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Estimates of Cetacean and Pinniped Bycatch in Northeast and Mid-Atlantic Bottom Trawl Fisheries, 2011-2015

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ABSTRACT

This report provides bycatch estimates for 9 species of small cetaceans and pinnipeds caught in the Northeast (NEBT) and Mid-Atlantic (MABT) bottom trawl fisheries during 2011-2015. Mean annual bycatch estimates from the NEBT fishery were 34.30 (coefficient of variation [CV] = 0.20) common dolphins (*Delphinus delphis delphis*), 0.83 (CV = 0.91) Risso's dolphins (*Grampus griseus*), 22.86 (CV = 0.18) long-finned pilot whales (*Globicephala melas*), 3.71 (CV = 0.49) harbor porpoises (*Phocoena phocoena phocoena*), 45.80 (CV = 0.14) Atlantic white-sided dolphins (*Lagenorhynchus acutus*), 3.73 (CV = 0.65) offshore common bottlenose dolphins (*Tursiops truncatus truncatus*), 31.49 (CV = 0.16) gray seals (*Halichoerus grypus grypus*), 0.58 (CV = 0.81) harp seals (*Pagophilus groenlandicus*), and 5.30 (CV = 0.34) harbor seals (*Phoca vitulina concolor*). Mean annual bycatch estimates in the MABT fishery were 280.13 (CV = 0.12) common dolphins, 27.61 (CV = 0.32) Risso's dolphins, 10.70 (CV = 0.43) offshore common bottlenose dolphins, 1.93 (CV = 0.94) Atlantic white-sided dolphins, 22.46 (CV = 0.44) gray seals, and 10.14 (CV = 0.53) harbor seals.

INTRODUCTION

The bycatch of marine mammals related to commercial fishing operations has been well documented around the globe with emphasis on mitigating bycatch primarily in passive gears such as gillnets (Northridge 1991; Reeves et al. 2013). Marine mammal bycatch in active gears such as bottom and midwater trawls has received less attention because of reports of lower bycatch levels in comparison to the passive gear (Read et al. 2006). However, with the global expansion of observer programs around the world, we have gained a better understanding of the diversity and extent to which marine mammals may be affected by interactions with mobile gear fisheries (Allen et al. 2014; Couperus 1997; Piroddi et al. 2011). Since the first estimates of cetacean bycatch in the US Northwest Atlantic bottom trawl fisheries reported by Rossman (2010), fisheries observer coverage has increased, and several additional species have been documented as bycatch in both the Northeast and Mid-Atlantic regions of the United States.

Lyssikatos (2015) analyzed the cetacean and pinniped bycatch in the Northeast and Mid-Atlantic bottom trawl fisheries from 2008-2013, providing bycatch estimates for 10 species, including minke whale (*Balaenoptera acutorostrata acutorostrata*), common dolphin (*Delphinus delphis delphis*), Risso's dolphin (*Grampus griseus*), long-finned pilot whale (*Globicephala melas*), harbor porpoise (*Phocoena phocoena phocoena*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*), offshore common bottlenose dolphin (*Tursiops truncatus truncatus*), gray seal (*Halichoerus grypus grypus*), harp seal (*Pagophilus groenlandicus*), and harbor seal (*Phoca vitulina concolor*). The presence and amount of species bycaught varied with the season and their distribution and abundance.

The northeast bottom trawl fishery (NEBT) is a dynamic fishery with year-round effort that varies in time and space, driven primarily by catch limits of sector shares based fishery management (Murphy et al. 2015). The species harvested include groundfishes such as haddock (*Melanogrammus aeglefinus*), pollock (*Pollachius virens*), white hake (*Urophycis tenuis*) and yellowtail flounder (*Pleuronectes ferruginea*); elasmobranchs such as spiny dogfish (*Squalus acanthias*) and skates (*Rajidae* spp); and invertebrate species such as longfin (*Doryteuthis pealeii*) and northern shortfin squid (*Illex illecebrosus*). The Mid-Atlantic bottom trawl fishery (MABT) also operates year round from the coastal continental shelf to the offshore slope waters. Unlike the NEBT, the MABT is not largely driven by sector shares, but the harvest of several of the species by the MABT is restricted by total allowable landings, days at sea limits, or gear restricted areas (Waring et al. 2016). The species landed by the MABT include spiny dogfish, skates, both shortfin (*Illex illecebrosus*) and longfin (*Loligo pealeii*) inshore squid, monkfish (*Lophius americanus*), Atlantic mackerel (*Scomber scombrus*), butterfish (*Peprilus triacanthus*), summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*), black sea bass (*Centropristes striatus*), weakfish (*Cynoscion regalis*), spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), and other warmer water coastal finfish species (Waring et al. 2016). There is some overlap in the species composition harvested by both NEBT and MABT, but there are species accessible only to one or the other.

This report provides bycatch estimates defined as mortality and serious injuries combined for 6 cetacean and 3 pinniped species incidentally captured by NEBT and MABT operations from 2011 to 2015. The species included are: Atlantic white-sided dolphin, common dolphin, common bottlenose dolphin (offshore stock), Risso's dolphin, long-finned pilot whale, harbor porpoise, harbor seal, gray seal, and harp seal. The potential biological removal (PBR) is a limit designed to ensure that populations are maintained at or restored to an optimum

sustainable population to meet legal requirements under the US Marine Mammal Protection Act (MMPA; 16 US Code 1387). In this context the annual stratified bycatch rates and total bycatch are estimated for each marine mammal species observed during the period of study, and the mean annual estimates of bycatch are then compared to each respective stock's PBR to evaluate the total impact of bottom trawl bycatch for each stock. The aim of this report is to document bycatch estimates for the 5 year period 2011-2015 to support the US Atlantic and Gulf of Mexico 2017 marine mammal stock assessment reports.

MATERIALS AND METHODS

The study area applicable to this analysis was defined by Lyssikatos (2015) and is bounded by the Gulf of Maine ecoregion in the Northeast region south to Cape Hatteras, NC, in the Mid-Atlantic region and excludes internal bay, sound, and estuarine waters.

Sampled Commercial Bottom Trawl Trip Data

Data from commercial bottom trawl fishing activities were extracted from the Northeast Fisheries Observer Program (NEFOP) and At-Sea Monitoring program (ASM) databases and used to estimate bottom trawl marine mammal bycatch rates. NEFOP samples multiple gear types in both the Northeast and Mid-Atlantic Regions for documenting and monitoring interactions of marine mammals, sea turtles, and finfish bycatch attributed to commercial fishing operations, while ASM collects a reduced dataset in comparison to NEFOP with primarily focus on scientific, management, and compliance data onboard groundfish commercial vessels. The coverage is an integral part of catch monitoring to ensure that Annual Catch Limits are not exceeded (Waring et al. 2016). Bottom trawl gear types included in the analysis were bottom otter trawl, haddock separator trawl, and Ruhle trawl.

