INCOMPLETE
Summary of Harbor Porpoise Bycatch in the Gulf of Maine/Georges Bank Area

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SUMMARY

Harbor porpoise bycatch in the gillnets fished in waters in the Gulf of Maine, Georges Bank and east of Cape Cod have been consistently high since about 2000, particularly high in the last three years 2005 to 2007. For simplicity, in the rest of this document this area will be called the Gulf of Maine area. This manuscript documents the bycatch patterns in the waters south of Cape Cod and attempts to identify factors as to why the bycatch was high. These results might lead to potential mitigation measures to reduce future bycatch in this area.

Since the implementation of the harbor porpoise Take Reduction Plan (TRP) on January 1, 1999, out of the 20,758 gillnet hauls observed in the Gulf of Maine, 104 harbor porpoises were observed taken. This bycatch occurred inside and outside of the South Closure Areas, and during each month of the year in at least some area and year. All takes were in gear targeting monkfish or winter skate.

INTRODUCTION

For the waters in the Gulf of Maine, Georges Bank, and east of Cape Cod, the harbor porpoise take reduction plan (TRP) divides the waters into a series of time and area closures where they are either completely closed to all gillnets or closed to gillnets that do not use pingers (Table 1). The names of the Closure Areas are Northeast, Mid-Coast, Massachusetts Bay (Mass Bay), Offshore, and Cashes Ledge. (Federal Register 1998). Two other areas of interest include the Western Gulf of Maine Closure Area (WGOM), which was a fishery management action created that closed this region all year round (reference), and an area proposed for future management under the harbor porpoise TRP, which I will call “Proposed New Closure”. For simplicity, in the rest of this document the region encompassing all of these closure areas will be called the Gulf of Maine area.

This paper investigates the harbor porpoise bycatch in the gillnet fishery in the Gulf of Maine after the TRP was in effect (January 1, 1999). Using data collected by the Northeast Fisheries Observer Program (NEFOP), the patterns in the harbor porpoise bycatch are described, the levels of compliance to the TRP mitigation measures are documented, and predicted effects of potential additional mitigation measures are evaluated. In addition, the bycatch patterns are related to gear characteristics, fishing practices and environmental factors to aid in explaining the patterns in the bycatch and to suggest potential management measures to reduce the harbor porpoise bycatch in this area.

DATA

The variables collected by the NEFOP that were used in these investigations are described in Appendix 1. In addition, to these variables for the data collected during 1999 to 2006, a variety

of environmental variables which are associated with the location and date of the haul were added (Appendix 1).

The observer data used in this investigation were only hauls that have complete latitude-longitude information. Thus, this restriction eliminated some hauls that were used in other analyses (e.g., bycatch estimates), and so the statistics may not match exactly to other analyses.

Data from 2007, which include only data collected during January 1 to May 31, are still preliminary and so have not been processed as completely as the older data.

GENERAL BYCATCH PATTERNS

In the waters in the Gulf of Maine during 01 January 1999 to 31May 2007, there were 20,758 hauls observed, which were from 4766 trips and 246 unique vessels. This was 1421 to 4102 hauls observed per year, which were from 311 to 1010 trips per year, and from 66 to 146 vessels per year (Table 2A).

In the waters in the Gulf of Maine during 01 January 1999 to 31May 2007, most of the harbor porpoise bycatch was close to shore within the Mid-Coast, Mass Bay and nearby areas that are outside of any closure (Figure 1). Bycatch was observed in each month, January to December, in some part of the Gulf of Maine in at least one year (Table 3). There were no hauls observed in the Northeast Closure Area at any time of the year. The number of hauls observed within each closure varied by month (Figure 2). Thus, the rest of this investigation will look at the bycatch patterns over the entire year within and outside of the Closure Areas. Note, the Northeast Closure Area will not be mentioned because there were no hauls observed in this Area.

Bycatch rates different by closure areas (Tables 2B-2G). The two areas with the highest bycatch rate were the Western GOM Closure Area (Table 2F) (overall all years and months, the bycatch rate (total observed number of harbor porpoises/total observed landings) was 0.056 takes/metric ton (mton) of landings) and the Mid-Coast Closure Area (Table 2D), 0.052 takes/mtons of landings. The area with the next highest bycatch rate was the Proposed New Closure Area (Table 2G), 0.040 takes/mton of landings. The Offshore Closure area did not have any observed bycatch.

Over the entire Gulf of Maine area, the bycatch rates were highest in February, March, April, November and December (Table 3). The Mid-Coast Closure had observed bycatch in nearly every month, where March and November had the highest bycatch rates (Table 4).

