

**Estimates
of Marine Mammal Bycatch
in the Northeast (New England)
Multispecies Sink Gillnet Fishery
in 1996**

by

Kathryn D. Bisack

September 2003

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Kathryn D. Bisack^{1,2}

Postal Address: ¹National Marine Fisheries Serv., 166 Water St., Woods Hole, MA 02543-1026
E-Mail Address: ²Kathryn.Bisack@noaa.gov

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Abstract

This report provides bycatch estimates of six marine mammal species incidentally taken in the 1996 Northeast (New England) multispecies sink gillnet fishery. The estimated total take of all marine mammals in the 1996 fishery was 2,364 animals (CV = 17%). This included 1,185 harbor porpoise (CV = 25%), 855 harbor seals (CV = 27%), 116 white-sided dolphins (CV = 114%), 69 common dolphins (CV = 139%), 49 gray seals (CV = 56%), and 90 harp seals (CV = 55%).

Introduction

During 1996, incidental takes of six marine mammal species were documented by fishery observers in the Northeast (New England) sink gillnet fishery. The purpose of this paper is to present estimates of the total bycatch of these six species in the 1996 Northeast sink gillnet fishery as required by the US Marine Mammal Protection Act (MMPA) of 1972 and its amendments of 1994.

The US sink gillnet fishery extends from Maine to North Carolina. This paper deals with the component of the fishery in New England waters north of 40°N. Sink gillnet gear fished in these waters consists of nets with 6-10 inch monofilament stretch mesh suspended between a buoyed head rope and a weighted ground line. A sink gillnet vessel generally deploys four to seven strings per trip, on average. One string typically consists of five to twelve nets strung together, in which the standard net length averages three hundred feet and height averages eleven feet. The gear normally soaks in the water for 24 to 72 hours, is hauled, the catch is removed and then reset. Target species include pollock and cod, flatfish, monkfish and dogfish. Marine mammals may become entangled in the gear and suffocate and die.

Harbor porpoise (*Phocoena phocoena*), white-sided dolphins (*Lagenorhynchus acutus*), common dolphins (*Delphinus delphis*), harbor seals (*Phoca vitulina*), gray seals (*Halichoerus grypus*), and harp seals (*Phoca groenlandica*) were incidentally taken in the Northeast sink gillnet fishery in 1996. Of these species, two are listed as strategic stocks (harbor porpoise and common dolphin), four are listed as nonstrategic (white-sided dolphins, harbor seals, gray seals, and harp seals) (Table 1) (Waring et al., 2002). A species is listed as 'strategic' if the total fisheries bycatch is greater than the Potential Biological Removal Rate (PBR).

Estimates of annual marine mammal bycatch in the Northeast sink gillnet fishery are available since 1990 (Bisack, 1993; Smith *et. al.* 1993; Bravington and Bisack, 1996; Bisack, 1997). Several methods have been used to derive bycatch estimates. The method presented in this paper is a modification of previous approaches and was developed because of changes implemented in the data collection system.

In June 1994, the National Marine Fisheries Service/Northeast Region's commercial fisheries data collection system, in which catch, effort and fishing location data were collected from dealer reports and voluntary dockside interviews of vessel captain or crew, was replaced by one in which fishing trip information was recorded in mandatory logbooks (Wigley *et al.*, 1998). The logbook data were not available at the time the 1994 and 1995 marine mammal bycatch estimates were made (Bisack, 1997). The marine mammal bycatch estimates presented here for 1996 utilize the logbook data and account for area/season closures in the analyses.

Data Sources and Methods

Data Sources

Three databases were used in estimating the marine mammal bycatches in 1996: (1) the NEFSC Sea Sampling (SS) program [Fishery Observer Program] data bases was used to estimate the bycatch of marine mammals per observed ton of fish caught; (2) the Northeast Dealer Report Weighout (WO) data base was used to determine the total landings in 1996 of all finfish caught in the Northeast sink gillnet fishery; and (3) the Northeast Vessel Trip (VTR) data base was used to allocate (prorate) the sink gillnet landings in the WO data base into spatially/temporally defined strata (season/port group or area closure) (Rossman and Merrick, 1999).¹

Stratification

To ensure similar fishing practices are grouped together to estimate the bycatch rates, spatial and temporal strata were delimited. The spatial stratification includes seven port groups (Bisack, 1997), an offshore area (SA 515, 464 and 522), and closed area strata. The seven port groups are northern Maine, southern Maine, New Hampshire, north of Boston, south of Boston, east of Cape Cod, and south of Cape Cod. The temporal stratification used was: winter (January - May), summer (June - August), and fall (September - December).

Five time/area closures (Figure 1) were added to the stratification scheme in 1996: 1) Downeast Maine (August 13 to September 15; 2) Mid-Coast (March 26 to April 25 and September 15 to December 31); 3) Mass Bay (March 1 - March 31); and 4) South Cape Cod (March 1 - March 31). Data collected during these closures were removed from the port/season strata (defined above) and placed in individual time/area closure strata (see Table 2). For example, sink gillnet trips in the March 26th to April 25th Mid-Coast closure were removed from three port strata (Southern Maine, New Hampshire, North of Boston) and placed in the Mid-Coast winter closure strata. A stratum was not created for the Downeast Closure as no sink gillnet landings were reported from this closure area in 1996.

