England MA	1	0.007	16.88	1.00	1	80
W	Subtotal	2	-	22.11	0.77	2	110
	Total	2	-	22.11	0.75	2	110

Table 9. Observed number of bycatch, estimated bycatch rates, estimated bycatch, coefficient of variation (CV), and lower (L) and upper (U) bounds on 95% confidence intervals (CI) of Atlantic gray seal (*Halichoerus grypus grypus*) bycatch in the New England sink gillnet fishery for 2013, by season and portgroup/management area. Seasons were defined as "W" (winter; January - May), "S" (summer; June - August), and "F" (fall; September - December).

Season	Portgroup/ Management Area (MA)	Observed Takes	Bycatch Rate	Estimated Takes	CV	95% CI L	95% CI U
F	East of Cape Cod	1	0.008	9.71	0.97	1	38
F	Mass Bay MA	3	3.579	146.27	0.75	3	731
F	Stellwagen Bank MA	1	0.091	8.42	0.88	1	39
F	Subtotal	5	-	164.40	0.83	10	770
S	East of Cape Cod	25	0.054	128.10	0.20	76	190
S	North of Boston	1	0.018	5.42	0.95	1	27
S	New Hampshire	1	0.012	5.74	0.92	1	32
S	Offshore	1	0.027	5.02	0.97	1	25
S	South of Cape Cod	2	0.027	47.91	0.70	2	166
S	Subtotal	30	-	192.19	0.21	122	305
W	Offshore MA	2	0.054	10.36	0.69	2	37
W	Southern New England MA	31	0.313	754.97	0.23	451	1172
W	Stellwagen Bank MA	1	0.035	4.93	0.86	1	23
W	Subtotal	34	-	770.26	0.22	468	1190
	Total	69	-	1126.85	0.20	745	1686

Table 10. Observed number of bycatch, estimated bycatch rates, estimated bycatch, coefficient of variation (CV), and lower (L) and upper (U) bounds on 95% confidence intervals (CI) of harbor seal (*Phoca vitulina concolor*) bycatch in the New England sink gillnet fishery for 2013, by season and portgroup/management area. Seasons were defined as "W" (winter; January - May), "S" (summer; June - August), and "F" (fall; September - December).

Season	Portgroup/ Management Area (MA)	Observed Takes	Bycatch Rate	Estimated Takes	CV	95% CI L	95% CI U
F	Midcoast MA	6	0.040	24.17	0.38	8	53
F	North of Boston	1	0.053	4.37	1.20	1	31
F	Subtotal	7	-	28.54	0.41	11	61
S	East of Cape Cod	1	0.002	4.74	0.98	1	17
S	North of Boston	5	0.092	27.72	0.53	6	80
S	New Hampshire	1	0.012	5.74	0.90	1	31
S	Offshore	3	0.075	13.95	0.66	3	44
S	Southern Maine	1	0.011	4.35	0.85	1	21
S	Subtotal	11	-	56.50	0.34	26	115
W	Mass Bay MA	1	0.113	4.05	0.76	1	15
W	Southern New England MA	2	0.022	53.06	0.72	2	174
W	Stellwagen Bank MA	1	0.035	4.93	0.87	1	22
W	Subtotal	4	-	62.04	0.62	8	191
	Total	22	-	147.08	0.30	78	266

Table 11. Observed number of bycatch, estimated bycatch rates, estimated bycatch, coefficient of variation (CV), and lower (L) and upper (U) bounds on 95% confidence intervals of estimated marine mammal bycatch in the mid-Atlantic gillnet fishery for 2013, by season, portgroup/management area, mesh size, and soak duration.

Species	Season	Portgroup/ Management Area (MA)	Mesh Size (in)	Soak Duration (hrs)	Observed Takes	Bycatch Rate	Estimated Takes	CV	95% CI	
									L	U
Short-beaked common dolphin	Dec-Jan	Waters off New Jersey	≥7	>72	1	0.146	25.34	0.80	1	80
(*Delphinus delphis delphis*)	Dec-Jan	Waters off New Jersey	≥7	≤72[a]	1	0.076	36.51	1.00	1	183
	All	Total	All	All	2	-	61.85	0.67	2	212
Harbor porpoise (*Phocoena phocoena phocoena*)	Feb-Mar	North Carolina	-[b]	-[b]	1	0.021	19.36	1.06	1	116

[a] Soak duration estimated from data imputation.
[b] NCDMF data do not include mesh size (in) or soak duration (hrs).