In all the times and areas that require pingers, the number of hauls that used at least 90% of the required number varied by year: 78%, 64%, 52%, 53%, 15%, 7%, 22%, 44%, and 74% in 1999 to 2007 (Figure 3).

In the Mid-Coast Closure Area during the times that pingers are required, in general, the bycatch rate of hauls with the required number of pingers is less than the bycatch rate of hauls without pingers and is less than the bycatch rates of hauls with less than the required number of required pingers (Figure 4).

REFERENCE

Federal Register 1998. Taking of Marine Mammals incidental to commercial fishing operations: Harbor porpoise take reduction plan regulations. Vol. 63, No 231 pg 66464-66490.

Appendix 1. Variables used in the bycatch rate model.

Variable Name	Description
LOCATION/TIME VARIABLES	
Day of year	Day of year: 1 = Jan. 1 for each year
Year	Year: 1999 to 2007
Month	Month: January to April
Longitude	Longitude
Latitude	Latitude
Steam time	Time spent steaming to fishing grounds from port
Bottom depth	Bottom depth (fathoms)
Distance to 50m	Distance to the 50 m depth contour
Distance to 100m	Distance to the 100 m depth contour
Distance to 200m	Distance to the 200 m depth contour
Distance to 500m	Distance to the 500 m depth contour
Distance to the coast	Distance to the nearest coastline (m)
N. Atlantic Oscillation	N. Atlantic Oscillation (NAO) monthly value
NAO - 1	NAO value including a 1 year lag
NAO - 2	NAO value including a 2 years lag
Winter NAO	Winter NAO monthly value
Winter NAO - 1	Winter NAO monthly value with 1 year lag
Winter NAO - 2	Winter NAO monthly value with 2 years lag
SST	Sea surface temperature (celcius)
Bottom water temperature	Bottom water temperature (celcius)
Bottom slope	Bottom slope
Chlorophyll	Chlorophyll level (from satellite)
log10(Chlorophyll)	log10(Chlorophyll level) (from satellite)
Sediment	Type of bottom sediment
FISHING PRACTICES	
Soak duration	Time net in the water (hrs)
Target species	Species captain said they were trying to get
Temporary home port	Temporary home port
Vessel gross tonnage	Vessel gross tonnage
Vessel length	Length of fishing vessel
Haul duration	Length of time of haul back (hrs)
Days absent	Number of days absent from a port
State landed	State that catch were landed in
Weather	Weather conditions
Wave height	Wave height

Appendix 1. continued. Variables investigated for the bycatch rate model.

Variable Name	Description
GEAR CHARACTERISTICS	
Twine size	Size of the twine (mm)
Mesh count	Number of meshs in the vertical direction of the net
Gear length	Total length of gear and spaces between nets
Net height	Height of net
Average mesh size	Average mesh size (inches)
Hang ratio	Hang ratio
Number of nets set	Number of nets that were set
Number of nets hauled	Number of nets that were hauled back
Used tie downs?	Were tie downs used: yes, no, unknown
Length tie downs	Length of tie downs
Used anchors?	Were anchors used: yes, no, unknown
Number of anchors	Number of anchors used on the string
Type of anchor	Type of anchor used
Anchor weight	Total weight of anchors (pounds)
Used additional weights?	Were additional weights used: yes, no, unknown
Additional weights	Amount of additional weights used (pounds)
Used droplines?	Were droplines used: yes, no, unknown
Lead line depth	Depth the lead line of the net is at (fathoms)
Weight of lead line	Total weight of the lead line
Used spaces?	Were spaces between the nets: yes, no, unknown
Space width	Width of spaces between nets
Number of spaces	Number of spaces between nets
Color of net	Color of net
Float distance	Distance between floats
Total number of floats	Total number of floats
OBSERVER PRACTICE	
Type of trip	Observer protocol: complete, limited

Table 1. Times areas in the Gulf of Maine that are either closed to all gillnets (closed) or else closed to all gillnets that do not use pingers.

AREA	**DATES**	**STATUS OF GILLNETS**
Northeast	August 15 - September 13	Closed
Mid-Coast	September 15 - May 31	Closed – pingers[1] allowed
Massachusetts Bay	December 1 - February 28/29	Closed - pingers[1] allowed
	March 1 - 31	Closed
	April 1 - May 31	Closed - pingers[1] allowed
Offshore	November 1 - May 31	Closed - pingers[1] allowed
Cashes Ledge	February 1 - 28/29	Closed
Western Gulf of Maine	All year round	Closed

[1] A pinger is defined as an acoustic deterrent device which, when immersed in water, broadcasts a 10kHz (± 2kHz) sound at 132 dB (± 4 dB) re 1 micropascal at 1 m, lasting 300 milliseconds (± 15 milliseconds), and repeating every 4 seconds (± 2 seconds).