Bycatch Rates

The bycatch rate in each stratum was calculated as the number of observed takes of marine mammals on sea sampling trips in the Northeast sink gillnet fishery divided by the total weight of fish caught during these trips. The bycatch rate is expressed as the number of marine mammals caught per ton of fish landed.² Only dedicated marine mammal trips were used.³ These trips were divided into two groups: trips with active pingers attached to the gear, and trips that did not use pingers. Bycatch rates were estimated for both types of trips. Vessels allowed to fish in any of the closure areas were required to use active pingers.

¹ The Rossman and Merrick (1999) paper is an alternative source for the proration algorithm. However, their proration method was based on the method presented in this paper. Details are in the appendix.

² A ton is equivalent to 2000 pounds.

³ On dedicated marine mammal trips the observer watches the gear being hauled back. On non-dedicated marine mammal trips, the observer collects other biological data and relies on the captain and crew to notify him/her if a marine mammal has been caught in the gear.

Observer Coverage

Observer coverage was defined as the ratio (in weight) of fish caught on marine mammal sampling trips in a time/area stratum to the total fish landings in that time/area stratum. The ratio therefore represents the fraction of total landings caught during observed trips.

Species Identification

Marine mammals incidentally taken during sampling trips were identified to species by the onboard fishery observers. However, nine (9) seals were captured whose species identification was recorded as unknown. For the bycatch estimates, these unknown seals were assigned to one of the identified seal species (harbor, gray, and harp) based on the species composition of the seals taken in the strata in which the unknown animals were captured. For example in the winter Mid-Coast closure stratum, 14 seals were taken: 5 unknown seals, 8 harbor seals, and 1 gray seal. Of the 9 known seals taken, 89% ($8/9=0.89$) were harbor seals and 11% ($1/9$) were gray seals. The 5 unknown seals were therefore assigned to species according to these percentages (*i.e.*, 4.4 harbor seals and 0.6 gray seals).

Bycatch Estimate Adjustment

The winter (January to May) 1996 offshore bycatch estimate was adjusted because observer coverage was extremely low in this time/area stratum. In February, only 2 trips (20 hauls) were observed with 8 harbor porpoise takes. During March through May combined, another 20 sink gillnet hauls were observed with no harbor porpoise takes (there were no trips in April). According to the WO database, total offshore sink gillnet fishery landings increased from 145 tons in February to 586 tons in May. Because of the low observer coverage, the bycatch estimate would be extremely biased if the February to May bycatch rate were multiplied by the total landings during these months. Therefore, the winter offshore bycatch estimate was based only on the observer data (and fishery landings) in February.

CV and Confidence Intervals

Standard bootstrapping techniques were used to derive confidence intervals and coefficients of variation (CV) for all of the strata bycatch estimates. The resampling unit was an entire trip (rather than an individual haul) as this ensured that any within trip dependence in the original data was carried over into the bycatch estimates.

The bootstrap results were adjusted in two strata where observer coverage was greater than 10% and where marine mammal takes occurred (Mid-Coast and Mass Bay strata) (Tables 2 and 3). These adjustments applied the finite correction factors so that the variance of the bycatch estimates would be accurately calculated.

Results and Discussion

Northeast Sink Gillnet Fishery Landings

In 1996, 24,277 tons of fish were landed in the Northeast sink gillnet fishery (Table 2). These were prorated to season/area strata based on the time/area distribution of sink gillnet landings in the 1996 VTR logbook database (Appendix A, Tables A1 and A2). Summer landings were greater than those in the winter and fall seasons in almost all strata.

Observer Coverage

Observer coverage was 4.1% in the winter, 1.8% in summer, and 3.3% in the fall (Table 2). A total of 96 takes of marine mammals were observed. These included 44 harbor porpoise, 31 harbor seals, 2 white-sided dolphins, 1 common dolphin, 3 gray seals, 6 harp seals and 9 unidentified seals (Table 3).

Observed harbor porpoise takes in 1996 occurred in some new areas and seasons compared to previous years. The new time and areas and port group were: (1) Winter/North Boston port stratum; (2) Fall/New Hampshire port stratum; and (3) Observed Fall/South of Cape Cod port stratum.⁴

Marine Mammal Incidental Take Estimates

The estimated total incidental take of all marine mammals in the Northeast sink gillnet fishery was 2,364 animals (CV = 17%). This included 1,185 harbor porpoise (CV = 25%), 855 harbor seals (CV = 27%), 116 white-sided dolphins (CV = 61%), 69 common dolphins (CV = 139%), 49 gray seals (CV = 56%), and 90 harp seals (CV = 55%). Bycatch rates and total estimated bycatch by species and strata are presented in Tables 4 and 5, respectively. Species-specific bycatch estimates for 1996 are summarized in Table 6.

Fifty five percent of the estimated takes in 1996 occurred in winter (1,298, CV=21%), twelve percent in summer (293, CV=48%), and thirty three percent during fall (773, CV=32%) (Table 5). The south of Cape Cod and North Boston port strata accounted for the largest percentage of the estimated takes in 1996, 32% (=764/2364) and 16% (=372/2364), respectively. In 1996 harbor porpoise takes occurred in new areas and seasons relative to previous years. The new time and areas and port group were 1) Winter - SA 522 - North Boston port group; 2) Fall - SA 515 - New Hampshire port group; and 3) Fall - SA 537-539 - South of Cape Cod port group.⁴

⁴ In 1995, there was one observed harbor porpoise take in SA 537-539 in the fall, however, the take did not occur on a dedicated marine trip and therefore the trip was eliminated from the bycatch rate analysis.