For the purpose of estimating total serious injury and mortality of small cetaceans and pinnipeds to include in annual stock assessment reports, "bycatch estimates" described in this report are defined as any observed interaction where the animal's condition was recorded by observers and monitors as either (1) fresh dead, (2) dead unknown condition, or (3) alive unknown condition. The observations also included captains' reports when an observer or monitor was on board the vessel but not able to observe the incident. Because trawl gear is actively towed for an average of 3 hours, it is assumed that animals with any stage of decomposition were already dead and decomposing when captured in the trawl and that the death was not attributed to the gear. Annual bycatch estimates are subsequently apportioned on no serious injury, serious injury, and mortality categories based on determinations made following guidelines described in NMFS (2012). Details on final animal determinations and their respective observed proportions (i.e., uninjured, not seriously injured, seriously injured, or dead) are described in separate reports (Waring et al. 2014, 2015; Wenzel et al. 2015, 2016). Total observed and estimated bycatch partitioned by serious injury and mortality is provided in the annual stock assessment reports (Waring et al. 2016).

Commercial Bottom Trawl Fleet Effort

Total commercial fishing effort and associated temporal and spatial fishing trip characteristics were obtained from mandatory vessel trip reports (VTRs) collected and administered by the Greater Atlantic Regional Fisheries Office (NMFS-GARFO 2014). Effort is

defined as days fished (gear tow duration in hours/24). VTR data were assumed to represent a near census of the Northeastern US bottom trawl fishing effort from Maine to North Carolina when used in fish stock assessments (Rago et al. 2005; Warden 2011). Therefore, the VTR effort data collected during 2011-2015 were assumed to represent a good approximation of total bottom trawl fishery effort when estimating total annual bycatch of cetaceans and pinnipeds.

Estimating Bycatch Rates and Mortality

Fisheries observer and VTR data were stratified by geographic region, year, season, and ecoregion. Years included 2011-2015, and seasons were defined by calendar year trimester (winter = Jan-Apr; spring and summer = May-Aug; fall = Sep-Dec). The ecoregions defined in Lyssikatos (2015) included the Gulf of Maine (GOM), Georges Bank (GB), and the Mid-Atlantic (MA). These ecoregions were informed by both geographic regions and ecological production units. There are 2 geographic regions applicable to our study area: the Northeast (NE) and the Mid-Atlantic (MA). The geographic regions were defined by the National Marine Fisheries Service (NMFS) annual List of Fisheries published in the Federal Register (NMFS 2014) and used to categorize various commercial fishing gears according to their risk of interacting with marine mammals. The same geographic regions were used to categorize total human-induced mortality in the NMFS annual stock assessment reports (Waring et al. 2016). Ecological production units are areas within the Northwest Atlantic large marine ecosystem that have unique biological, chemical, and physical characteristics supporting various assemblages of marine life (Ecosystem Assessment Program 2012). The NE geographic region was further stratified by ecoregion (GOM and GB) as a comprehensive means of capturing unique habitat characteristics that influence the presence of marine mammals in these areas, thereby decreasing variance in estimated bycatch rates (Rossman 2010; Murray 2013). The MA geographic and ecoregion represent the same spatial area, so the 2 terms are used interchangeably throughout this report.

Stratified bycatch rates and estimates were calculated by using a standard ratio-estimator defined as the product of the ratio of the sum of the observed bycatch mortality (y) to the sum of observed days fished (x) times total days fished (X) for each cetacean species (i) and stratum defined by geographic region (r), year (t), season (s), and ecoregion (e):

$$\hat{Y}_{irtse} = \frac{\sum y_{irtse}}{\sum x_{rtse}} X_{rtse}$$

In the particular case of pilot whales, the long-finned pilot whale's distribution is known to overlap with the short-finned pilot whale's (*Globicephala macrorhynchus*) distribution between the southern flank of Georges Bank and New Jersey. However, long-finned pilot whales bycaught in bottom trawl gear during 2011-2015 were all north of 39°N latitude, a region assigned with low probability for the presence of short-finned pilot whale species based on water temperature and depth (Waring et al. 2016). As a result, all pilot whales bycaught during the period of 2011-2015 were assigned to the long-finned pilot whale species.

The keyword search method described in Lyssikatos (2015) was performed to evaluate the use of acoustic deterrents (pingers) by bottom trawl fishermen. There was no evidence of pinger usage on bottom trawl gear from observer records since 2011. As a result, pinger effects on small cetacean and pinniped bycatch rates from bottom trawl gear are not evaluated in this

report. See Lyssikatos (2015) for details on pinger effects from 2011 and earlier years.

Estimating Uncertainty

Standard errors were estimated by using a standard bootstrap procedure (Efron and Tibshirani 1993). An observed trip was defined as the sampling unit and the finite population correction factor was applied to the bycatch rate standard error for all strata with 10% or higher observer coverage (Cochran 1977). The coefficient of variation was calculated with the standard formula for independent variables, and the lognormal 95% confidence intervals were calculated for annual estimates reported by region, year, and species following the method proposed by Buckland et al. (1993) where:

$$VAR(\log_e M) = 1 + \log_e \left[\frac{VAR(M)}{M^2} \right]$$

$$C = \exp[z_\alpha \cdot \sqrt{VAR(\log_e M)}]$$

M is mortality and z_α is the z-value of the standardized normal deviate. The lower and upper intervals are then given by:

$$\frac{M}{C} \text{ and } M \times C$$

RESULTS

Nine species of marine mammals were bycaught during 2011 to 2015 by the bottom trawl fisheries in the Northeast (NE) and Mid-Atlantic (MA) geographic regions. The observer coverage, defined as the percentage of the VTR trips in which an observer was onboard a fishing vessel, averaged 11.16%, ranging from 9.85% for 2012 and 2013 with a maximum coverage of 14.22% in 2014 (Table 1).