Table 12. Summary of 2013 full pinger deployment for NEFOP-observed hauls within times and areas where pingers were required by the 2010 Harbor Porpoise Take Reduction Plan (HPTRP). Seasons were defined as "W" (winter; January - May), "S" (summer; June - August), and "F" (fall; September - December).

Season	Management Area (MA)	Hauls w/ Missing Information[a]	Full Pinger Deployment Hauls	Total Observed Hauls	Full Pinger Deployment Proportion[b]
F	Mass Bay MA	2	25	29	0.93
F	Midcoast MA	3	308	318	0.98
F	Offshore MA	0	16	17	0.94
F	Southern New England MA	0	10	11	0.91
F	Stellwagen Bank MA	0	36	36	1.00
F	Sub-total	5	395	411	0.97
W	Mass Bay MA	0	41	43	0.95
W	Midcoast MA	5	43	53	0.90
W	Offshore MA	13	101	120	0.94
W	Southern New England MA	0	180	202	0.89
W	Stellwagen Bank MA	0	82	83	0.99
W	Sub-total	18	447	501	0.93
	Total	23	842	912	0.95

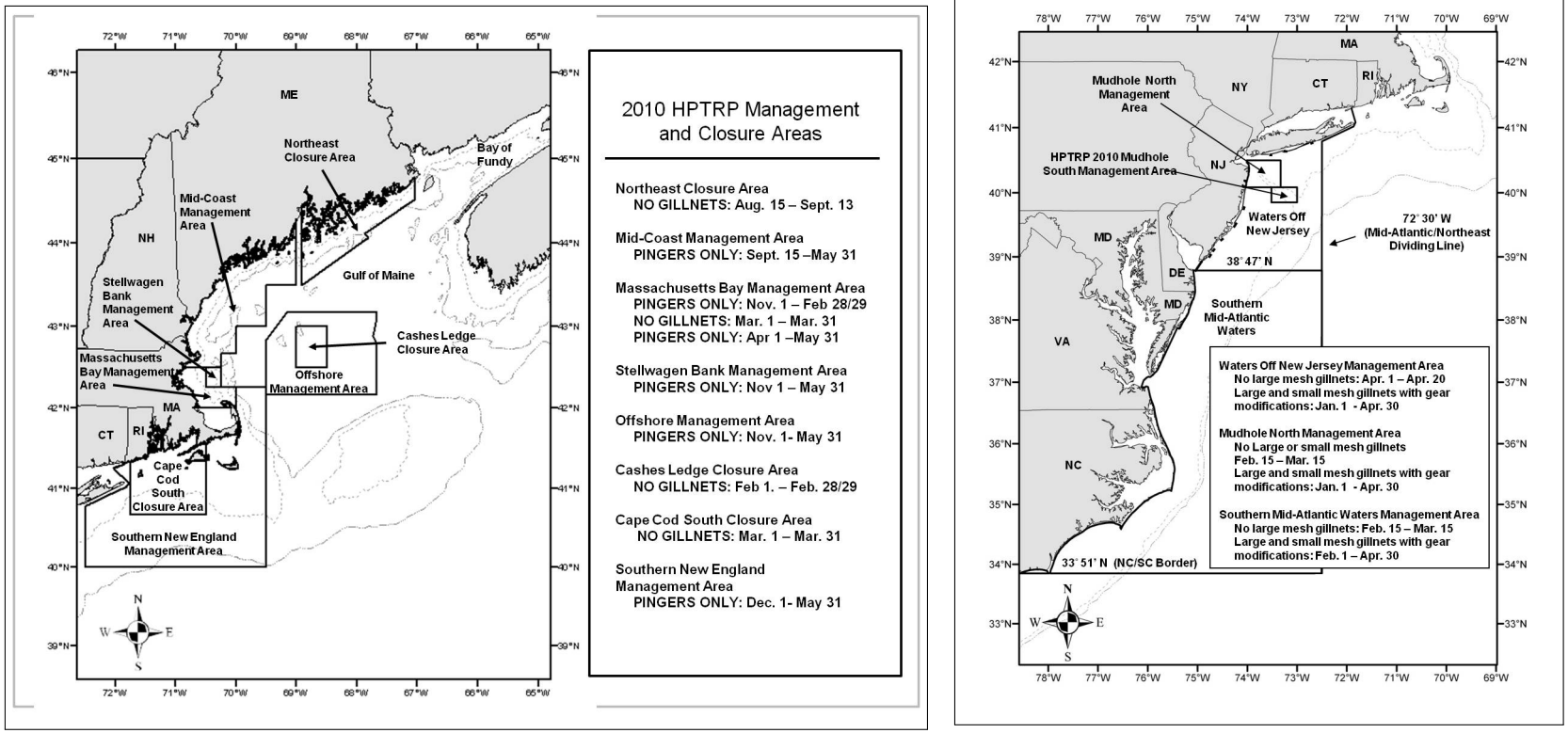
[a] NEFOP-observed hauls missing information needed to calculate full pinger deployment.

