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UPDATE: Identification of river herring hotspots at sea using fisheries dependent and independent datasets

Prepared for the Atlantic Herring PDT

by

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August 2010

Background

At its May 2010 meeting, the New England Fisheries Management Council Herring Oversight Committee (Committee) tasked the Plan Development Team (PDT) with identifying river herring hotspots as part of the analysis for Amendment 5 to the Atlantic Herring fishery management plan (FMP). Specifically, one of the objectives for Amendment 5 of the FMP is to address river herring bycatch in the Atlantic herring, *Clupea harengus*, fishery.

Here, the term "river herring" refers to alewife, *Alosa pseudoharengus*, and blueback herring, *Alosa aestivalis*. This analysis combines available data on both species to identify river herring hotspots. As recommended by the Committee at its July 2010 meeting, the following is an update to the methods and analysis developed by the PDT to identify river herring hotspots.

Study Area

The study area includes the Atlantic herring fishery management plan areas that overlap the Eastern US Continental shelf (Fig. 1).

Datasets and Data Selection

Multiple data sources are used in this analysis to identify river herring hotspots at sea. These sources include fishery dependent (Vessel Trip Reports, VTR and Northeast Fishery Observer Program, NEFOP) and fishery independent (National Marine Fisheries Service, NMFS bottom-trawl surveys) datasets (Tables 1-3). The most recent 5 years (2005-2009) of fishery dependent data and all years (1948-2008) of fishery independent are pooled separately by dataset in the analysis.

Data from directed herring trips were selected from VTR and NEFOP databases and grouped into bimonthly blocks (Tables 1 and 2). Here, directed herring trips were defined as 2,000 lbs of kept Atlantic herring on a trip. Data from other non-directed trips is not included in the analysis, but may become the scope of future examination. In addition, fishery dependent data included three broad gear categories: bottom otter-trawl, purse seine, and mid-water trawl (combining single and pair mid-water trawls).

River herring data from observed directed herring trips (NEFOP) were presence/absence and weight (lbs) from each haul or set. Data from the Massachusetts Division of Marine Fisheries and the Maine Department of Marine Resources portside surveys were excluded because spatial information was not available for all years and all trips.

Selected river herring data from NMFS bottom-trawl surveys included presence/absence and the number of individuals found at each sampling location. Surveys were separated by season: winter, spring, summer and fall (Tables 3 and 4).

Methods

Fishing Effort and River Herring Bycatch

To understand where and when the directed herring fishery operated throughout the fishing year, bimonthly maps and tables of the number of trips per statistical area were constructed using VTRs (Appendix Tables A1-A6 and Figs. A1-A6). Fishing effort was approximated by the number of trips within a statistical area. Bimonthly maps of fishing effort by statistical areas were color-coded from hot (red) to cool (blue) to identify fishing effort concentration areas.

These maps were overlaid with bimonthly NEFOP data on river herring bycatch events from observed hauls and sets. Circles of increasing size represent the magnitude of the bycatch event. These bycatch events were binned into circles of increasing size using all years and months combined and then mapped separately in bimonthly blocks.

Survey Hotspots

Seasonal NMFS bottom-trawl surveys were used to identify river herring "hotspot" areas. Analyses for the winter, spring, summer and fall surveys were conducted separately using a quarter degree squares spatial stratification scheme. Greater than 10 tows per square were required for inclusion in the analysis. Squares with less than 10 tows were omitted from the analysis.

For each seasonal survey, two metrics were used to determine hotspots:

- percent occurrence and
- percent occurrence and catch in number (number of individuals).

Percent occurrence. Within each square, percent occurrence was defined as the count of tows with river herring present divided by the total tows. For example if for a given area, the number of tows was 100, and out of those 100 tows 66 tows detected river herring. The percent occurrence for that area was 66%. The percent occurrence for each square was used for ranking. Maps of ranked squares were color-coded from hot (red) to cool (blue or purple) to identify river herring hotspot areas.