Observed total bycatch of 387 animals included 198 common dolphins, 71 Atlantic white-sided dolphins, 47 gray seals, 31 long-finned pilot whales, 13 Risso's dolphins, 13 harbor seals, 9 offshore common bottlenose dolphins, 4 harbor porpoise, and 1 harp seal (Table 1; Figure 1). Overall for species bycaught in both regions, the mean mortality estimates were higher for the MA region in comparison to the NE region with the exception of 2 species, Atlantic white-sided dolphin and gray seal (Table 2). By ecoregion there were 86 bycatch events reported for Georges Bank, 115 for the Gulf of Maine, and 186 in the Mid-Atlantic (Table 3).

Northeast Region Bycatch Mortality Estimates

Average annual bycatch estimates were highest for Atlantic white-sided dolphins (45.80, CV = 0.14), common dolphins (34.30, CV = 0.20), gray seals (31.49, CV = 0.16), and long-finned pilot whales (22.86, CV = 0.18). Offshore common bottlenose dolphin, Risso's dolphin, and harbor porpoise bycatch was sporadic in the region with estimates averaging fewer than 5 animals per year. The same situation occurred for harbor and harp seals, in which the average combined annual bycatch estimates, were fewer than 6 animals per year (Table 2; Figure 2).

During 2011-2015, there was a difference of 5% in the average observer coverage rates between the 2 NE ecoregions. GOM had coverage of 27.3% and ranged from 18.64 - 42.51%, while GB had coverage of 22.1% and ranged from 8.37 - 36.6%. Bycatch mortality occurred

year round in both the GOM and GB ecoregions. However, the total bycatch mortality estimate was greater in the GOM ecoregion, with the highest values in winter attributed to Atlantic white-sided dolphin. Fall bycatch was dominated by long-finned pilot whale, and the lowest bycatch occurred in summer with levels comparable for all species. In contrast GB was dominated by common dolphin with relatively constant bycatch year round, followed by gray seals and long-finned pilot whale (Table 3; Figure 3).

Mid-Atlantic Region Bycatch Mortality Estimates

Average annual bycatch estimates during 2011-2015 were highest for common dolphins (280.13, CV = 0.12) followed by Risso's (27.61, CV = 0.32) and offshore bottlenose (10.70, CV = 0.43) dolphins. Both gray seal and harbor seals takes were observed in the MA, with estimates of 22.46 (CV = 0.44) and 10.14 (CV = 0.53) annual bycatch respectively. Atlantic white-sided dolphin bycatch was rare in the region, with an estimate of fewer than 2 animals per year (Table 2; Figure 2).

During 2011-2015, observer coverage was 9.67%, ranging from 2.39% - 15.04% in the MA region. Bycatch occurred year round but was dominated by common dolphin for all seasons, followed by Risso's dolphin which was an order of magnitude lower. Offshore bottlenose dolphin and gray seal bycatch was variable and occurred primarily during fall and summer, respectively (Table 3; Figure 3).

DISCUSSION

During 2011-2015, 9 species of small cetaceans and pinnipeds were bycaught through interactions with the NE and MA bottom trawl fisheries. For species bycaught in both regions, the mean mortality estimates were higher for the MA region than for the NE region. The bycatch composition was more diverse in the NE than in the MA bottom trawl fisheries; 6 species were bycaught in both regions; and 3 species were unique to the NE region: harp seal, harbor porpoise, and long-finned pilot whale (Table 2; Figure 2). Lyssikatos (2015) reported a similar difference between areas in relation to the species composition and bycatch estimates with the exception of the presence of minke whale bycatch in the NE region, which has not been observed since 2008.

Common and Atlantic white-sided dolphins were the most frequently bycaught marine mammal species observed in bottom trawl gear during 2011-2015. White-sided dolphin showed high interannual variability in total bycatch estimates. The distribution of white-sided dolphins is considered to be restricted to temperate and subpolar waters of the North Atlantic, primarily in continental shelf waters to the 100 m depth contour (Evans 1987; Hamazaki 2002; Doksaeter et al 2008). This distribution would explain the higher incidence of bycatch recorded during winter for the species in the NE region and the presence of a single individual bycaught during winter in the MA region. This tendency contrasts with the common dolphin bycatch that occurs across both NE and MA geographic regions. This species is distributed along the continental shelf between the 100 and 2000 m isobaths and is also associated with Gulf Stream features (Waring et al. 2016). The distribution of the species would explain the high bycatch rate in the MA region, which made up 40% of the total mortality reported and the highest recorded for the entire study area for 2011-2015. The observed bycatch and the estimated bycatch rate from this report are comparable to Lyssikatos (2015) for the study area. Changes in the species distribution might modify bycatch rates in a particular region, for instance Lyssikatos (2015) identified a change in the long-finned pilot whale bycatch between 2000-2005 where the species was largely restricted

to the MA and during 2008-2013 where it shifted completely to the NE region.

The analysis of the NE and MA bottom trawl fisheries during 2011-2015 shows long-finned pilot whale bycatch occurred only in the NE region, indicating the need for more data and more comprehensive analyses to evaluate the spatial shift in the long-finned pilot whale bycatch. Lyssikatos (2015) discussed 2 plausible causes that might explain the change in the bycatch of the species, which include changes in the fishing practices or changes in the pilot whale distribution caused by changes in the environment.

Total fisheries observer coverage was higher in the GOM and GB ecoregions than in the MA because of the allocation of at-sea monitors in addition to traditional fisheries observers in the NE region. At-sea monitors are allocated to commercial fishing vessels targeting multispecies groundfish to meet quota monitoring requirements that are generally not required for the vast majority of bottom trawl effort occurring in the MA region. As a result, observer coverage rates are disproportionately higher in the NE region, reaching 75% of the total observer effort. This tendency is consistent with the findings by Lyssikatos (2015). The ASM program is intended to be transitioned to an industry-funded program in the future (US Department of Commerce 2016). The impact on the quality assurance/quality control (QA/QC) standards of switching to an industry-funded ASM program in the NE region and subsequent reporting of marine mammal bycatch events from ASM trips is uncertain. The integrity of traditional NEFOP observer coverage and its data collection will not be affected by modifications to the ASM program.

Mean annual bycatch estimates attributed to bottom trawl gear for 7 of the species described in this report are below their PBRs for 2011-2015. The 2 exceptions are gray seals and harp seals, which have unknown PBRs (Waring et al. 2016). Maintaining consistent fisheries observer sampling of commercial bottom trawl fishing effort will allow continued monitoring of cetacean and pinniped bycatch, informing future evaluation of changes in bycatch patterns in the greater Northwest Atlantic large marine ecosystem.