[b] Full pinger deployment hauls / (Total observed hauls - Hauls w/ missing information).

Table 13. Summary of 2013 pinger functionality for a limited number of NEFOP-observed hauls within times and areas where pingers were required by the 2010 Harbor Porpoise Take Reduction Plan (HPTRP). Seasons were defined as "W" (winter; January - May), "S" (summer; June - August), and "F" (fall; September - December).

Season	Management Area (MA)	Observed Hauls	Lost	Not Working	Working	Unkown	Total Tested Pingers	Proportion Working[a]
F	Mass Bay MA	1	0	0	10	0	10	1.00
F	Midcoast MA	9	0	0	107	2	109	1.00
F	Stellwagen Bank MA	5	0	0	42	14	56	1.00
F	Sub-total	15	0	0	159	16	175	1.00
W	Mass Bay MA	27	4	5	277	0	286	0.97
W	Midcoast MA	15	7	25	131	0	163	0.80
W	Southern New England MA	86	36	48	1396	3	1483	0.94
W	Stellwagen Bank MA	47	0	0	550	0	550	1.00
W	Sub-total	175	47	78	2354	3	2482	0.95
	Total	190	47	78	2513	19	2657	0.95

[a] Working / (Total tested pingers - Unknown).



a. **b.**

Figure 1. 2010 Harbor Porpoise Take Reduction Plan (HPTRP) management areas for the northeast (a) and mid-Atlantic (b).