Table 2. Descriptive statistics of the bycatch of harbor porpoises in the Gulf of Maine during 01 January 1999 to 31 May 2007, for all of the Gulf of Maine, and each closure area.

A. All of the Gulf of Maine

All of Gulf of Maine	Year									Total
	1999	2000	2001	2002	2003	2004	2005	2006	2007*	
Number of observed hauls	2453	2742	1967	1642	2094	4102	3711	1421	626	20758
Number of observed trips	451	628	417	399	563	1010	865	311	122	4766
Number of observed vessels	81	87	66	72	99	146	121	111	55	246
Number of observed hauls with one or more take	11	9	1	8	9	13	36	8	1	96
Total number of observed takes	13	10	2	8	9	14	39	8	1	104
Bycatch rate (observed total takes/observed number of hauls)	0.005	0.004	0.001	0.005	0.004	0.003	0.011	0.006	0.002	0.005
Bycatch rate (observed total takes/observed mt of landings)	0.015	0.018	0.005	0.025	0.022	0.017	0.043	0.023	0.009	0.022

B. Cashes Ledge Closure

Cashes Ledge Closure	Year									Total
	1999	2000	2001	2002	2003	2004	2005	2006	2007*	
Number of observed hauls	50	0	9	5	4	73	57	8	15	221
Number of observed trips	8	0	2	1	2	8	10	2	2	35
Number of observed vessels	5	0	2	1	1	6	7	2	2	17
Number of observed hauls with one or more take	0	0	0	0	2	0	0	0	0	2
Total number of observed takes	0	0	0	0	2	0	0	0	0	2
Bycatch rate (observed total takes/observed number of hauls)	0	0	0	0	0.5	0	0	0	0	0.009
Bycatch rate (observed total takes/observed mt of landings)	0	0	0	0	1.159	0	0	0	0	0.023

* 2007 data are from 01 January to 31 May; other years include data from January to December.

Table 2.continue. Descriptive statistics of the bycatch of harbor porpoises in the Gulf of Maine during 01 January 1999 to 31 May 2007, for all of the Gulf of Maine, and each closure area.

C. Mass Bay Closure

Mass Bay	Year									Total
	1999	2000	2001	2002	2003	2004	2005	2006	2007*	
Number of observed hauls	331	332	249	304	667	889	536	168	78	3554
Number of observed trips	80	95	60	91	208	282	160	61	34	1071
Number of observed vessels	16	19	17	19	36	44	36	29	22	94
Number of observed hauls with one or more take	0	0	0	2	1	0	5	0	0	8
Total number of observed takes	0	0	0	2	1	0	5	0	0	8
Bycatch rate (observed total takes/observed number of hauls)	0	0	0	0.007	0.001	0	0.009	0	0	0.002
Bycatch rate (observed total takes/observed mt of landings)	0	0	0	0.048	0.010	0	0.084	0	0	0.016

D. Mid Coast Closure

Mid Coast	Year									Total
	1999	2000	2001	2002	2003	2004	2005	2006	2007*	
Number of observed hauls	476	573	445	502	428	1271	1308	323	19	5345
Number of observed trips	133	198	161	169	165	376	350	93	7	1652
Number of observed vessels	26	34	24	37	41	76	73	49	7	137
Number of observed hauls with one or more take	8	6	1	5	4	5	16	3	1	49
Total number of observed takes	9	7	2	5	4	6	19	3	1	56
Bycatch rate (observed total takes/observed number of hauls)	0.019	0.012	0.004	0.01	0.009	0.005	0.015	0.009	0.053	0.01
Bycatch rate (observed total takes/observed mt of landings)	0.062	0.075	0.033	0.069	0.045	0.024	0.063	0.043	1.229	0.052

* 2007 data are from 01 January to 31 May; other years include data from January to December.

Table 2.continue. Descriptive statistics of the bycatch of harbor porpoises in the Gulf of Maine during 01 January 1999 to 31 May 2007, for all of the Gulf of Maine, and each closure area.