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Table 1. Total numbers of observed marine mammals bycaught, excluding decomposed animals, in Northeast and Mid-Atlantic commercial bottom trawl gear, 2011-2015. Observer coverage (Obs Cov %) is the percentage of observed trips relative to total Vessel Trip Report (VTR) trips. Days fished (DF) is the amount of time (hours) the net was in the water divided by 24 hours.

Species	2011	2012	2013	2014	2015	Total	Mean
Atlantic white-sided dolphin (<i>Lagenorhynchus acutus</i>)	47	9	8	4	3	71	14.2
Common dolphin (<i>Delphinus delphis delphis</i>)	55	44	28	41	30	198	39.6
Risso's dolphin (<i>Grampus griseus</i>)	2	1	4	3	3	13	2.6
Common bottlenose dolphin (<i>Tursiops truncatus truncatus</i>)	2	1	0	3	3	9	1.8
Harbor porpoise (<i>Phocoena phocoena phocoena</i>)	2	0	1	1	0	4	0.8
Long-finned pilot whale (<i>Globicephala melas</i>)	12	10	4	5	0	31	6.2
Harbor seal (<i>Phoca vitulina concolor</i>)	3	4	2	3	1	13	2.6
Gray seal (<i>Halichoerus grypus grypus</i>)	22	9	7	5	4	47	9.4
Harp seal (<i>Pagophilus groenlandicus</i>)	1	0	0	0	0	1	0.2
Observed Trips	2,240	2,063	1,830	2,188	1,761	10,082	2,016
Observed Tows	25,541	19,935	17,180	19,451	15,846	97,953	19,591
Observed DF	3,664	3,062	2,466	2,714	2,139	14,045	2,809
Total VTR Trips	21,224	20,946	18,581	15,392	14,183	90,326	18,065
Total VTR DF	14,612	16,104	14,150	16,286	14,437	75,589	15,118
Obs Cov %	10.55	9.85	9.85	14.22	12.42	11.16	11.16

Table 2. Total and mean annual bycatch estimates in Northeast and Mid-Atlantic commercial bottom trawl trips for years 2011-2015 by species and region. The annual coefficients of variation (CV) are in parentheses. NA = not applicable.

Species	Region	2011	2012	2013	2014	2015	Total Bycatch	Mean Bycatch	CV
Common Dolphin (<i>Delphinus delphis delphis</i>)	Northeast	73.35 (0.32)	42.26 (0.47)	16.84 (0.54)	17.47 (0.53)	21.58 (0.45)	171.50	34.30	0.20
	Mid-Atlantic	249.38 (0.23)	318.04 (0.24)	254.29 (0.29)	328.81 (0.29)	250.11 (0.32)	1400.63	280.13	0.12
Risso's Dolphin (<i>Grampus griseus</i>)	Northeast	0.00 (NA)	0.00 (NA)	0.00 (NA)	4.16 (0.91)	0.00 (NA)	4.16	0.83	0.91
	Mid-Atlantic	27.25 (0.68) ¹	7.57 (0.92)	42.08 (0.71)	21.15 (0.93)	40.08 (0.63)	138.06	27.61	0.32
Long-finned pilot whale (<i>Globicephala melas</i>)	Northeast	33.61 (0.27)	32.79 (0.27)	16.16 (0.42)	31.75 (0.44)	0.00 (NA)	114.31	22.86	0.18
Gray Seal (<i>Halichoerus grypus grypus</i>)	Northeast	58.40 (0.21)	37.38 (0.44)	19.96 (0.37)	19.01 (0.45)	22.69 (0.46)	157.44	31.49	0.16
	Mid-Atlantic	37.93 (0.54)	42.22 (0.96)	25.19 (0.67)	6.96 (0.96)	0.00 (NA)	112.30	22.46	0.44
Harbor porpoise (<i>Phocoena phocoena phocoena</i>)	Northeast	5.88 (0.58)	0.00 (NA)	7.18 (0.98)	5.50 (0.86)	0.00 (NA)	18.56	3.71	0.49
Atlantic white-sided dolphin (<i>Lagenorhynchus acutus</i>)	Northeast	137.54 (0.20)	27.15 (0.38)	33.24 (0.31)	16.21 (0.50)	14.86 (0.52)	229.00	45.80	0.14
	Mid-Atlantic	0.00 (NA)	0.00 (NA)	0.00 (NA)	9.67 (0.94)	0.00 (NA)	9.67	1.93	0.94
Harp seal (<i>Pagophilus groenlandicus</i>)	Northeast	2.91 (0.81)	0.00 (NA)	0.00 (NA)	0.00 (NA)	0.00 (NA)	2.91	0.58	0.81
Harbor seal (<i>Phoca vitulina concolor</i>)	Northeast	8.76 (0.46)	2.83 (0.81)	4.19 (0.89)	10.70 (0.63)	0.00 (NA)	26.48	5.30	0.34
	Mid-Atlantic	0.00 (NA)	22.72 (0.96)	10.90 (0.96)	9.67 (0.95)	7.41 (1.00)	50.70	10.14	0.53
Common bottlenose dolphin (<i>Tursiops truncatus truncatus</i>)	Northeast	0.00 (NA)	0.00 (NA)	0.00 (NA)	0.00 (NA)	18.65 (0.65)	18.65	3.73	0.65
	Mid-Atlantic	14.59 (0.64)	14.30 (0.93)	0.00 (NA)	24.62 (0.66)	0.00 (NA)	53.51	10.70	0.43

¹ The 2011 bycatch estimate for Risso's dolphin takes acoustic deterrents effects into account. For details on methodology please refer to Lyssikatos 2015.

Table 3. Stratified observed bycatch (OBS Byc), bycatch rates (Byc Rate), total (VTR DF) and observed days fished (OBS DF), percent coverage (Cov %), total bycatch mortality (M), and coefficient of variation (CV) by species, region (NE = Northeast, MA = Mid-Atlantic; shaded rows), year (2011-2015), season (w = January-April, s = May-August, f = September-December), and ecoregion (ECO; GOM = Gulf of Maine, GB = Georges Bank, MA = Mid-Atlantic) in Northeast and Mid-Atlantic commercial bottom trawl trips, 2011-2015. Years and seasons absent from the 5-year time series means no bycatch events were observed; thus, the estimated total bycatch for that year is defined as zero.