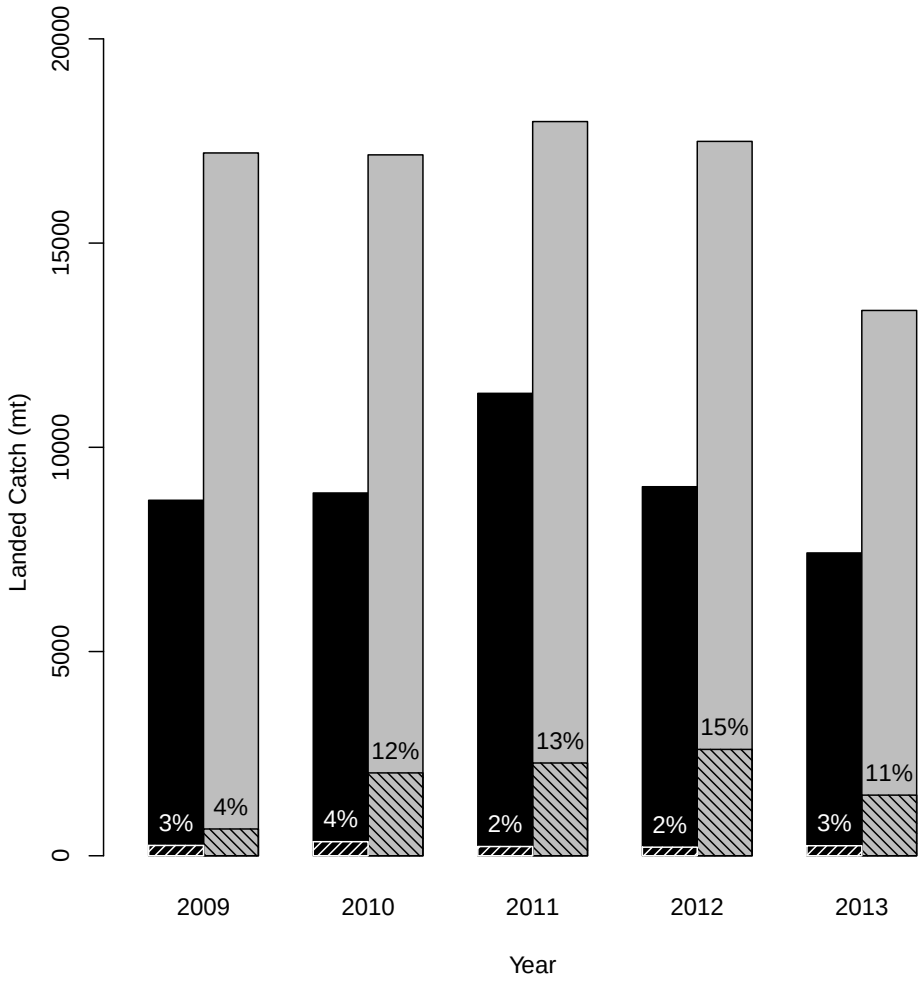


Figure 2. Prorated commercial landings for the New England sink (gray) and mid-Atlantic (black) gillnet fisheries from 2009 - 2013. Annual observer coverage is denoted by the hatched areas, and represents the percentage of prorated commercial landings observed by the Northeast Fishery Observer and Northeast Fishery At-Sea Monitoring Programs.

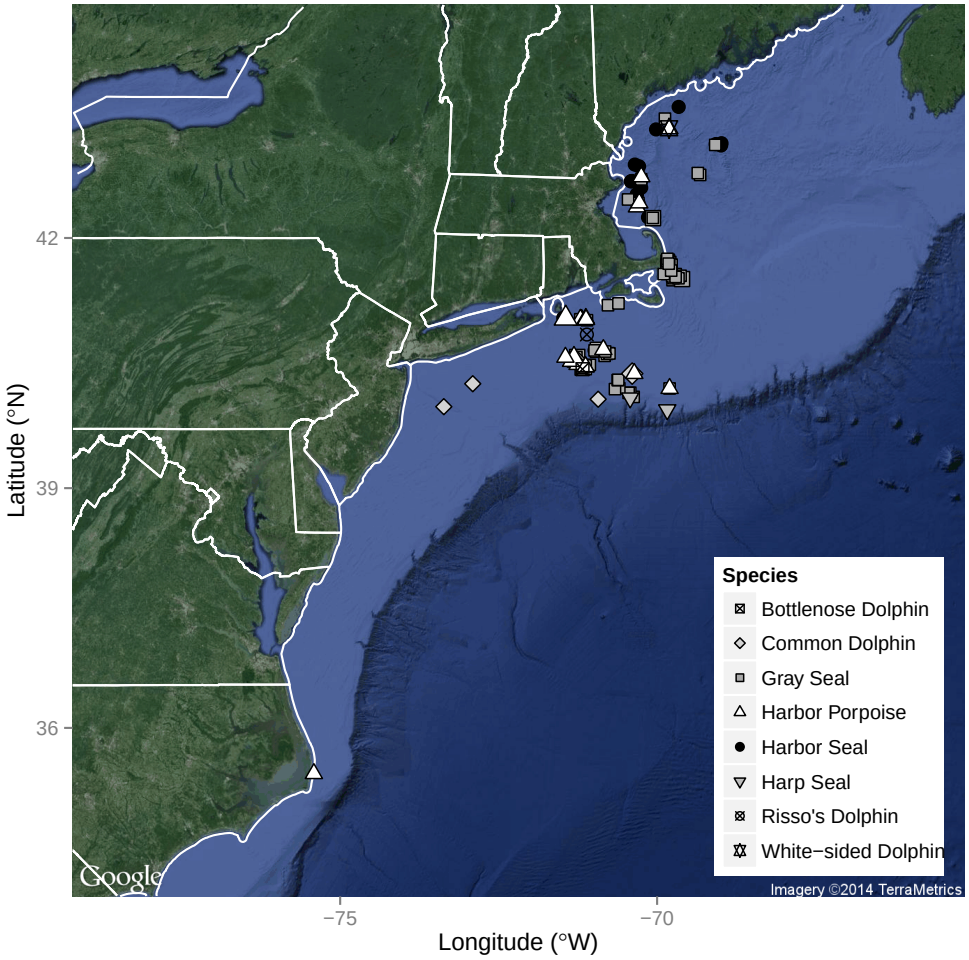


Figure 3. Geographic locations of observed hauls with marine mammal bycatch in the 2013 New England sink and mid-Atlantic gillnet fisheries. Points are scaled by the magnitude of bycatch. Marine mammal species include common bottlenose dolphin (*Tursiops truncatus truncatus*), short-beaked common dolphin (*Delphinus delphis delphis*), gray seal (*Halichoerus grypus grypus*), harbor porpoise (*Phocoena phocoena phocoena*), harbor seal (*Phoca vitulina concolor*), harp seal (*Pagophilus groenlandicus*), Risso's dolphin (*Grampus griseus*), and Atlantic white-sided dolphin (*Lagenorhynchus acutus*).