Closures - Pingers

During the winter season, bycatch rates of harbor porpoise and harbor seals were highest in marine mammal closure areas where pingers were required (e.g., Mid-Coast closure area) than in the areas where pingers were not required (Table 4). This is based on the assumption that all the gear fishing during the closure in the Mid-Coast area had active pingers, and outside of the closure there were no pingers being used or they were not active.

Bootstrap Replicate Analysis

The distribution of the bootstrap replicates differed by species (Table 7; Figure 2: Frame 2a to 2f). The null hypothesis that the bootstrap replicates followed a normal distribution was rejected for all six species. The bootstrap replicates for harbor porpoise, harbor seals, and harp seals followed a lognormal distribution ($p > 0.15$).⁴

Summary of marine mammal bycatch estimates, 1993 to 1996

Annual estimates of marine mammal bycatch in the Northeast sink gillnet fishery during 1993-1996 range from a low of 2,321 animals in 1993 to a high of 4,550 animals in 1994 (Table 8). Changes in the annual estimates are due to inter-annual variability in bycatch rates and changes in annual landings (Table 9).

Harbor porpoise, harbor seals, white-sided dolphins, and gray seals have been consistently taken in the sink gillnet fishery over the years. Harp seal takes first occurred in 1995, while hooded seal and common dolphin takes first occurred in 1995 and 1996, respectively. 1995 by takes of. The increase in the number of species of seals taken in the sink gillnet fishery is probably due to improved species identification methods (use of photographs, tooth and skull examination protocols, etc) implemented in 1994.

⁴ Some studies have assumed the distribution of the total bycatch to be normal or lognormal (Wade 1998; Johnson *et. al.* 1999).

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Table 1. Abundance estimates, fisheries bycatch estimates (1992 to 1996 and 1997 to 2001), Potential Biological Removal Rate (PBR) and stock status (strategic or non-strategic) for six marine mammal species incidentally caught in the Northeast sink gillnet fishery.

Species	Stock Assessment Years	Abundance (numbers of animals)	Annual Fisheries Bycatch Estimates		PBR	Strategic
			All Fisheries	Northeast Sink Gillnet		
Harbor Porpoise	1992-1996 ¹	54,300	1667	1460	483	Y
	1997-2001 ²	74,695	365	277	747	Y
White-sided Dolphin	1992-1996	27,200	218	159	192	Y
	1997-2001	37,904	102	59	364	N
Common Dolphin	1992-1996	22,215	247	13	155	Y
	1997-2001	23,655	190	29	227	Y
Harbor Seal	1992-1996	30,990	898	898	1859	N
	1997-2001	91,546	972	893	5493	N
Gray Seal	1992-1996	2,010	41	41	121	N
	1997-2001	N/A ³	309	103	N/A	N
Harp Seal	1992-1996	N/A	329	329	N/A	N
	1997-2001	N/A	109	242	N/A	N

¹ Waring *et al.* (1999) and

² Waring *et al.* (2002).

³ N/A = not applicable

Table 2. Total observed landings in tons (SS), total landings in tons (WO), and marine mammal observer coverage by percentage of landings observed (COV) in the Northeast sink gillnet fishery in 1996, by season, port group, and marine mammal closure strata

Season	Data Base & Cover	Ports							Off Shore	Marine Mammal Closures ¹			Season Total
		Northern Maine	Southern Maine	New Hampshire	North Boston	South Boston	East Cape Cod	South Cape Cod		Mid-Coast	Mass Bay	South Cape Cod	
Winter	SS	-	2.8	15.7	30.5	6.6	5.6	36.3	5.0	9.5	13.1	7.3	132.4
	WO	1.0	232.0	288.9	591.3	151.0	274.3	1474.7	85.0 ²	82.0	14.2	50.3	3,244.7
	Cov	-	1.2	5.4	5.2	4.4	2.0	2.5	6.1	11.6	92.3	14.5	4.1
Summer	SS	23.9	67.5	43.0	19.8	29.9	33.6	7.4	0	*	*	*	225.1
	WO	261.9	732.2	1,164.0	1,564.1	3,674.2	2,405.8	1,601.3	1,306.5	*	*	*	12,710.0
	Cov	9.1	9.2	3.7	1.3	0.8	1.4	0.5	-	*	*	-	1.8
Fall	SS	9.0	4.5	2.7	16.8	92.6	40.2	21.9	25.3	58.6	*	*	271.6
	WO	52.9	184.0	148.3	1,149.6	1,632.4	1,761.4	1,509.6	1,067.9	816.1	*	*	8,322.2
	Cov	17.0	2.4	1.8	1.5	5.7	2.3	1.5	2.4	7.2	*	*	3.3
Total	SS	32.9	74.8	61.4	67.1	129.1	79.4	65.6	30.3	68.1	13.1	7.3	629.1
	WO	315.8	1,148.2	1,601.2	3,305.0	5,457.6	4,441.5	4,585.6	2,459.4	898.1	14.2	50.3	24,276.9
	Cov	10.4	6.5	3.8	2.0	2.4	1.8	1.4	1.2	7.6	92.3	14.5	2.6

¹ The Downeast Closure is not included here. No landings were reported from within this closure.

² This only includes February landings. Total winter landings for the offshore area was 1,177.4 tons.