Species	Region	Year	Season	ECO	VTR DF	OBS DF	Cov %	OBS Byc	Byc Rate	M	CV
Common dolphin <i>(Delphinus delphis delphis)</i>	NE	2011	f	GB	918	291	31.75	6	0.0206	18.90	0.43
	NE	2011	f	GOM	1856	789	42.55	2	0.0025	4.70	0.74
	NE	2011	s	GB	1202	440	36.60	8	0.0182	21.86	0.55
	NE	2011	w	GB	693	174	25.09	7	0.0403	27.90	0.64
	NE	2012	f	GB	770	196	25.39	4	0.0205	15.75	0.88
	NE	2012	w	GB	671	142	21.12	5	0.0353	23.68	0.59
	NE	2012	w	GOM	2860	1011	35.36	1	0.001	2.83	0.78
	NE	2013	f	GB	858	188	21.86	2	0.0107	9.15	0.64
	NE	2013	s	GB	1009	262	25.99	2	0.0076	7.69	0.92
	NE	2014	f	GB	947	145	15.31	2	0.0137	12.97	0.65
	NE	2014	f	GOM	2144	471	21.97	1	0.0021	4.50	0.89
	NE	2015	f	GB	881	141	16.00	1	0.0071	6.26	0.88
	NE	2015	s	GB	1183	229	19.36	2	0.0087	10.29	0.66
	NE	2015	w	GOM	2397	481	20.07	1	0.0021	5.03	0.89
	MA	2011	f	MA	1948	293	15.06	16	0.0545	106.27	0.32
	MA	2011	s	MA	2154	162	7.54	3	0.0185	39.80	0.73
	MA	2011	w	MA	2255	284	12.58	13	0.0458	103.31	0.33
	MA	2012	f	MA	2054	144	6.99	9	0.0627	128.72	0.36
	MA	2012	w	MA	2553	337	13.20	25	0.0741	189.32	0.33
	MA	2013	f	MA	2029	206	10.18	10	0.0484	98.28	0.51
	MA	2013	s	MA	1943	154	7.94	2	0.0130	25.19	0.97
	MA	2013	w	MA	2040	187	9.17	12	0.0641	130.82	0.37
	MA	2014	f	MA	1990	285	14.32	19	0.0666	132.53	0.25
	MA	2014	s	MA	2274	214	9.41	13	0.0607	138.03	0.65
	MA	2014	w	MA	2249	231	10.27	6	0.0259	58.25	0.54
	MA	2015	f	MA	1808	207	11.45	16	0.0775	140.12	0.47
	MA	2015	s	MA	2320	93	4.01	2	0.0216	50.11	0.67
	MA	2015	w	MA	1901	254	13.36	8	0.0315	59.88	0.41

Table 3, continued. Stratified observed bycatch (OBS Byc), bycatch rates (Byc Rate), total (VTR DF) and observed days fished (OBS DF), percent coverage (Cov %), total bycatch mortality (M), and coefficient of variation (CV) by species, region (NE = Northeast, MA = Mid-Atlantic; shaded rows), year (2011-2015), season (w = January-April, s = May-August, f = September-December), and ecoregion (ECO; GOM = Gulf of Maine, GB = Georges Bank, MA = Mid-Atlantic) in Northeast and Mid-Atlantic commercial bottom trawl trips, 2011-2015. Years and seasons absent from the 5-year time series means no bycatch events were observed; thus, the estimated total bycatch for that year is defined as zero.

Species	Region	Year	Season	ECO	VTR DF	OBS DF	Cov %	OBS Byc	Byc Rate	M	CV
Long-finned pilot whale (<i>Globicephala melas</i>)	NE	2011	f	GB	918	291	31.75	1	0.0034	3.15	0.84
	NE	2011	f	GOM	1856	789	42.55	6	0.0076	14.10	0.37
	NE	2011	s	GB	1202	440	36.60	2	0.0045	5.46	0.81
	NE	2011	s	GOM	1395	477	34.17	1	0.0021	2.93	0.78
	NE	2011	w	GB	693	174	25.09	2	0.0115	7.97	0.59
	NE	2012	f	GB	770	196	25.39	1	0.0051	3.94	0.86
	NE	2012	f	GOM	1983	597	30.09	3	0.0050	9.97	0.47
	NE	2012	w	GB	671	142	21.12	1	0.0071	4.74	0.84
	NE	2012	w	GOM	2860	1011	35.36	5	0.0049	14.14	0.37
	NE	2013	f	GOM	1612	432	26.81	2	0.0046	7.46	0.59
	NE	2013	s	GOM	1481	340	22.98	2	0.0059	8.70	0.60
	NE	2014	w	GB	478	40	8.37	1	0.0252	12.05	1.01
	NE	2014	f	GOM	2144	471	21.97	2	0.0042	9.00	0.63
	NE	2014	w	GOM	3058	570	18.64	2	0.0035	10.70	0.64
Atlantic white-sided dolphin (<i>Lagenorhynchus acutus</i>)	NE	2011	s	GB	1202	440	36.60	2	0.0045	5.46	0.56
	NE	2011	s	GOM	1395	477	34.17	2	0.0042	5.85	0.60
	NE	2011	w	GB	693	174	25.09	1	0.0058	3.99	0.90
	NE	2011	w	GOM	2190	753	34.36	42	0.0558	122.23	0.22
	NE	2012	s	GOM	1831	405	22.11	1	0.0025	4.52	0.91
	NE	2012	w	GOM	2860	1011	35.36	8	0.0079	22.63	0.42
	NE	2013	f	GOM	1612	432	26.81	1	0.0023	3.73	0.85
	NE	2013	s	GOM	1481	340	22.98	1	0.0029	4.35	0.84
	NE	2013	w	GOM	2552	609	23.85	6	0.0099	25.15	0.36
	NE	2014	w	GOM	3058	570	18.64	3	0.0053	16.21	0.51
	NE	2015	w	GOM	2397	481	20.07	3	0.0062	14.86	0.52
	MA	2014	w	MA	2249	231	10.27	1	0.0043	9.67	0.95

Table 3, continued. Stratified observed bycatch (OBS Byc), bycatch rates (Byc Rate), total (VTR DF) and observed days fished (OBS DF), percent coverage (Cov %), total bycatch mortality (M), and coefficient of variation (CV) by species, region (NE = Northeast, MA = Mid-Atlantic; shaded rows), year (2011-2015), season (w = January-April, s = May-August, f = September-December), and ecoregion (ECO; GOM = Gulf of Maine, GB = Georges Bank, MA = Mid-Atlantic) in Northeast and Mid-Atlantic commercial bottom trawl trips, 2011-2015. Years and seasons absent from the 5-year time series means no bycatch events were observed; thus, the estimated total bycatch for that year is defined as zero.