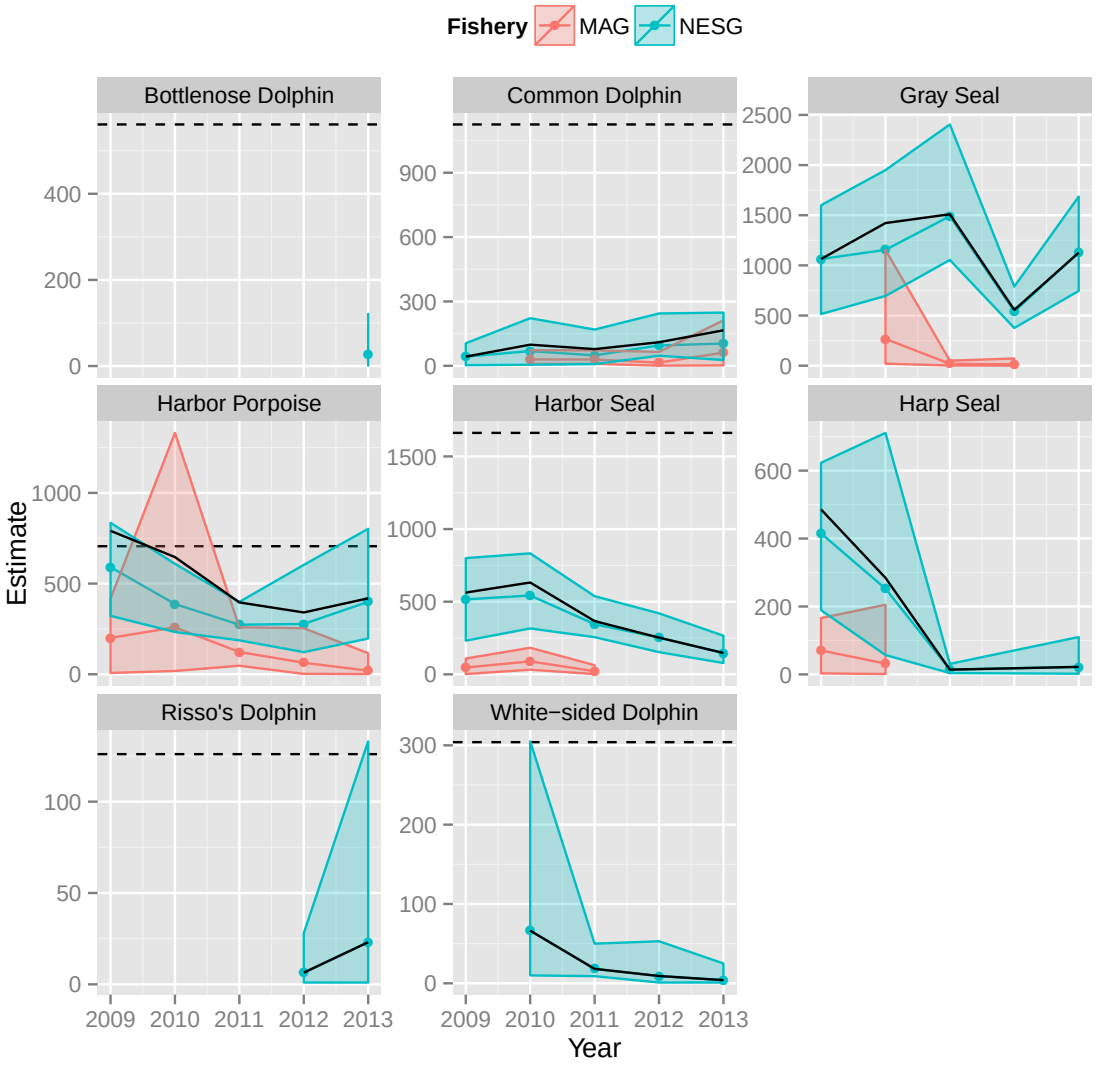


Figure 4. Estimated marine mammal bycatch and 95% confidence intervals for the New England sink (green) and mid-Atlantic (red) gillnet fisheries from 2009 - 2013. Black, dashed, horizontal lines denote the Potential Biological Removal (PBR) from the most recent Stock Assessment Report (Waring et al. 2014). Black, solid lines indicate overall trends in bycatch (i.e., NESG point estimate + MAG point estimate). Marine mammal species include common bottlenose dolphin (*Tursiops truncatus truncatus*), short-beaked common dolphin (*Delphinus delphis delphis*), gray seal (*Halichoerus grypus grypus*), harbor porpoise (*Phocoena phocoena phocoena*), harbor seal (*Phoca vitulina concolor*), harp seal (*Pagophilus groenlandicus*), Risso's dolphin (*Grampus griseus*), and Atlantic white-sided dolphin (*Lagenorhynchus acutus*). Years in which marine mammal bycatch was not observed were not represented.