Percent occurrence and catch in number. An algorithm defined hot spots based on the intersection of the set of squares above a selected quantile for percent occurrence and set of squares above a selected quantile of a summary statistic for river herring catch (number of individuals). Tows with no river herring catch were omitted from the analysis. For example, candidate hotspots can be defined using the 75th quantile of percent occurrence and 75th quantile of median catch in number. Candidate "hot spot" squares were identified as squares meeting the following criteria:

- percent occurrence and mean catch in number ≥ the 75th quantiles of both variables

- percent occurrence and median catch in number ≥ the 75th quantiles of both variables
- percent occurrence and catch in number ≥ the 75th quantiles of both variables.

Candidate squares were ranked using each metric and recorded in respective tables, plots and maps (Appendix Tables A7-A18, Figs. A7- A38). These candidate hotspots were overlaid with bimonthly directed fishing trips per statistical area (VTRs) and river herring bycatch from observed hauls and sets (NEFOP) based on the timing of the NMFS bottom-trawl surveys (Figs. 2-5, Table 4).

Results

Fishing Effort and River Herring Bycatch

Visual differences in the spatial and temporal distribution of directed herring trips were evident from maps of fishing effort (Appendix Figs. A1-A6). In general during the first six months of the year, fishing effort shifted from the northern Mid-Atlantic Bight and southern New England waters (January-February) to primarily southern New England waters (March-April), and then to the Gulf of Maine (May-June). Then, fishing effort concentrated in the Gulf of Maine and Georges Bank (July-August and September-October), contracting to the Gulf of Maine and southern New England waters (November-December) at the end of the year.

Using NEFOP haul and set data, river herring bycatch events were inspected bimonthly (Appendix Figs. A1-A6). River herring bycatch events included areas in Ipswich Bay, off the back of Cape Cod, and in the northern Mid-Atlantic Bight (January-February and March-April). River herring bycatch events occurred in the northern Gulf of Maine and off the back of Cape Cod (May- June). Bycatch events also included areas in the northern Gulf of Maine (July-August and September-October), Ipswich Bay (September-October and November-December), and Massachusetts Bay, the back of Cape Cod, south of Martha's Vineyard, and near Block Island (November-December).

Survey Hotspots

Results include river herring hotspot areas ranked in tables, plots, and maps:

- percent occurrence (Appendix Figs. A31-A34)
- percent occurrence and mean catch in number ≥ the 75th quantiles of both variables (Appendix Tables A7, A10, A13, A16, and Figs. A7, A10, A13, A16, A19, A22, A25, A28, A35-A38)
- percent occurrence and median catch in number ≥ the 75th quantiles of both variables (Appendix Tables A8, A11, A14, A17, and Figs. A8, A11, A14, A17, A20, A23, A26, A29, A35-A38)
- percent occurrence and catch in number ≥ the 75th quantiles of both variables (Appendix Tables A9, A12, A15, A18, and Figs. A9, A12, A15, A18, A21, A24, A27, A30, A35-A38)

Each of these above combinations produced different hotspot maps, but there was substantial overlap among maps of candidate river herring hotspot areas (Appendix Figs. A35-A38 and Table 5). The number of identified candidate river herring hotspot areas also varied by identification method and season (Table 5).

Fishing Effort, River Herring Bycatch, and Survey Hotspots

Fishery Observer data, Vessel Trip Reports and seasonal candidate hotspots provide can be integrated at the bimonthly-quarter degree square resolution. Fishery observer data can provide information on the distribution of observed river herring bycatch on a bimonthly-block basis for areas where the fishery is prosecuted. VTR data can provide spatial distribution of fishing effort. Note that the historic distribution of effort reflects locations where Atlantic herring and Atlantic mackerel can be caught. These target species may be available in other areas not currently fished because of regulations or economic considerations. Candidate hotspots are defined as bimonthly blocks combinations with high (≥75th quantile) of both percent occurrence and counts. The candidate spots provide information on the relative likelihood of encountering river herring for areas that have either little to no fishing effort or observer coverage. The candidate hotspots can be useful for evaluating the likely impact of changing the spatial-temporal distribution of fishing effort on reducing river herring bycatch.