E. Offshore Closure

Offshore	Year									Total
	1999	2000	2001	2002	2003	2004	2005	2006	2007*	
Number of observed hauls	280	162	103	31	59	96	127	142	139	1139
Number of observed trips	24	15	11	7	5	14	19	12	11	118
Number of observed vessels	16	8	7	5	4	11	12	9	8	42
Number of observed hauls with one or more take	0	0	0	0	0	0	0	0	0	0
Total number of observed takes	0	0	0	0	0	0	0	0	0	0
Bycatch rate (observed total takes/observed number of hauls)	0	0	0	0	0	0	0	0	0	0
Bycatch rate (observed total takes/observed mt of landings)	0	0	0	0	0	0	0	0	0	0

F. Western Gulf of Maine Closed Area

Western GOM Closed Area	Year									Total
	1999	2000	2001	2002	2003	2004	2005	2006	2007*	
Number of observed hauls	62	130	58	53	47	114	154	96	14	728
Number of observed trips	36	55	36	31	19	58	79	39	9	362
Number of observed vessels	13	16	14	13	11	24	27	19	7	60
Number of observed hauls with one or more take	0	2	0	1	0	1	3	3	0	10
Total number of observed takes	0	2	0	1	0	1	3	3	0	10
Bycatch rate (observed total takes/observed number of hauls)	0	0.125	0	0.077	0	0.042	0.111	0.158	0	0.014
Bycatch rate (observed total takes/observed mt of landings)	0	0.076	0	0.105	0	0.025	0.073	0.138	0	0.056

* 2007 data are from 01 January to 31 May; other years include data from January to December.

Table 2.continue. Descriptive statistics of the bycatch of harbor porpoises in the Gulf of Maine during 01 January 1999 to 31 May 2007, for all of the Gulf of Maine, and each closure area.

G. Proposed Closed Area

Proposed closure	Year									Total
	1999	2000	2001	2002	2003	2004	2005	2006	2007*	
Number of observed hauls	201	265	191	117	193	618	609	285	245	2724
Number of observed trips	63	101	61	44	72	197	182	84	66	870
Number of observed vessels	19	27	20	14	23	36	32	30	27	83
Number of observed hauls with one or more take	0	0	0	0	1	6	9	2	0	18
Total number of observed takes	0	0	0	0	1	6	9	2	0	18
Bycatch rate (observed total takes/observed number of hauls)	0	0	0	0	0.043	0.167	0.281	0.067	0	0.007
Bycatch rate (observed total takes/observed mt of landings)	0	0	0	0	0.032	0.065	0.104	0.06	0	0.040

H. Outside all the above closures

Outside all closures	Year									Total
	1999	2000	2001	2002	2003	2004	2005	2006	2007*	
Number of observed hauls	1053	1280	912	630	696	1041	920	399	116	7047
Number of observed trips	178	237	169	127	136	190	193	77	17	1324
Number of observed vessels	36	42	37	36	39	46	37	37	12	120
Number of observed hauls with one or more take	3	1	0	0	1	1	3	0	0	9
Total number of observed takes	4	1	0	0	1	1	3	0	0	10
Bycatch rate (observed total takes/observed number of hauls)	0.111	0.024	0	0	0.026	0.022	0.081	0	0	0.001
Bycatch rate (observed total takes/observed mt of landings)	0.011	0.004	0	0	0.007	0.003	0.009	0	0	0.005

* 2007 data are from 01 January to 31 May; other years include data from January to December.

Table 3. By month, the number of observed hauls and takes and resulting bycatch rates using data from 01 January 1999 to 31 May 2007.

Month	Number of observed hauls	Number of observed takes	Bycatch rate (obs takes /obs hauls)	Bycatch rate (obs takes/obs mt of landing)
1999 to 2007				
Jan	1344	5	0.004	0.022
Feb	1245	9	0.007	0.056
Mar	1390	8	0.006	0.038
Apr	837	5	0.006	0.040
May	1244	1	0.001	0.005
1999 to 2006				
Jun	2018	3	0.001	0.007
Jul	2368	2	0.001	0.003
Aug	2515	1	0.000	0.002
Sep	2431	6	0.002	0.010
Oct	1818	11	0.006	0.023
Nov	1881	34	0.018	0.066
Dec	1667	19	0.011	0.044

Table 4. By month and closure area, (A) the number of takes and (B) resulting harbor porpoise bycatch rates (sum of number of observed takes/sum of landings (in mtons)), using data from 01 January 1999 to 31 May 2007.