Species	Region	Year	Season	ECO	VTR DF	OBS DF	Cov %	OBS Byc	Byc Rate	M	CV
Risso's Dolphin (<i>Grampus griseus</i>)	NE	2014	s	GB	1299	310	23.86	1	0.0032	4.16	0.89
	MA	2011	f	MA	1948	293	15.06	1	0.0034	6.64	0.90
	MA	2011	w	MA	84	4	4.96	1	0.2410	20.17	0.97
	MA	2012	w	MA	2553	337	13.20	1	0.0030	7.57	0.92
	MA	2013	f	MA	2029	206	10.18	3	0.0145	29.48	0.95
	MA	2013	s	MA	1843	154	7.94	1	0.0065	12.60	0.92
	MA	2014	s	MA	2274	214	9.41	2	0.0093	21.15	0.98
	MA	2015	s	MA	2320	93	4.01	1	0.0108	25.06	0.93
	MA	2015	w	MA	1901	254	13.36	2	0.0079	15.02	0.63
Common bottlenose dolphin (<i>Tursiops truncatus truncatus</i>)	NE	2015	f	GB	881	141	16.00	2	0.0142	12.51	0.88
	NE	2015	w	GB	458	74	16.16	1	0.0134	6.14	0.90
	MA	2011	f	MA	1948	293	15.06	1	0.0034	6.64	0.90
	MA	2011	w	MA	2255	284	12.58	1	0.0036	7.95	0.90
	MA	2012	f	MA	2054	144	6.99	1	0.0070	14.30	0.99
	MA	2014	f	MA	1990	285	14.32	2	0.0070	13.93	0.92
	MA	2014	s	MA	2274	214	9.41	1	0.0047	10.69	0.97
Harbor porpoise (<i>Phocoena phocoena phocoena</i>)	NE	2011	f	GB	918	291	31.75	1	0.0034	3.15	0.83
	NE	2011	s	GB	1202	440	36.60	1	0.0023	2.73	0.79
	NE	2013	w	GB	625	87	13.92	1	0.0115	7.18	0.98
	NE	2014	w	GOM	3058	570	18.64	1	0.0018	5.50	0.87

Table 3, continued. Stratified observed bycatch (OBS Byc), bycatch rates (Byc Rate), total (VTR DF) and observed days fished (OBS DF), percent coverage (Cov %), total bycatch mortality (M), and coefficient of variation (CV) by species, region (NE = Northeast, MA = Mid-Atlantic; shaded rows), year (2011-2015), season (w = January-April, s = May-August, f = September-December), and ecoregion (ECO; GOM = Gulf of Maine, GB = Georges Bank, MA = Mid-Atlantic) in Northeast and Mid-Atlantic commercial bottom trawl trips, 2011-2015. Years and seasons absent from the 5-year time series means no bycatch events were observed; thus, the estimated total bycatch for that year is defined as zero.

Species	Region	Year	Season	ECO	VTR DF	OBS DF	Cov %	OBS Byc	Byc Rate	M	CV
Gray seal (<i>Halichoerus grypus grypus</i>)	NE	2011	f	GB	918	291	31.75	1	0.0034	3.15	0.84
	NE	2011	f	GOM	1856	789	42.55	2	0.0025	4.70	0.54
	NE	2011	s	GB	1202	440	36.6	8	0.0182	21.86	0.31
	NE	2011	s	GOM	1395	477	34.17	2	0.0042	5.85	0.57
	NE	2011	w	GB	693	174	25.09	5	0.0288	19.93	0.45
	NE	2011	w	GOM	2190	753	34.36	1	0.0013	2.91	0.81
	NE	2012	s	GB	1076	177	16.41	4	0.0226	24.37	0.64
	NE	2012	s	GOM	1831	405	22.11	1	0.0025	4.52	0.86
	NE	2012	w	GOM	2860	1011	35.36	3	0.003	8.49	0.46
	NE	2013	f	GB	858	188	21.86	1	0.0053	4.58	0.86
	NE	2013	s	GB	1009	262	25.99	4	0.0153	15.39	0.4
	NE	2014	s	GB	1299	310	23.86	2	0.0064	8.31	0.63
	NE	2014	w	GOM	3058	570	18.64	2	0.0035	10.70	0.63
	NE	2015	f	GB	881	141	16.00	1	0.0071	6.26	0.93
	NE	2015	s	GB	1183	229	19.36	2	0.0087	10.29	0.65
	NE	2015	w	GB	458	74	16.16	1	0.0134	6.14	0.90
	MA	2011	s	MA	2154	162	7.54	2	0.0123	26.53	0.64
	MA	2011	w	MA	2255	284	12.58	1	0.0035	7.95	0.95
	MA	2012	s	MA	2305	55	2.37	1	0.0183	42.22	0.96
	MA	2013	s	MA	1943	154	7.94	2	0.0130	25.19	0.67
MA	2014	f	MA	285	1990	14.32	1	0.0035	6.96	0.94	
Harbor seal (<i>Phoca vitulina concolor</i>)	NE	2011	s	GOM	1395	477	34.17	2	0.0042	5.85	0.57
	NE	2011	w	GOM	2190	753	34.36	1	0.0013	2.91	0.81
	NE	2012	w	GOM	2860	1011	35.36	1	0.0010	2.83	0.81
	NE	2013	w	GOM	2552	609	23.85	1	0.0016	4.19	0.89
	NE	2014	w	GOM	3058	570	18.64	2	0.0035	10.70	0.64
	MA	2012	w	MA	2553	337	13.20	3	0.0089	22.72	0.96
	MA	2013	w	MA	2040	187	9.17	1	0.0053	10.90	0.96
	MA	2014	w	MA	2249	231	10.27	1	0.0043	9.67	0.96
	MA	2015	w	MA	1901	254	13.36	1	0.0039	7.41	0.94
Harp seal (<i>Pagophilus groenlandicus</i>)	NE	2011	w	GOM	2190	753	34.36	1	0.0013	2.91	0.81