We provide an example of the integrative approach by overlaying candidate hotspots identified using blocks at or above the 75th quantiles of the median catch in number and percent occurrence with fishing effort and observed river herring bycatch (Figures 2-5). We note that resolution finer than bimonthly and quarter degree square is not feasible.

Additional Information

State by state migration patterns of alewife, blueback herring, and American shad, *Alosa sapidissima*, in state fresh waters are included for reference (Table A19).

Tables

Jan-Dec	Gear Category			
Year	OT	PR	PS	ALL
2005	77	774	200	1051
2006	150	739	175	1064
2007	414	389	365	1168
2008	109	304	246	659
2009	203	406	225	834
ALL	953	2612	1211	**4776**

Jan-Feb	Gear Category			
Year	OT	PR	PS	ALL
2005	10	89	0	99
2006	52	108	0	160
2007	140	141	0	281
2008	56	101	0	157
2009	79	128	0	207
ALL	337	567	0	**904**

Mar-Apr	Gear Category			
Year	OT	PR	PS	ALL
2005	5	48	0	53
2006	19	71	0	90
2007	15	65	0	80
2008	7	44	0	51
2009	26	55	0	81
ALL	72	283	0	**355**

May-Jun	Gear Category			
Year	OT	PR	PS	ALL
2005	7	151	25	183
2006	0	158	27	185
2007	0	75	52	127
2008	0	25	53	78
2009	1	18	53	72
ALL	8	427	210	**645**

Jun-Aug	Gear Category			
Year	OT	PR	PS	ALL
2005	7	182	88	277
2006	12	202	94	308
2007	163	0	187	350
2008	17	12	177	206
2009	27	9	121	157
ALL	226	405	667	**1298**

Sep-Oct	Gear Category			
Year	OT	PR	PS	ALL
2005	20	195	82	297
2006	25	143	54	222
2007	64	52	126	242
2008	10	68	16	94
2009	25	128	45	198
ALL	144	586	323	**1053**

Nov-Dec	Gear Category			
Year	OT	PR	PS	ALL
2005	28	109	5	142
2006	42	57	0	99
2007	32	56	0	88
2008	19	54	0	73
2009	45	68	6	119
ALL	166	344	11	**521**

Table 1: Number of directed herring trips separated by gear, year and bimonthly groupings. Directed herring trips defined as 2,000 lbs of kept Atlantic herring on a trip. Gear categories include bottom otter-trawl (OT), purse seine (PS) and mid-water trawl (PR). Mid-water trawl (PR) refers to pair and single mid-water trawls. Source: Vessel Trip Report Database 2005-2009.

Jan-Dec	Gear Category			
Year	OT	PR	PS	ALL
2005	15	465	95	575
2006	64	120	0	184
2007	59	75	27	161
2008	8	209	69	286
2009	35	437	97	569
ALL	181	1306	288	**1775**

Jan-Feb	Gear Category			
Year	OT	PR	PS	ALL
2005	0	39	0	39
2006	36	72	0	108
2007	37	19	0	56
2008	4	44	0	48
2009	23	76	0	99
ALL	100	250	0	**350**

Mar-Apr	Gear Category			
Year	OT	PR	PS	ALL
2005	0	21	0	21
2006	0	3	0	3
2007	0	22	0	22
2008	0	41	0	41
2009	4	34	0	38
ALL	4	121	0	**125**

May-Jun	Gear Category			
Year	OT	PR	PS	ALL
2005	0	64	5	69
2006	0	6	0	6
2007	0	3	0	3
2008	0	28	25	53
2009	0	37	39	76
ALL	0	138	69	**207**