A. Number of observed takes

Month	Cashes Ledge	Mass Bay	MidCoast	Offshore	WGOM	Proposed	Outside	TOTAL
1999 to 2007								
Jan	0	0	1	0	1	3	0	5
Feb	0	0	0	0	2	7	0	9
Mar	0	1	3	0	1	2	1	8
Apr	0	0	0	0	0	0	5	5
May	0	0	0	0	0	0	1	1
1999 to 2006								
Jun	2	0	1	0	0	0	0	3
Jul	0	0	2	0	0	0	0	2
Aug	0	0	1	0	0	0	0	1
Sep	0	2	4	0	0	0	0	6
Oct	0	0	11	0	0	0	0	11
Nov	0	2	26	0	5	0	1	34
Dec	0	3	7	0	1	6	2	19
TOTAL	2	8	56	0	10	18	10	104

B. Bycatch rate (number of observed takes/observed mtons of landing)

Month	Cashes Ledge	Mass Bay	MidCoast	Offshore	WGOM	Proposed	Outside	TOTAL
1999 to 2007								
Jan	0	0	0.045	0	0.082	0.047	0	0.022
Feb	0	0	0	0	0.192	0.192	0	0.056
Mar	0	0.267	0.156	0	0.047	0.037	0.017	0.038
Apr	0	0	0	0	0	0	0.069	0.040
May	0	0	0	0	0	0	0.010	0.005
Jun	0.332	0	0.032	0	0	0	0	0.007
Jul	0	0	0.010	0	0	0	0	0.003
Aug	0	0	0.006	0	0	0	0	0.002
Sep	0	0.023	0.028	0	0	0	0	0.010
Oct	0	0	0.066	0	0	0	0	0.023
Nov	0	0.052	0.121	0	0.145	0	0.005	0.066
Dec	0	0.043	0.071	0	0.095	0.079	0.018	0.044
TOTAL	0.023	0.016	0.052	0	0.056	0.040	0.005	0.022

Figure 1. Location of observed hauls without takes (small dot) and those with takes (red circles). Data are from January 1999 to May 2007.