* No closure during this season

- No observer trips (SS) or WO landings recorded

Table 3. Total observed takes of marine mammals in the 1996 Northeast sink gillnet fishery by species, season, port group, and marine mammal closure strata.

Species and Season		Ports						Off Shore	Marine Mammal Closures			Season Total	
		Northern Maine	Southern Maine	New Hampshire	North Boston	South Boston	East Cape Cod		South Cape Cod	Mid-Coast	Mass Bay		South Cape Cod
Harbor Porpoise	W	-	1	3	4	0	0	9	8	7	1	0	33
	S	1	0	0	0	0	0	0	0	*	*	*	1
	F	0	0	0	2	2	0	2	1	3	*	*	10
Harbor Seal	W	-	0	2	1	5	0	3	0	8 ¹	0	0	19
	S	0	2	2 ¹	1	0	0	0	0	*	*	*	5
	F	0	0	0	0	0	0	1	3	3 ¹	*	*	7
White-sided Dolphin	S	0	0	0	0	0	1	0	0	*	*	*	1
	F	0	0	0	0	0	1	0	0	0	*	*	1
Common Dolphin	F	0	0	0	0	0	0	1	0	0	0	0	1
Gray Seal	W	-	0	0	1	0	0	0	0	1 ¹	0	0	2
	F	0	0	0	0	0	0	0	0	1 ¹	*	*	1
Harp Seal	W	-	0	2	2	0	0	0	0	1 ¹	1	0	6
Unknown Seals	W	-	0	0	0	0	0	0	0	5 ¹	0	0	5
	S	0	0	2	0	0	0	0	0	*	*	*	2
	F	0	0	0	1 ²	0	0	0	0	1 ¹	*	*	2
All Mammals	W	-	1	7	8	5	0	12	8	22	2	0	65
	S	1	2	4	1	0	1	0	0	*	*	*	9
	F	0	0	0	3	2	1	4	4	8	*	*	22

¹ Unknown seals will be prorated to this cell.

² There were no seal taken in any other port/area within this season and therefore not prorated.

* No closure during this season

- No observer sampling

Table 4. Marine mammal bycatch rates (takes/observed landings) in 1996 in the Northeast sink gillnet fishery, by species, season, port group and marine mammal closure strata with (CV in parentheses).

Species and Season		Ports						Off Shore	Marine Mammal Closures			
		Northern Maine	Southern Maine	New Hampshire	North Boston	South Boston	East Cape Cod		South Cape Cod	Mid-Coast	Mass Bay	South Cape Cod
Harbor Porpoise	W	-	0.357 (106)	0.191 (113)	0.131 (48)	0	0	0.248 (51)	1.60 (19)	0.737 (48)	0.076 (106)	0
	S	0.042 (69)	0	0	0	0	0	0	0	*	*	*
	F	0	0	0	0.119 (89)	0.022 (111)	0	0.091 (120)	0.040 (97)	0.051 (76)	*	*
Harbor Seal	W	-	0	0.127 (72)	0.033 (104)	0.758 (45)	0	0.083 (60)	0	1.263 ¹ (66)	0	0
	S	0	0.030 (67)	0.093 ¹ (187)	0.051 (114)	0	0	0	0	*	*	*
	F	0	0	0	0	0	0	0.046 (880)	0.118 (114)	0.064 ¹ (77)	*	*
White-sided Dolphin	S	0	0	0	0	0	0.030 (73)	0	0	*	*	*
	F	0	0	0	0	0	0.025 (96)	0	0	0	*	*
Common Dolphin	F	0	0	0	0	0	0	0.046 (143)	0	0	0	0
Gray Seal	W	-	0	0	0.033 (100)	0	0	0	0	0.158 ¹ (155)	0	0
	F	0	0	0	0	0	0	0	0	0.021 ¹ (119)	*	*
Harp Seal	W	-	0	0.127 (108)	0.066 (69)	0	0	0	0	0.158 ¹ (133)	0.076 (113)	0
All Marine Mammals	W	-	0.357 (106)	0.446 (59)	0.262 (38)	0.758 (45)	0	0.331 (47)	1.600 (19)	2.316 (31)	0.153 (77)	0
	S	0.042 (69)	0.030 (67)	0.093 (187)	0.051 (114)	0	0.030 (73)	0	0	*	*	*
	F	0	0	0	0.119 (89)	0.022 (111)	0.025 (96)	0.183 (68)	0.158 (89)	0.136 (60)	*	*

* No closure during this season

- No observed trips

¹ Rate includes unknown seals

Table 5. Estimates of total marine mammal bycatch in 1996 in the Northeast sink gillnet fishery, by species, season, port group and marine mammal closure strata, with CV in parentheses and 95% confidence intervals below.