Jul-Aug	Gear Category			
Year	OT	PR	PS	ALL
2005	3	112	47	162
2006	16	17	0	33
2007	11	0	18	29
2008	4	15	36	55
2009	0	11	51	62
ALL	34	155	152	**341**

Sep-Oct	Gear Category			
Year	OT	PR	PS	ALL
2005	12	111	43	166
2006	8	20	0	28
2007	3	15	9	27
2008	0	42	8	50
2009	4	194	3	201
ALL	27	382	63	**472**

Nov-Dec	Gear Category			
Year	OT	PR	PS	ALL
2005	0	118	0	118
2006	4	2	0	6
2007	8	16	0	24
2008	0	39	0	39
2009	4	85	4	93
ALL	16	260	4	**280**

Table 2: Observed hauls from directed herring trips separated by gear, year and bimonthly groupings. Gear categories include bottom otter-trawl (OT), purse seine (PS) and mid-water trawl (PR). Mid-water trawl (PR) refers to pair and single mid-water trawls. Directed herring trips defined as 2,000 lbs of kept Atlantic herring on a trip. Source: NEFOP Database 2005-2009.

	Season				
Year	Winter	Spring	Summer	Fall	ALL
1948			52		52
1949			167		167
↓					
1963			154	88	242
1964	105		148	126	379
1965	99		151	142	392
1966	105			147	252
1967				195	195
1968		199		192	391
1969		203	204	175	582
1970		215		180	395
1971		203		216	419
1972	52	199		449	700
1973		481		436	917
1974		385		366	751
1975		267		391	658
1976		373		339	712
1977		353	262	407	1022
1978	77	385	264	529	1255
1979		469	245	556	1270
1980		435	264	388	1087
1981	81	366	160	356	963
1982		330		282	612
1983		327		343	670
1984		339		302	641
1985		317		289	606
1986		321		287	608
1987		285		290	575
1988		289		285	574
1989		252		277	529
1990		289		292	581
1991		291	6	305	602
1992	112	281		284	677
1993	105	285	56	299	745
1994	75	299	22	288	684
1995	117	288	26	297	728
1996	110	287		263	660
1997	108	290		287	685
1998	116	321		294	731
1999	118	291		295	704
2000	106	290		294	690
2001	140	279		283	702
2002	134	272		288	694
2003	65	270		280	615
2004	114	284		277	675
2005	80	260		278	618
2006	101	292		305	698
2007	114	312		294	720
2008		297		305	602
ALL	2234	12471	2181	13541	**30427**

Table 3: Number of tows from seasonal research surveys separated by year and season. Source: NMFS bottom-trawl surveys 1948-2008.

Month	Fishing Quarter	NMFS BTS Seasons			
		Winter	Spring	Summer	Fall
January	1	210			
February	1	1878	32		
March	1	85	6013		
April	2	61	5567		
May	2		821		
June	2		38	39	
July	3			764	
August	3			1350	
September	3			28	4545
October	4				6688
November	4				2152
December	4				156

Table 4: Number of tows from seasonal research surveys separated month, fishing quarter, and survey season. Note that spring and fall surveys overlap multiple fishing quarters. Source: NMFS bottom-trawl surveys 1948-2008.

Season	Number of Candidate Areas		
	mean	median	75th
Winter	12	16	14
Spring	25	37	27
Summer	13	18	18
Fall	20	29	29

Table 5: Resulting number of candidate river herring hotspot areas by season. Candidate "hot spot" quarter degree squares identified as squares with percent occurrence and mean catch in number ≥ the 75th quantiles of both variables (mean), percent occurrence and median catch in number ≥ the 75th quantiles of both variables (median), and percent occurrence and catch in number ≥ the 75th quantiles of both variables (75th). Source: NMFS bottom-trawl surveys 1948-2008.