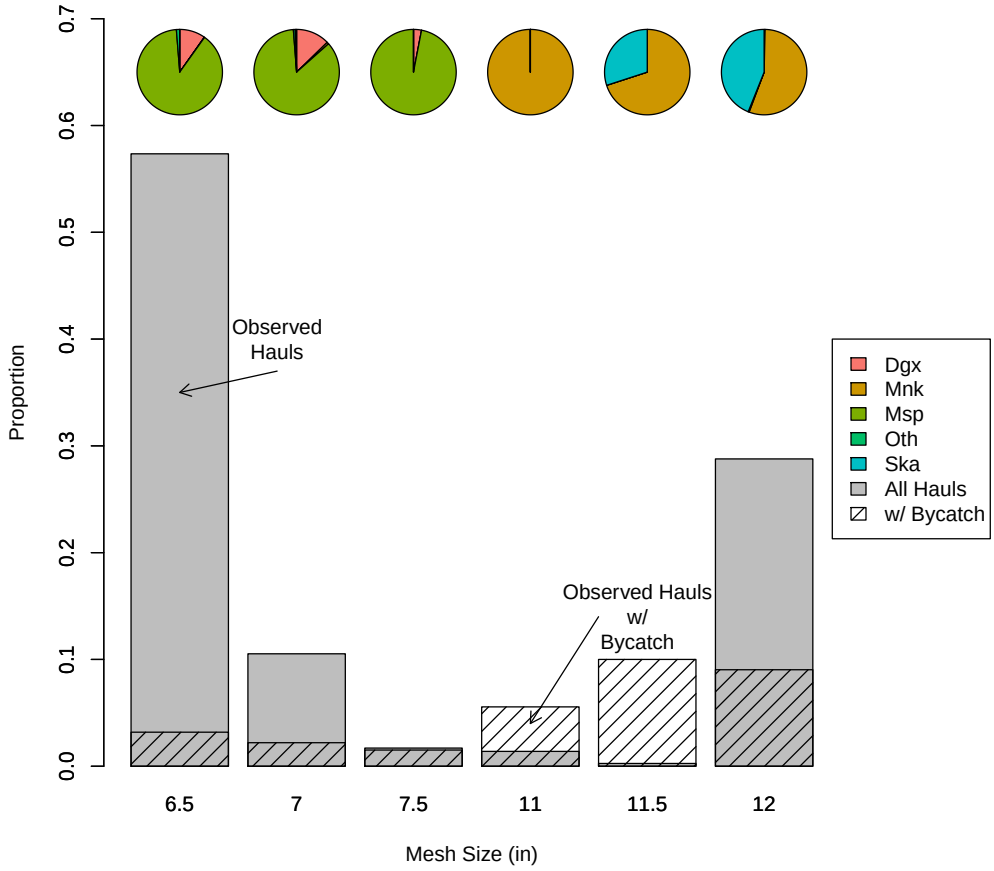


Figure 5. Superimposed distributions of mesh size (in) for observed hauls and observed hauls with marine mammal bycatch in the 2013 New England sink gillnet fishery. Only those mesh sizes with observed marine mammal bycatch are shown. Pie charts above bars refer to the composition of targeted fish species for observed hauls, aggregated into five categories: Dgx = spiny dogfish (*Squalus acanthias*), Mnk = monkfish (*Lophius americanus*), Msp = multispecies groundfish, Oth = other, and Ska = skate (*Raja ocellata* or *Raja eriancea*). The 'Oth' category included scup (*Stenotomus chrysops*), American lobster (*Homarus americanus*), unknown fish, smooth dogfish (*Mustelus canis*), unknown dogfish, Atlantic bonito (*Sarda sarda*), bluefish (*Pomatomus saltatrix*), and striped bass (*Morone saxatilis*).