Species and Season		Ports						Off Shore	Marine Mammal Closures			Season Total	
		Northern Maine	Southern Maine	New Hampshire	North Boston	South Boston	East Cape Cod		South Cape Cod	Mid-Coast	Mass Bay		South Cape Cod
Harbor Porpoise	W	-	83 (106) 1-314	55 (113) 3-220	78 (49) 18-160	0	0	366 (51) 94-810	136 (19) 90-163	60 (43) 21-124	1 (7) 1-2	0	779 (29) 445-1286
	S	11 (69) 1-55	0	0	0	0	0	0	0	*	*	*	11 (69) 1-54
	F	0	0	0	137 (89) 2-476	36 (111) 2-137	0	138 (120) 2-515	42 (99) 1-136	42 (70) 3-108	*	*	395 (53) 93-904
Harbor Seal	W	-	0	37 (69) 2-95	19 (98) 1-61	115 (42) 38-221	0	122 (61) 3-289	0	104 (40) 31-193	0	0	397 (25) 219-611
	S	0	22 (65) 2-52	108 (91) 2-321	80 (118) 1-315	0	0	0	0	*	*	*	210 (65) 10-511
	F	0	0	0	0	0	0	69 (85) 1-175	127 (123) 3-540	52 (58) 3-122	*	*	248 (73) 28-663
White-sided Dolphin	S	0	0	0	0	0	72 (77) 1-168	0	0	*	*	*	72 (77) 1-168
	F	0	0	0	0	0	44 (97) 1-143	0	0	0	*	*	44 (97) 1-143
Common Dolphin	F	0	0	0	0	0	0	69 (139) 1-324	0	0	*	*	69 (139) 1-329
Gray Seal	W	-	0	0	19 (104) 1-64	0	0	0	0	13 (89) 1-41	0	0	32 (72) 2-89
	F	0	0	0	0	0	0	0	0	17 (85) 1-50	*	*	17(87) 1-50
Harp Seal	W	0	0	37 (110) 1-136	39 (71) 2-102	0	0	0	0	13 (82) 1-37	1 (7) 1-3	0	90 (55) 13-209
All Marine Mammals	W	-	83 (106) 1-313	129 (64) 17-325	155 (39) 43-281	115 (42) 38-221	0	488 (45) 159-983	136 (19) 90-163	190(30) 97-316	2 (5) 1-3	0	1298 (21) 886-1962
	S	11 (69) 1-55	22 (65) 2-52	108 (91) 2-321	80 (118) 1-315	0	72 (77) 1-168	0	0	*	*	*	293 (48) 68-614
	F	0	0	0	137(108) 3-570	36 (111) 2-135	44 (97) 1-142	276 (69) 4-702	169 (96) 4-584	111 (55) 21-250	*	*	773 (32) 391-1482
Total Marine Mammals by Port Group		11	105	237	372	151	116	764	305	301	2	0	2,364

* No closure during this season

Table 6. Estimated bycatch in 1996 of six species of marine mammals taken in the Northeast sink gillnet with the associated coefficients of variation in parentheses (CV) and 95% confidence intervals (CI)

Species	Annual Estimate (CV)	CI
Harbor Porpoise	1185 (25)	710 - 1894
Harbor Seal	855 (27)	466 - 1322
White-sided Dolphin	116 (61)	2 - 248
Common Dolphin	69 (139)	1 - 324
Gray Seal	49 (56)	3 - 114
Harp Seal	90 (55)	13 - 209
Total	2364 (17)	1786 - 3385

Table 7. Measures of skewness and kurtosis for the 1996 bycatch bootstrap replicates and a fitted lognormal distribution to the bootstrap replicates with the Kolmogorov-Smirnoff statistic and p value for the lognormal distribution by species

Species	Bootstrap Distribution		Lognormal Distribution		K-S (Lognormal)	
	Skew	Kurt	Skew	Kurt	Value	p
Harbor Porpoise	0.51	3.45	0.76	4.03	0.026	> 0.15
Harbor Seal	0.63	3.72	0.83	4.24	0.030	> 0.15
White-sided Dolphin	0.037	2.66	33.2	9850.8	0.24	Reject
Common Dolphin	1.78	6.78	1950	5.86 E+8	0.27	Reject
Gray Seal	0.73	3.75	4.83	63.0	0.15	Reject
Harp Seal	0.51	3.45	0.76	4.03	0.026	> 0.15

Table 8. Total estimated bycatch (CV in parentheses) of marine mammals in the Northeast sink gillnet fishery, by species, 1993-1996.

Species	1993	1994	1995	1996
Harbor Porpoise	1,400 (18)	2,100 (19)	1,400 (27)	1,185 (29)
Harbor Seal	698 (19)	1,330 (25)	1,182 (21)	855 (27)
White-sided Dolphin	205 (31)	240 (51)	80 (116)	116 (61)
Common Dolphin	0	0	0	69 (139)
Gray Seal	18 (100)	19 (95)	117 (42)	49 (56)
Harp Seal	0	861 (58)	694 (27)	90 (55)
Hooded Seal	0	0	28 (96)	0
Total	2,321	4,550	3,501	2,364

Table 9. Observed takes of harbor porpoise, harbor porpoise bycatch rates (takes/observed landings), and total finfish landings in tons (WO) in the Northeast sink gillnet fishery, by season and year, 1993-1996.

Season	Statistic	Harbor Porpoise			
		1993	1994	1995	1996
Winter	Obs Take	21	22	33	33
	Bycatch Rate	0.158	0.228	0.187	0.249
	WO	3,548	4,082	5,017	4,337
Summer	Obs Take	11	5	0	1
	Bycatch Rate	0.054	0.031	0.000	0.004
	WO	10,866	9,864	10,491	12,710
Fall	Obs Take	21	70	7	10
	Bycatch Rate	0.073	0.357	0.053	0.037
	WO	7,186	4,441	5,342	8,322
Total	Obs Take	53	97	40	44
	Bycatch Rate	0.085	0.214	0.069	0.070
	WO	21,600	18,387	20,850	25,369
	Bycatch	1,400	2,100	1,400	1,200

Figure 1.
Marine mammal closed areas to vessels fishing sink gillnet gear
in New England