Figures

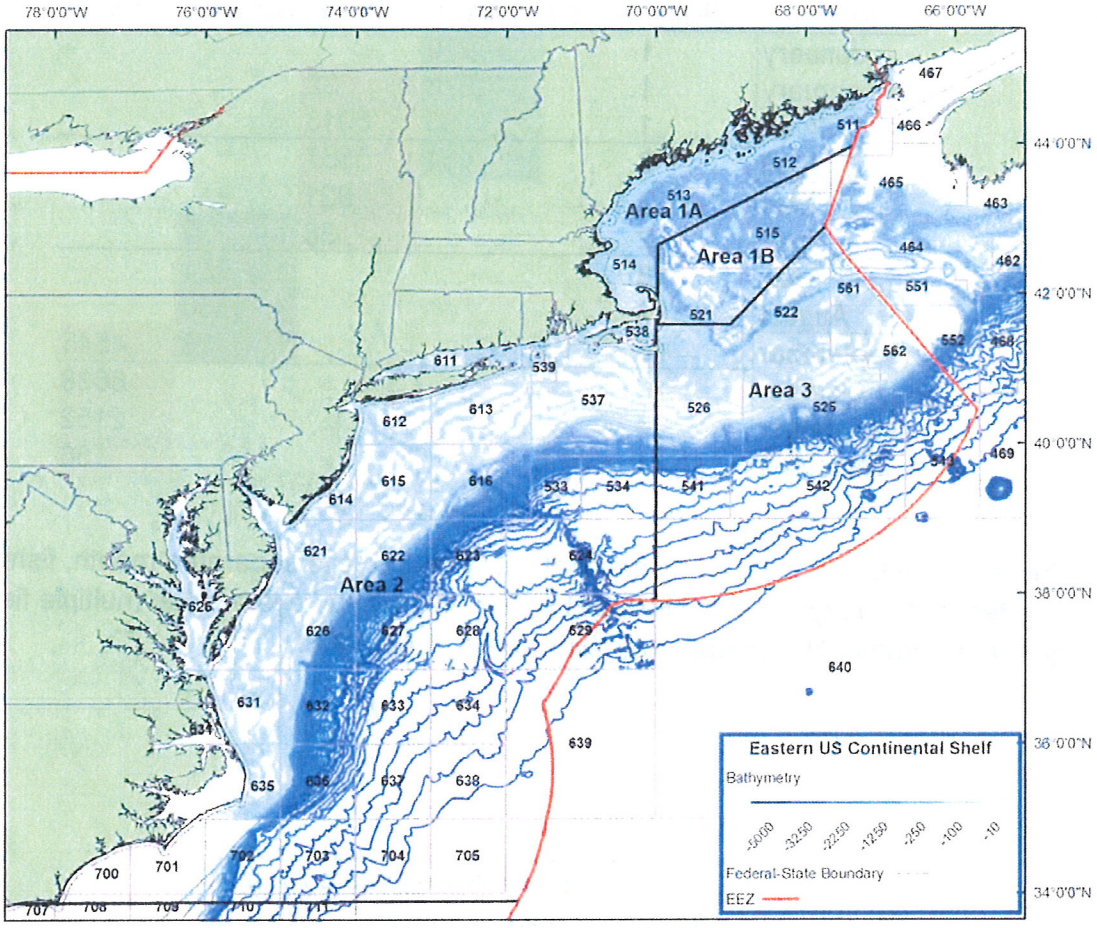


Figure 1: Study area of the Eastern US Continental Shelf. Overlapping Atlantic herring fishery management plan areas (Area 1A, 1B, 2, and 3) and fisheries management statistical areas (400-700s) indicated.