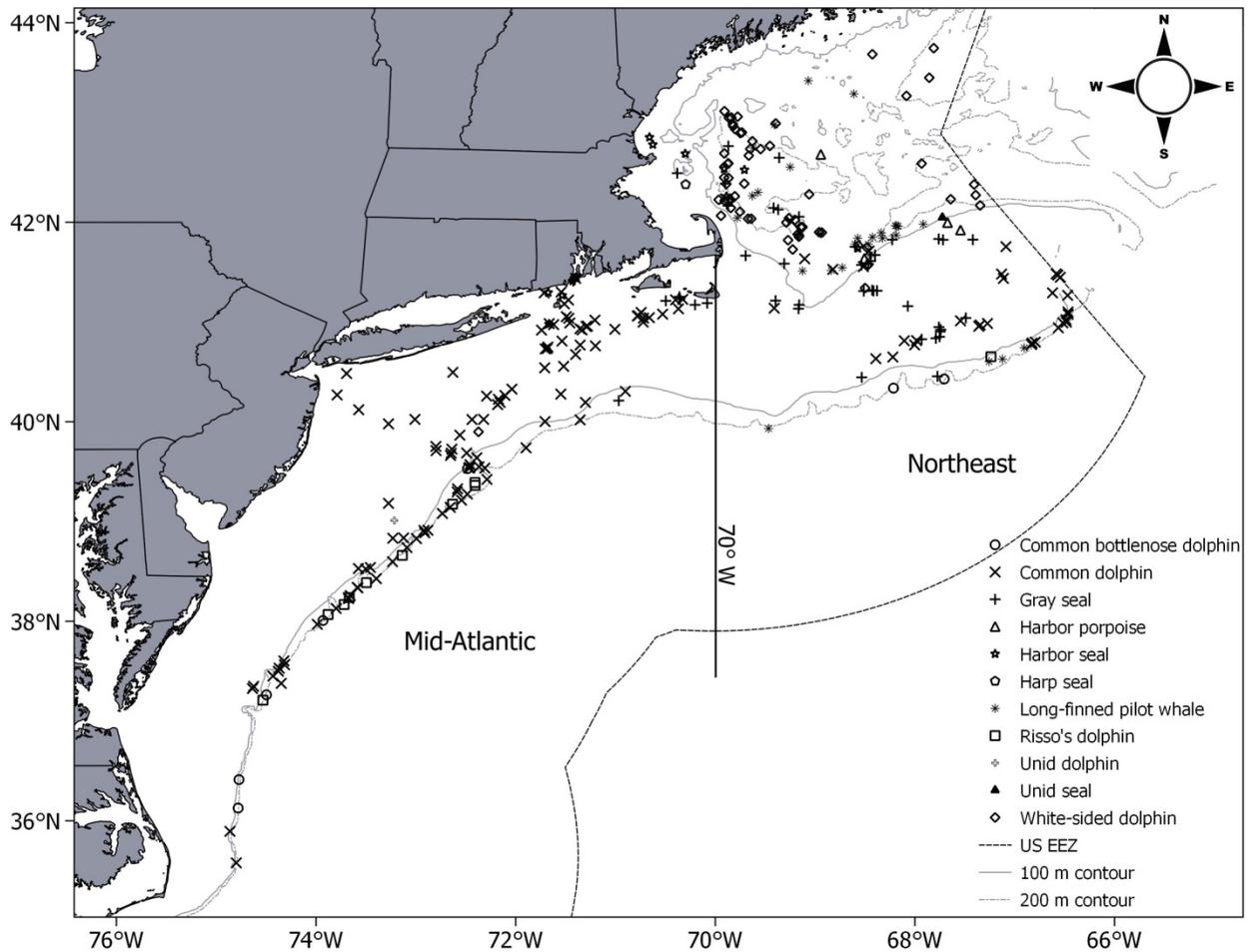


Figure 1. Incidentals take locations from the observed commercial trips in the Northeast and Mid-Atlantic study areas during 2011 to 2015 for Atlantic white-sided dolphin (*Lagenorhynchus acutus*), common dolphin (*Delphinus delphis delphis*), long-finned pilot whale (*Globicephala melas*), common bottlenose dolphin (*Tursiops truncatus truncatus*), Risso's dolphin (*Grampus griseus*), harbor porpoise (*Phocoena phocoena phocoena*), gray seal (*Halichoerus grypus grypus*), harbor seal (*Phoca vitulina concolor*), and harp seal (*Pagophilus groenlandicus*). The strata were delimited by the 70°W longitude.