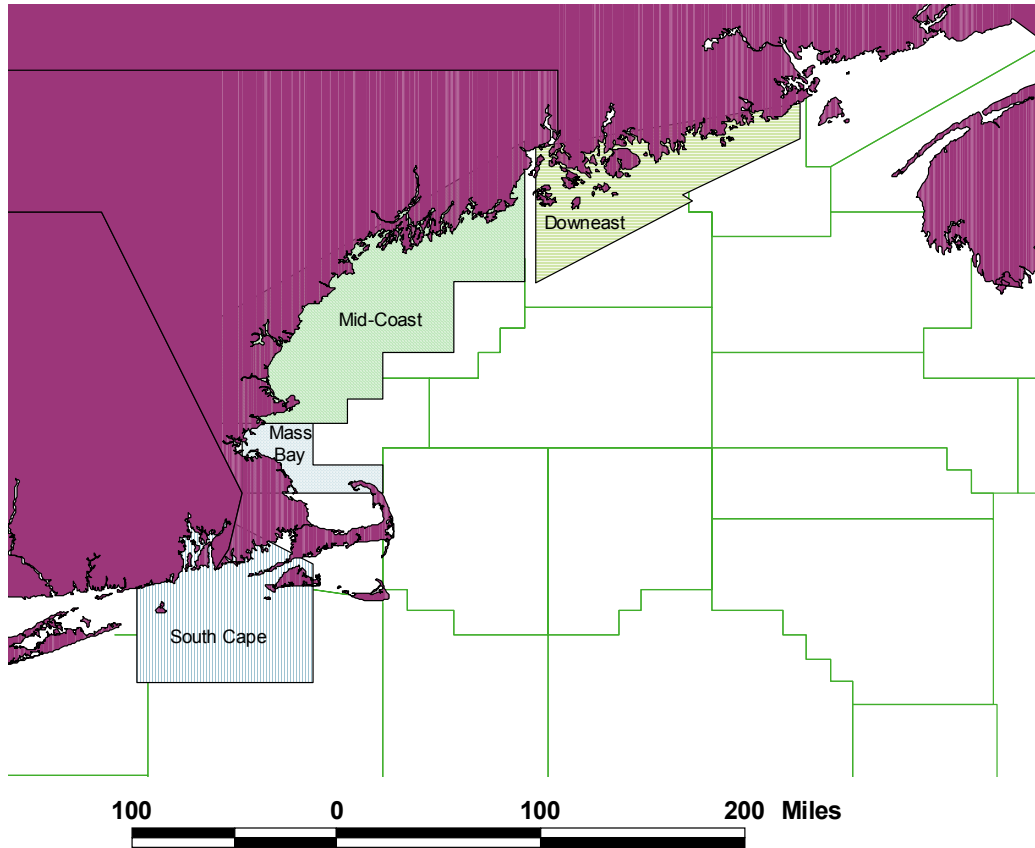
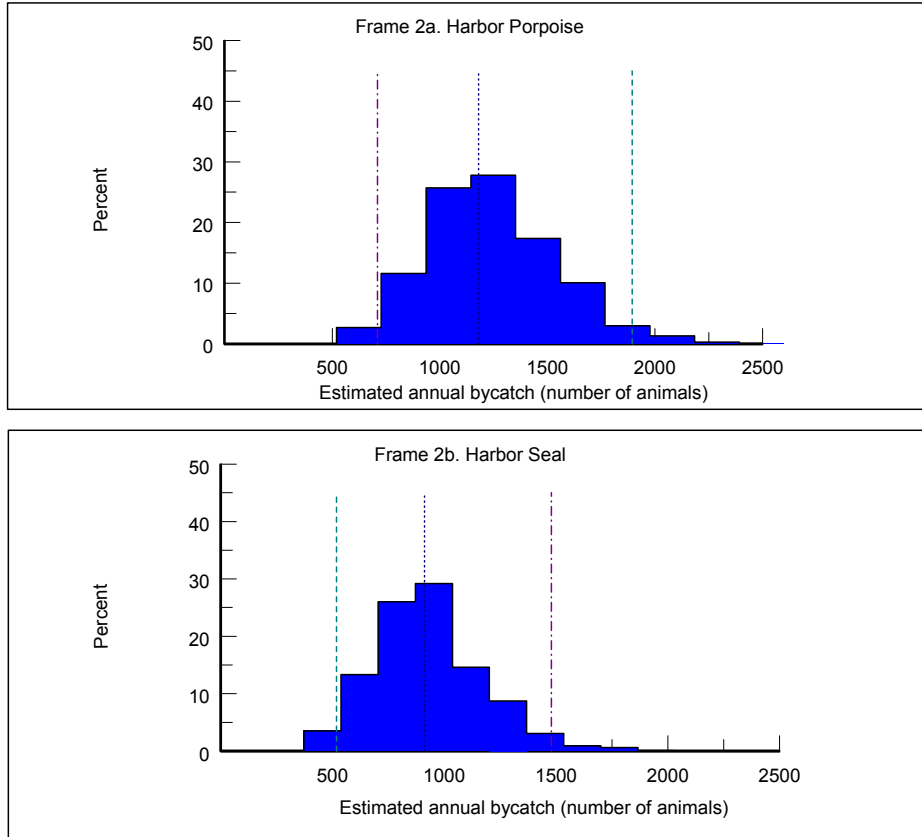
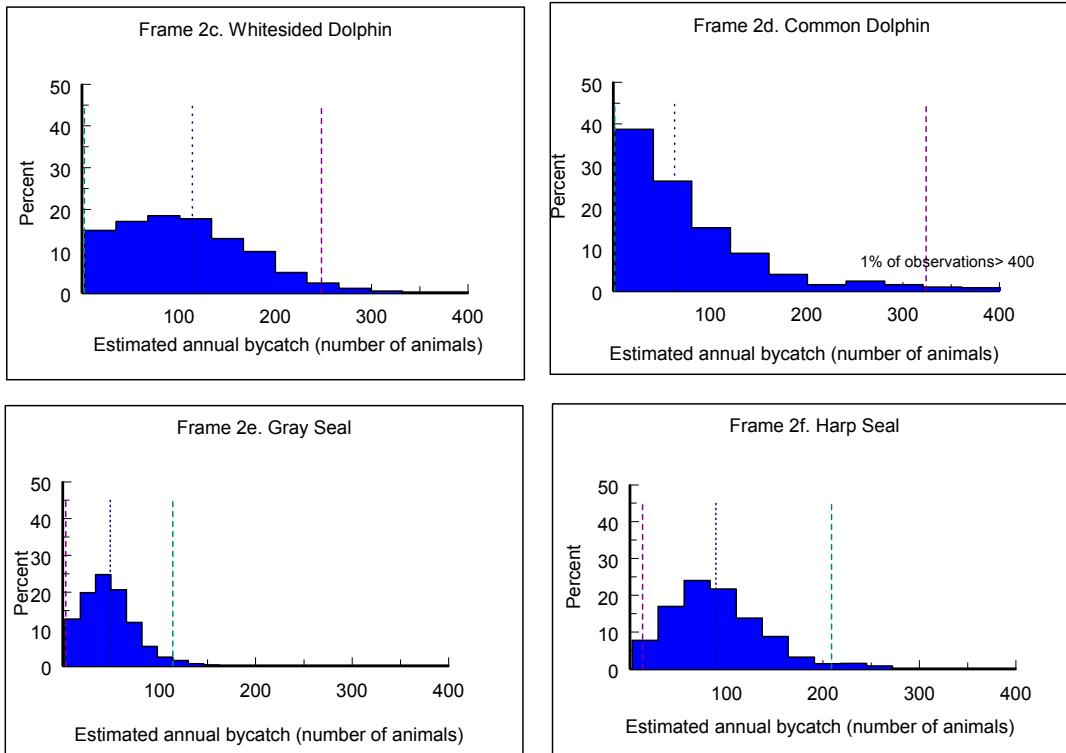