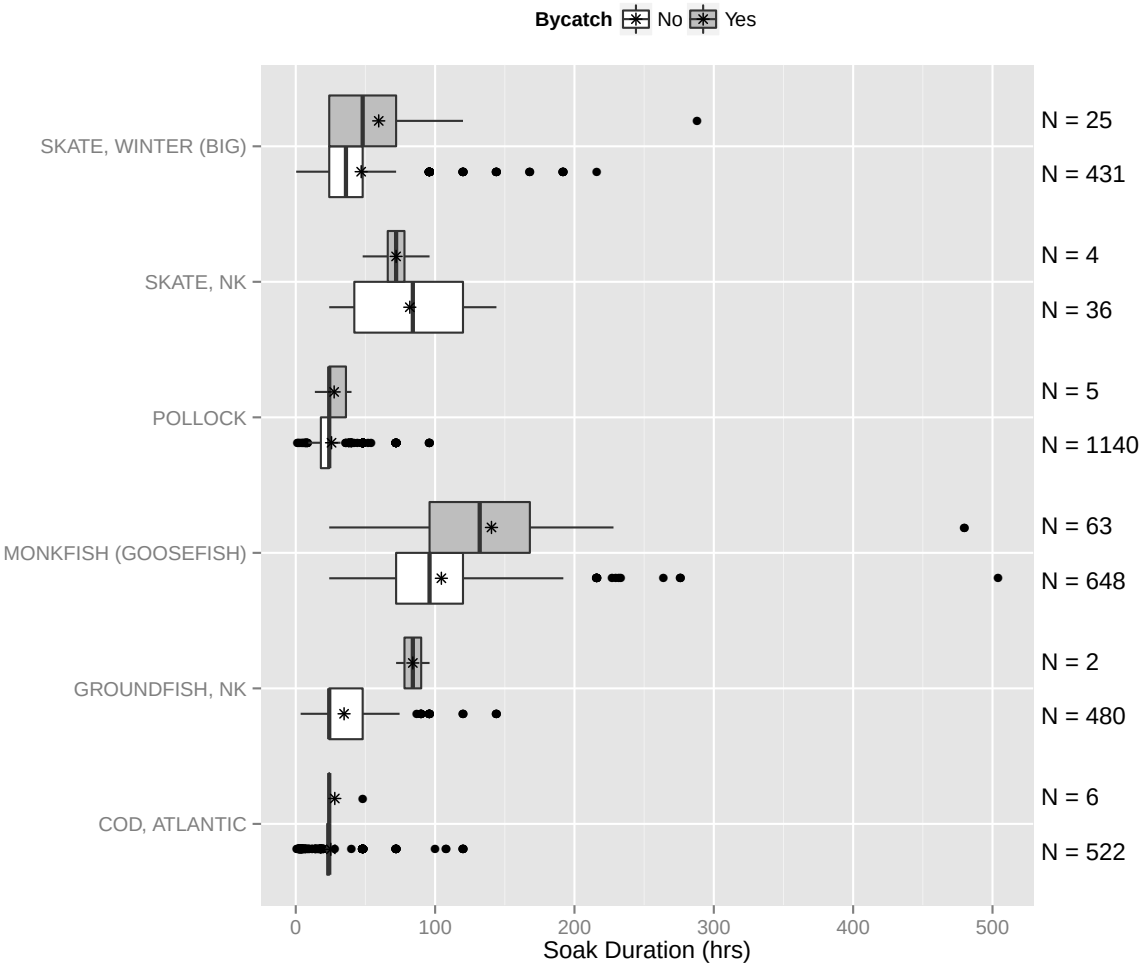


Figure 6. Boxplots of soak duration (hrs) by target fish species for observed hauls and observed hauls with marine mammal bycatch in the 2013 New England sink gillnet fishery. Only those target fish species with observed marine mammal bycatch are shown. Sample sizes are shown to the far right of the boxplots. Stars indicate the average, circles indicate outliers, and NK refers to an unknown species. Target fish species include winter skate (*Raja ocellata*), pollock (*Pollachius virens*), monkfish (*Lophius americanus*), and Atlantic cod (*Gadus morhua*).