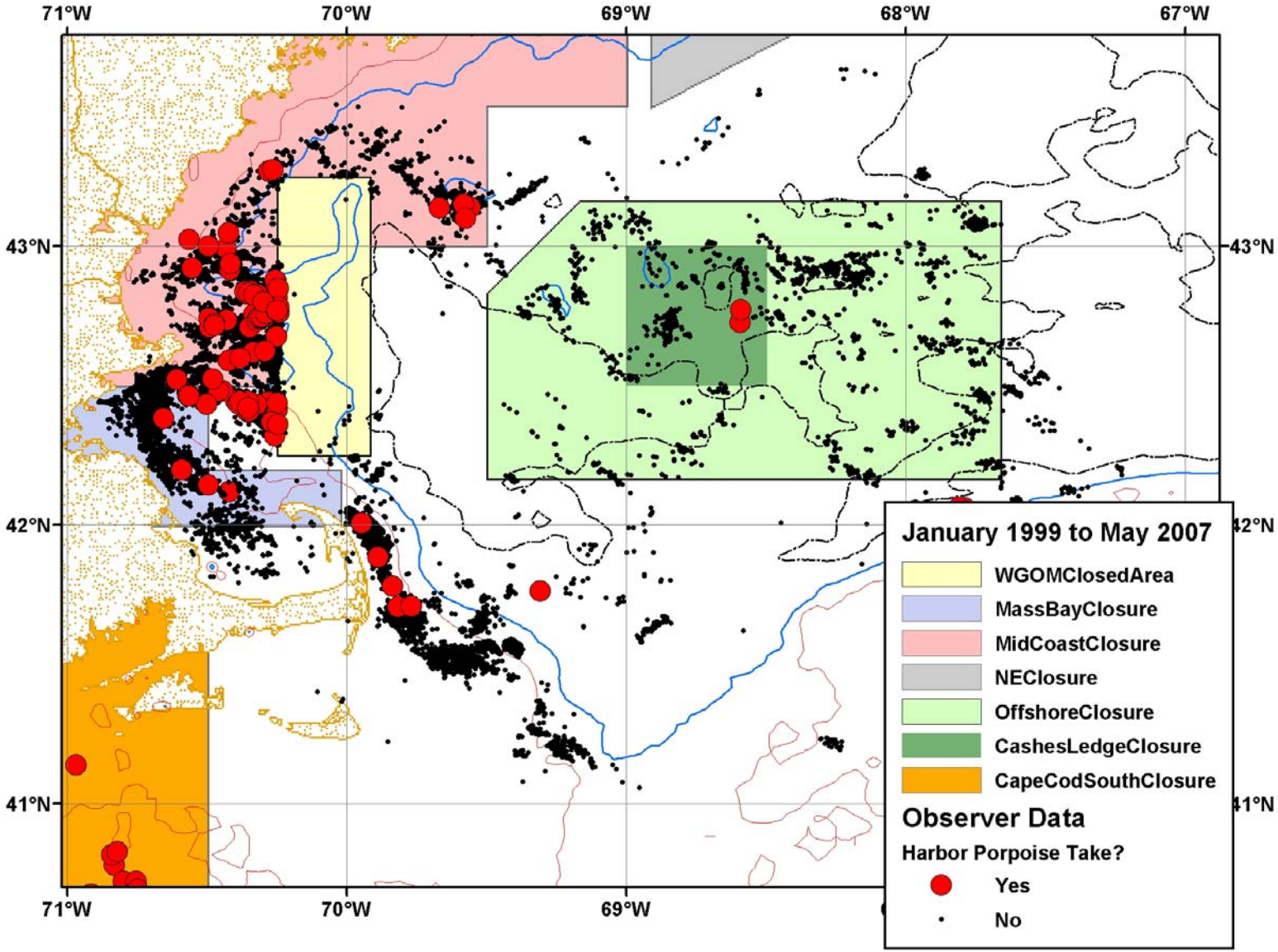

Figure 2. By month, the number of observed hauls within each closure and outside all closures, using data from 01 January 1999 to 31 May 2007.