Figure 2. Bootstrap replicates generated to estimate 95% confidence limits of annual bycatch by species



Note: Vertical lines denote the annual point estimate and the lower and upper 95% confidence limits associated with this estimate

Figure 2. Bootstrap replicates generated to estimate 95% confidence limits of annual bycatch by species



Note: Vertical lines denote the annual point estimate of bycatch and the lower and upper 95% confidence limits associated with this estimate.

Appendix A.

Estimating the spatial pattern of fishing in the 1996 Northeast Sink Gillnet Fishery

Introduction

This appendix documents the method used to estimate the spatial distribution of total landings in the 1996 Northeast sink gillnet fishery. The method presented here was new as a result of a changing data collection system. Specifically, the Northeast Fisheries Science Center (NEFSC) switched from a port agent interview system to a mandatory self-reporting logbook system. The earlier data collection system had port agents interview fishers for trip locations and the port agents then merged the trip location with dealer data. This study presents preliminary results because a trip-based allocation for the entire (all gear types) commercial database is in progress.

Two databases were used to estimate the spatial distribution of fish landings: the dealer data (WO) and the self-reporting vessel trip report (VTR) logbook data. The dealer data include the total trip landings, port, vessel, and date of landing. The logbook data include these data elements plus the location of the fishing trip. To date, the dealer data have been considered a census of total landings (Bisack, 1997; Bisack and Dinardo, 1992; Bravington and Bisack, 1996) and the VTR data is considered a sample of the census.

Estimates of total landings by area and time were used to expand the observed marine mammal bycatch rates to derive total marine mammal bycatches. The logbook data were stratified temporally and spatially to account for marine mammal bycatch and fishery landings patterns. Historically the temporal stratification has been by seasons: winter (January - May), summer (June - August), and fall (September - December). The spatial stratification has been by port, where port is a surrogate for area: Northern Maine, Southern Maine, New Hampshire, Northern Boston and Southern Boston.⁵ These strata were not sufficient in 1996 due to the implementation of time and area closures to reduce harbor porpoise bycatch.

As such, in 1996, a new stratification was developed and it was the first year VTR data was used in marine mammal bycatch analysis.

⁵ Bisack (1997) indicated that gillnet vessels in New England fish close to their port of landing. This may be due to the fleet consisting of small vessels that primarily fish for only one day and then return to port.

Data and Methods

The data used in the bycatch analysis were the 1996 dealer (WO) data and 1996 vessel trip report (VTR) logbook data for the New England multispecies sink gillnet fishery. VTR and WO data from ports north of and including the south of Cape Cod port were included.

Assumptions

1. Dealer data (WO) are a census of total landings.
2. VTR data are a representative sample of the census data.

Stratification

For details, see this section in main part of the paper.

Proration

VTR landings were used to prorate WO landings within a season and port by area. The steps below describe the overall proration scheme.