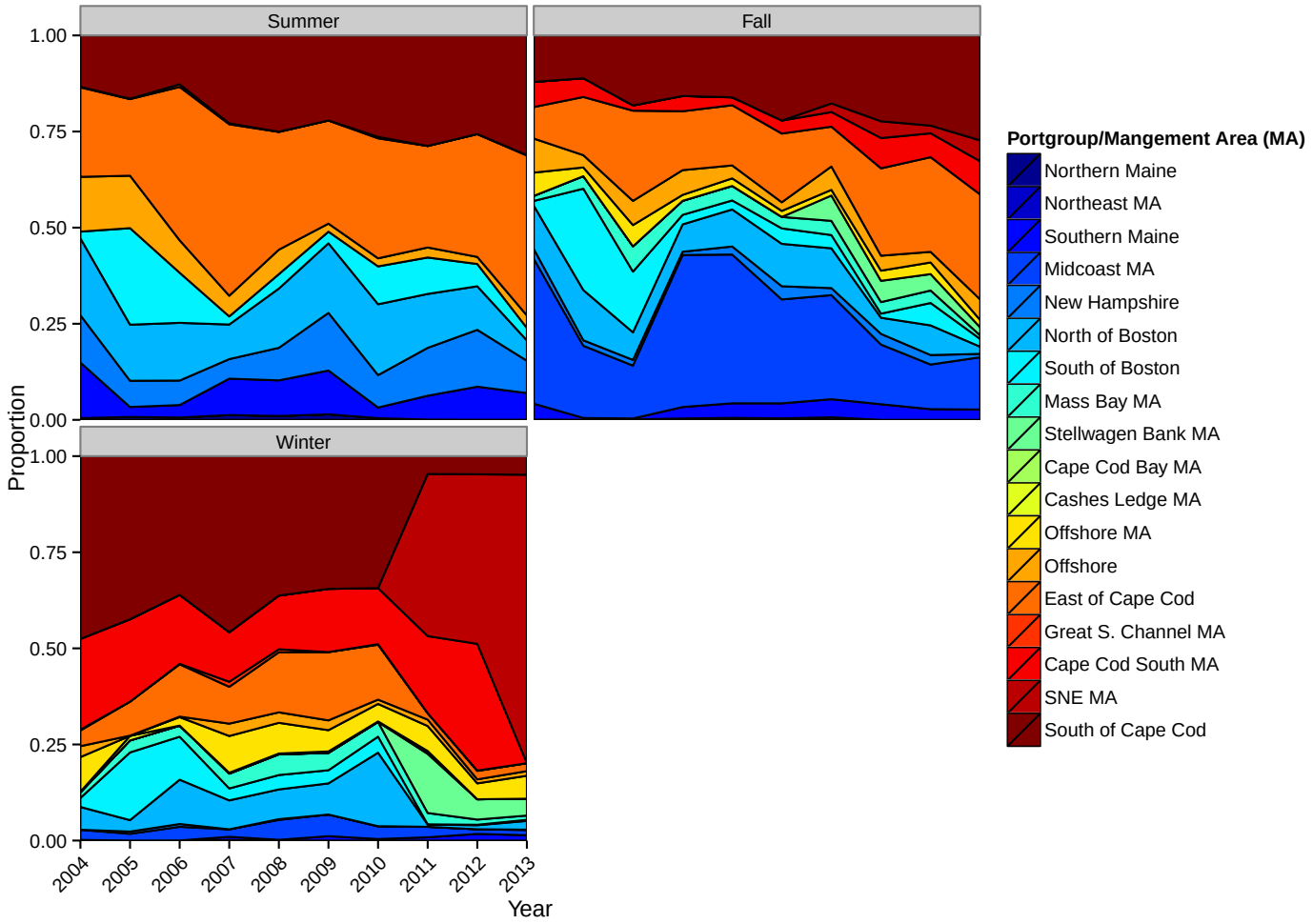


Figure 7. Proportion of prorated commercial landings for the New England sink gillnet fishery by portgroup/management area (MA) and season from 2004 - 2013. Seasons were defined as "W" (winter; January - May), "S" (summer; June - August), and "F" (fall; September - December). The Southern New England (SNE) and Stellwagen Bank Management Areas (MAs) were created in 2010 with the 2010 Harbor Porpoise Take Reduction Plan (HPTRP).

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