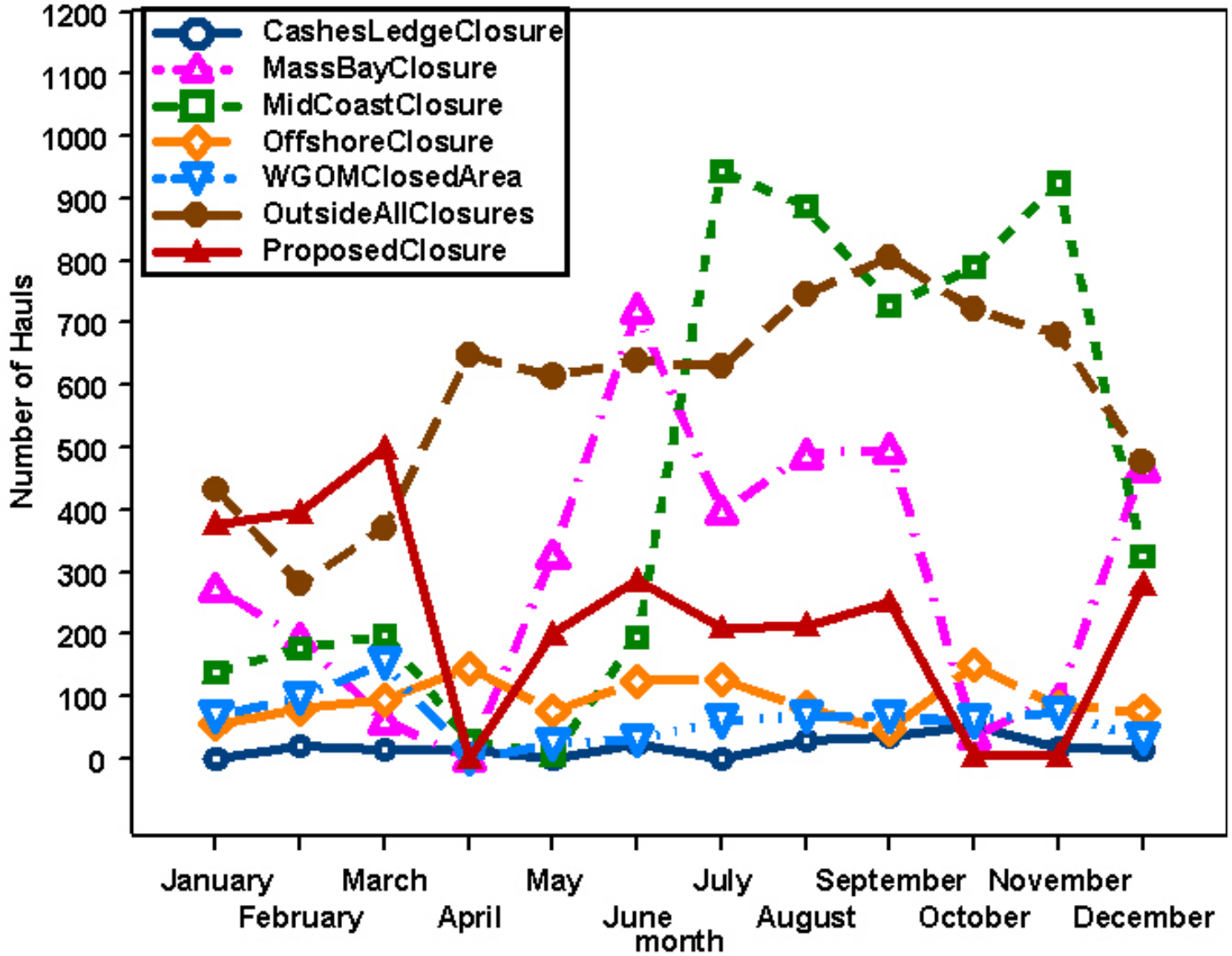

Figure 3. By year, number of pingers on strings of various number of nets. A string has the required number of pingers if the symbol is on the red diagonal line. Hauls (symbols) below the line do not have the required number of pingers. Symbols for hauls without a take is a small blue circle, and the symbol for hauls with one or more takes is the large red triangle.