1. The VTR landings data and WO landings data were summed over all species landed within each season and port group. The VTR sample was then examined for biases.
2. Within a season and port group, VTR landings were spatially stratified into the following areas: 1) closure areas; 2) offshore (SA 515,522 and 464); and 3) non-closure and non-offshore area. The percentage of landings by area were then calculated within each season and port group combination. For example, in northern Maine in the winter season, no landings occurred in the closed areas, 97% of landings occurred offshore, and 3% were in the non-closure areas.
3. WO landings were prorated. Within each season port, WO season port landings are multiplied by the percentage of VTR landings in an area (Step 2). For example, if 100 lbs of fish were landed in Maine in the summer season and the VTR data revealed 90% of the landings were offshore, then 90 lbs would be prorated to the offshore area in Maine during the summer.
4. Total offshore landings were the sum of all port group offshore landings. Similarly, all landings in the closure areas were summed since several port groups may have been fishing within a closure.

Data Problems

Within the 1996 VTR data set, some trip records have missing information on port codes and fishing location. Of the 13,307 records in the 1996 VTR database, 3,776 records (28%) contain limited location data (only statistical areas) and 900 records (7%) have missing port codes.

To utilize as many VTR logbooks as possible, all trips were sorted by vessel permit number and date of the trip. Each record with a missing port code was matched with the closest record in time for that vessel with an identified port code. It was then assumed that the vessel landed in the same port on two consecutive trips.

Trips without latitude and longitude entries were eliminated.

Results

The landings distributions, by port and season, for the VTR logbook and dealer WO were generally similar (Table A1). WO landings were consistently higher compared to the VTR, except in the Northern Maine stratum. The percent of landings by port group in the VTR logbook and the WO differ by a maximum of 6.4% in the winter (North Boston), 6.1% (North Boston) and 6.0% (South Cape Cod) in the summer, and 3.1% in the fall (New Hampshire).

VTR landings indicate sink gillnet vessels have a larger percentage of landings offshore in winter than during summer and fall; however, landings are lowest in the winter season (Table A2). Sink gillnet landings in the marine mammal closure areas were highest in the fall compared to the winter and summer seasons.

Table A1. 1996 Northeast sink gillnet fishery VTR logbook and WO (L)andings in tons of fish and percentage (%) by port group, Winter (January - May), Summer (June - August), and Fall (September - December)

Port Group	Winter				Summer				Fall			
	VTR Logbook		WO		VTR Logbook		WO		VTR Logbook		WO	
	L	%	%	L	L	%	%	L	L	%	%	L
Northern.Maine	68	2.5	0.7	29	326	4.9	2.3	293	176	3.1	1.0	83
Southern .Maine	278	10.1	13.0	563	596	8.9	8.4	1,072	194	3.5	6.1	511
New Hampshire	266	9.7	15.2	661	694	10.3	11.6	1,479	481	8.5	11.6	969
Northern Boston	815	29.8	23.4	1,016	1,521	22.6	16.5	2,091	1,115	19.8	20.5	1710
Southern Boston	203	7.4	3.6	155	2,060	30.7	29.3	3,729	1,195	21.3	19.6	1634
East of Cape Cod	170	6.2	8.9	388	1,067	15.9	19.2	2,435	1,342	23.9	21.6	1801
South of Cape Cod	940	34.3	35.2	1,525	451	6.7	12.7	1,611	1,121	19.9	19.4	1614
Total	2,740	100	100	4,337	6,715	100	100	12,710	5,624	100	100	8,322

Table A2. Distribution of 1996 Northeast sink gillnet VTR landings by season and area

Winter 1996 Port Group	VTR Logbook	Percent of Logbook Landings				
		Non-closure and Non-offshore	Closures			Offshore
			Mid-Coast	Mass-Bay	South Cape	
Northern Maine	68	3.4	0	0	0	96.6
Southern Maine	278	41.2	0	0	0	58.8
New Hampshire	266	43.7	8.1	0	0	48.2
Northern Boston	815	58.2	2.8	1.0	0	38.0
Southern Boston	203	97.4	0	2.6	0	0
East of Cape Cod	170	70.7	0	0	0	29.3
South of Cape Cod	940	96.7	0	0	3.3	0
Total	2,740					

Table A2. (Continued)

Summer 1996 Port Group	VTR Logbook	Percent of Logbook Landings		
		Non-closure and Non-offshore	Closures	Offshore
			Downeast	
Northern Maine	326	89.4	0	10.6
Southern Maine	596	68.3	0	31.7
New Hampshire	694	78.7	0	21.3
Northern Boston	1,521	74.8	0	25.2
Southern Boston	2,060	98.5	0	1.5
East of Cape Cod	1,067	98.8	0	1.2
South of Cape Cod	451	99.4	0	0.6
Total	6,715			

Fall 1996 Port Group	VTR Logbook	Percent of Logbook Landings			
		Non-closure and Non-offshore	Downeast Closure	Mid-Coast Closure	Offshore
Northern Maine	176	63.7	0	0	36.3
Southern Maine	194	36.0	0	16.6	47.4
New Hampshire	481	15.3	0	52.7	32.0
Northern Boston	1,115	67.2	0	12.9	19.9
Southern Boston	1,195	99.9	0	0	0.1
East of Cape Cod	1,342	97.8	0	0	2.2
South of Cape Cod	1,121	93.5	0	0	6.5
Total	5,624				

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