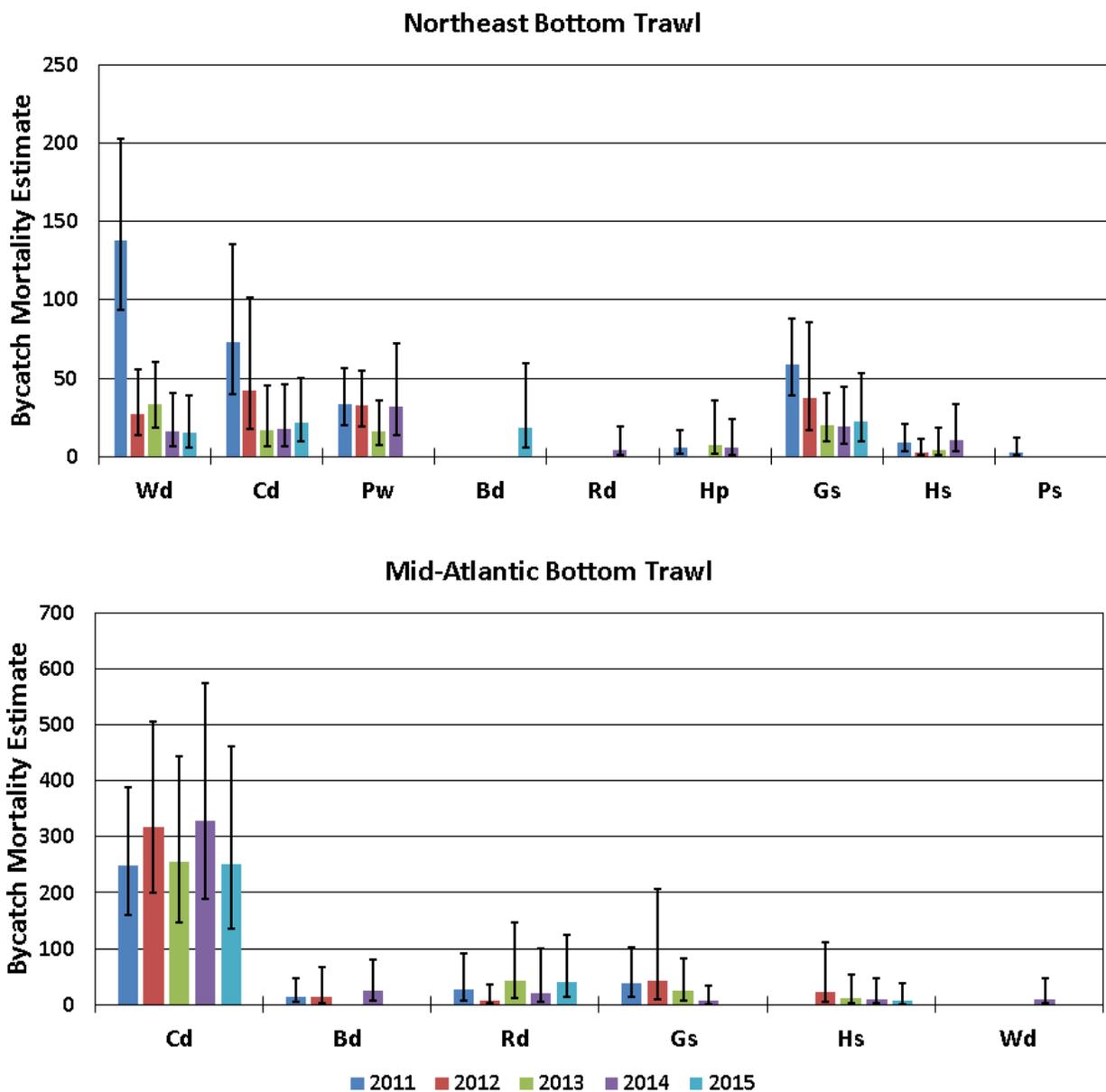


Figure 2. Annual bycatch mortality estimates (lognormal 95% Confidence interval) for bottom trawl gear by region, species and year in Northeast and Mid-Atlantic commercial bottom trawl trips, 2011-2015. Wd = Atlantic white-sided dolphin (*Lagenorhynchus acutus*), Cd = common dolphin (*Delphinus delphis delphis*), Pw = long-finned pilot whale (*Globicephala melas*), Bd = common bottlenose dolphin (*Tursiops truncatus truncatus*), Rd = Risso's dolphin (*Grampus griseus*), Hp = harbor porpoise (*Phocoena phocoena phocoena*), Gs = gray seal (*Halichoerus grypus grypus*), Hs = harbor seal (*Phoca vitulina concolor*), Ps = harp seal (*Pagophilus groenlandicus*).

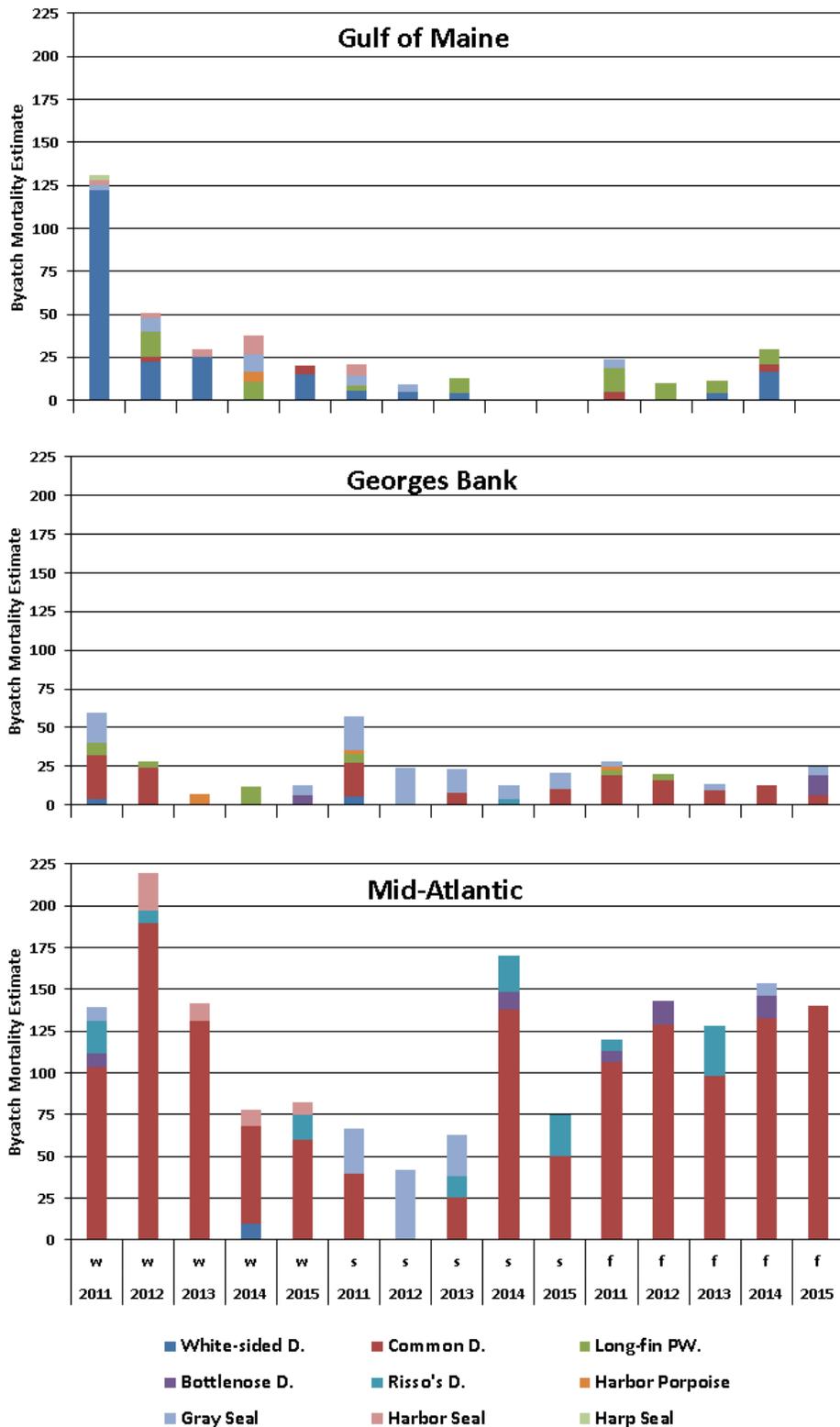


Figure 3. Bycatch mortality estimates in Northeast and Mid-Atlantic commercial bottom trawl trips stratified by ecoregion, year, season, and species (Atlantic white-sided dolphin [*Lagenorhynchus acutus*], common dolphin [*Delphinus delphis delphis*], long-finned pilot whale [*Globicephala melas*], bottlenose dolphin [*Tursiops truncatus truncatus*], Risso's dolphin [*Grampus griseus*], harbor porpoise [*Phocoena phocoena phocoena*], gray seal [*Halichoerus grypus grypus*], harbor seal [*Phoca vitulina concolor*] and harp seal [*Pagophilus groenlandicus*]).

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