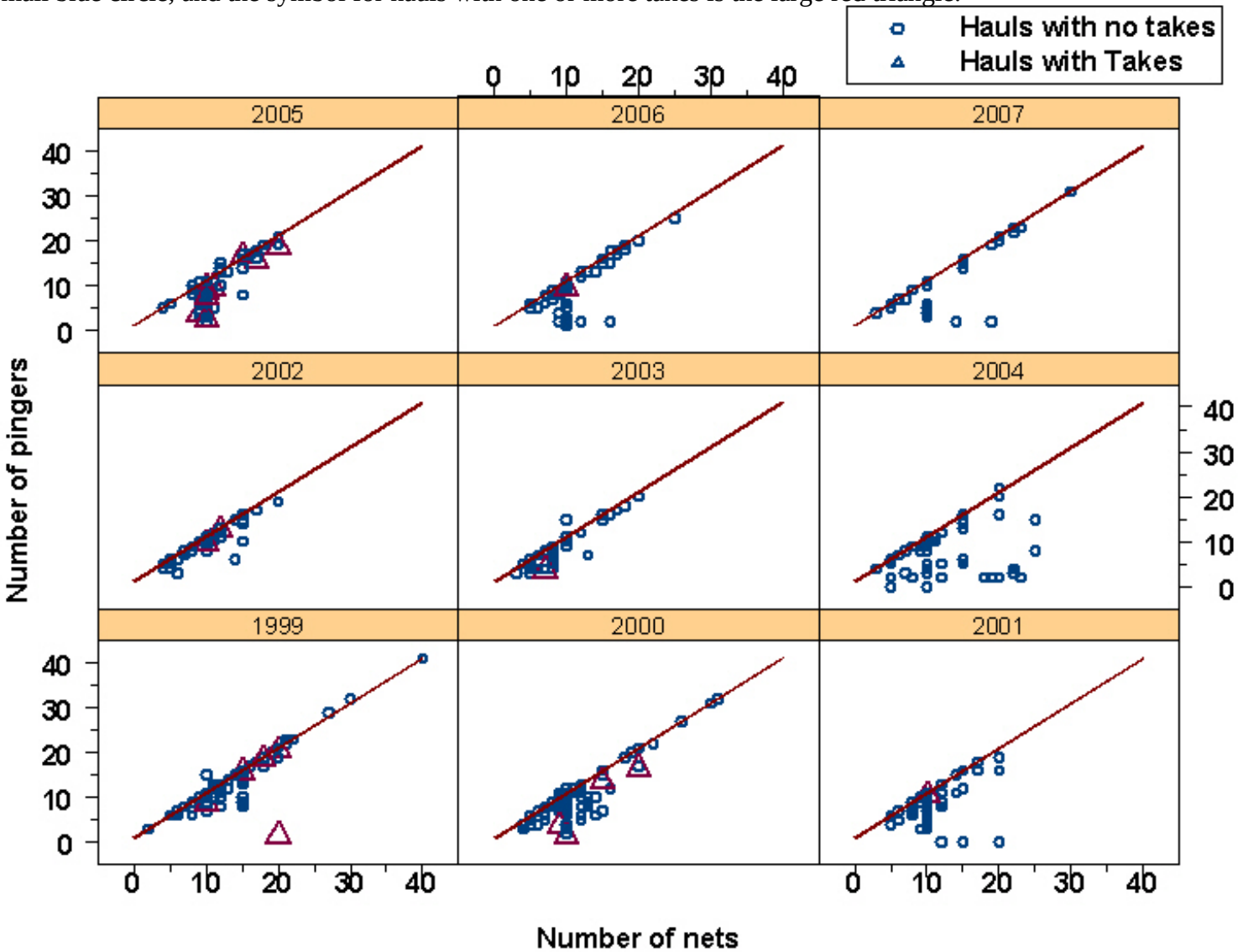
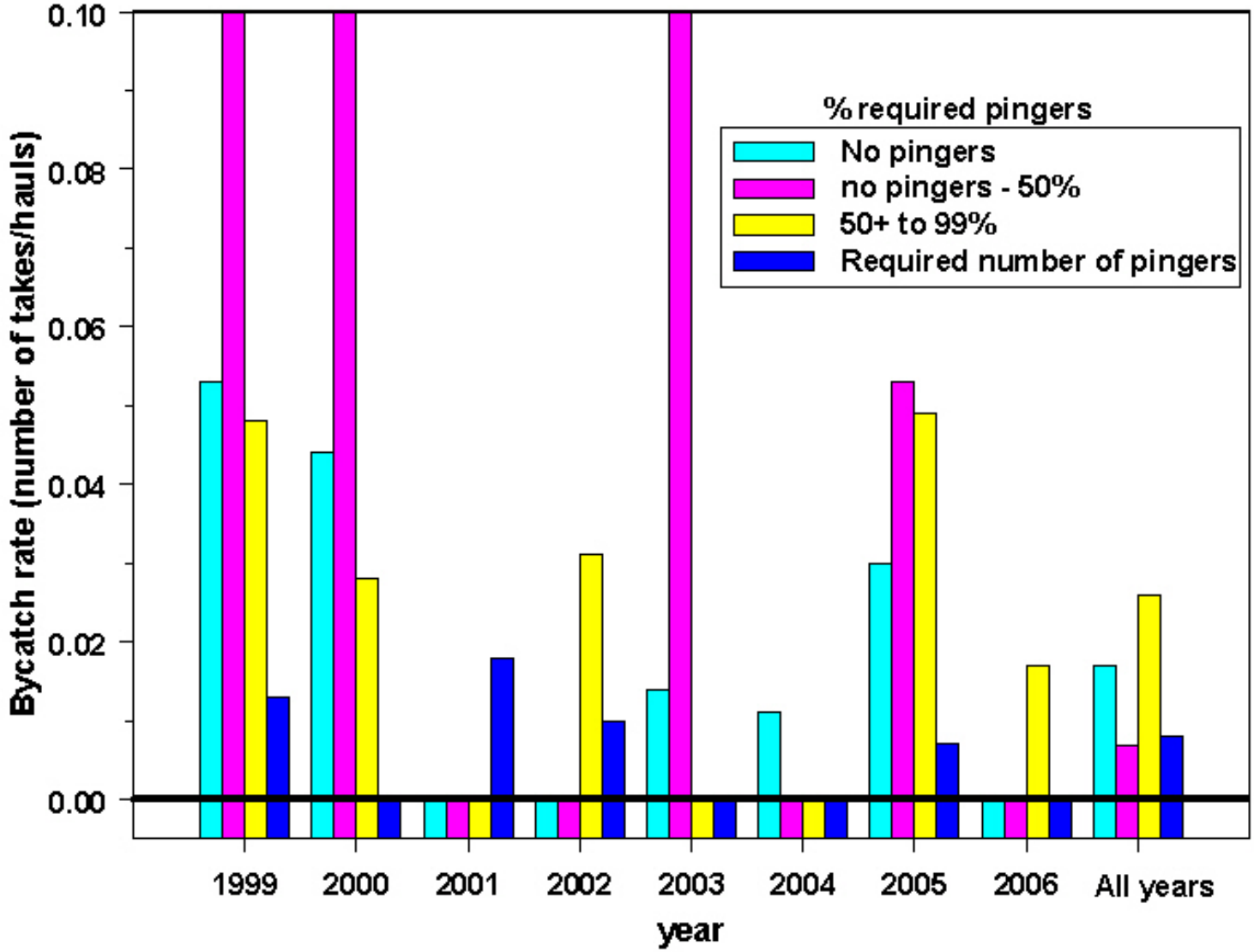
Figure 4. In Mid-Coast Closure during the times pingers are needed, the bycatch rate (total number of takes per hauls) by year and by the percentage of pingers that were required for that string length. Light blue bars are hauls without pingers. Dark blue bars are hauls with all of the required number of pingers.