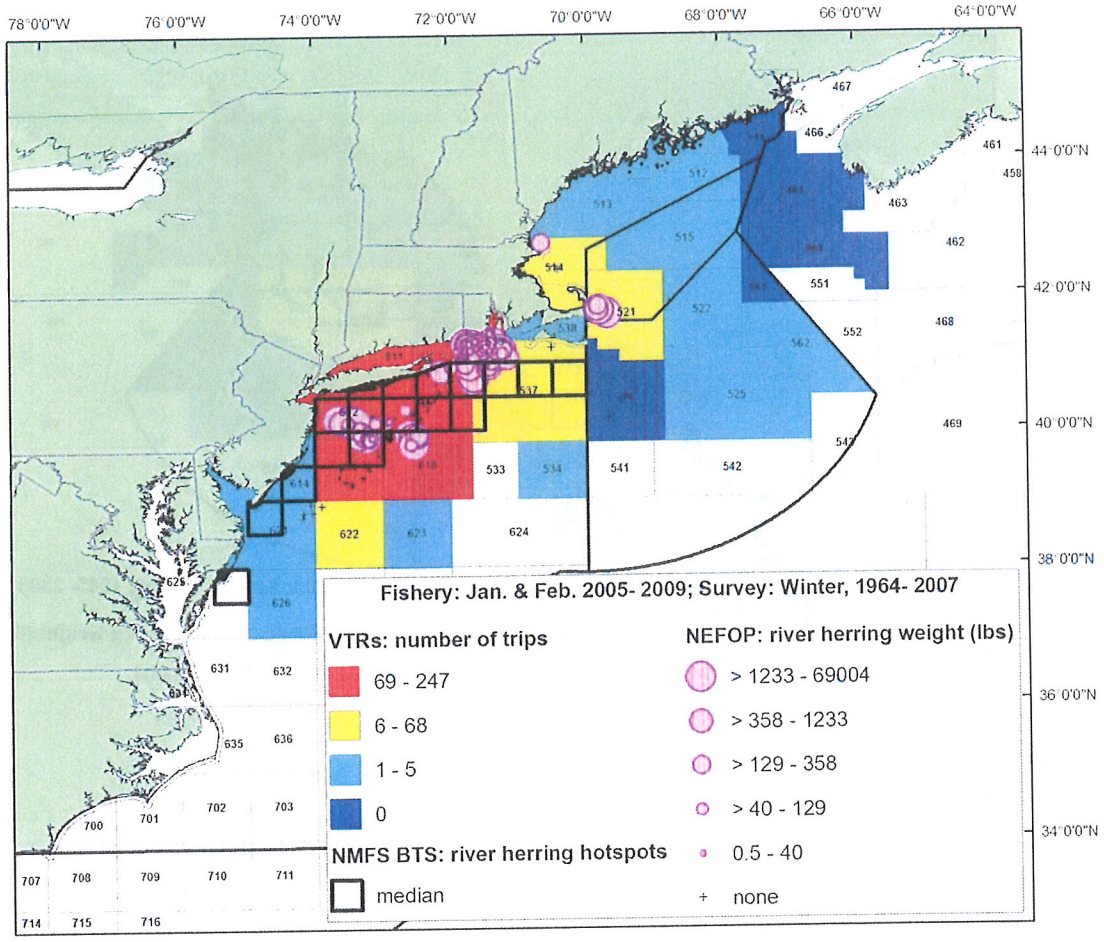


Figure 2: Reported trips (VTR) and observed hauls and sets (NEFOP) during January and February, 2005-2009 for directed herring trips by bottom otter-trawls, purse seines, and mid-water trawls (single and paired). Trips by statistical area are grouped from 69-247 (red), 6-68 (yellow), 1-5 (aqua), and 0 (dark blue) trips. Scaled pink circles represent river herring bycatch (lbs) in observed hauls and sets for directed herring trips. A "+" signifies that an observed haul or set did not catch river herring. Directed herring trips are defined as 2,000 lbs of kept Atlantic herring on a trip. Winter candidate river herring "hot spot" quarter degree squares identified as squares with percent occurrence and median catch in number ≥ the 75th quantiles of both variables (bold outlined quarter degree squares). Sources: VTR Database 2005-2009, NEFOP Database 2005-2009, and Winter 1963-2007 NMFS bottom-trawl surveys.

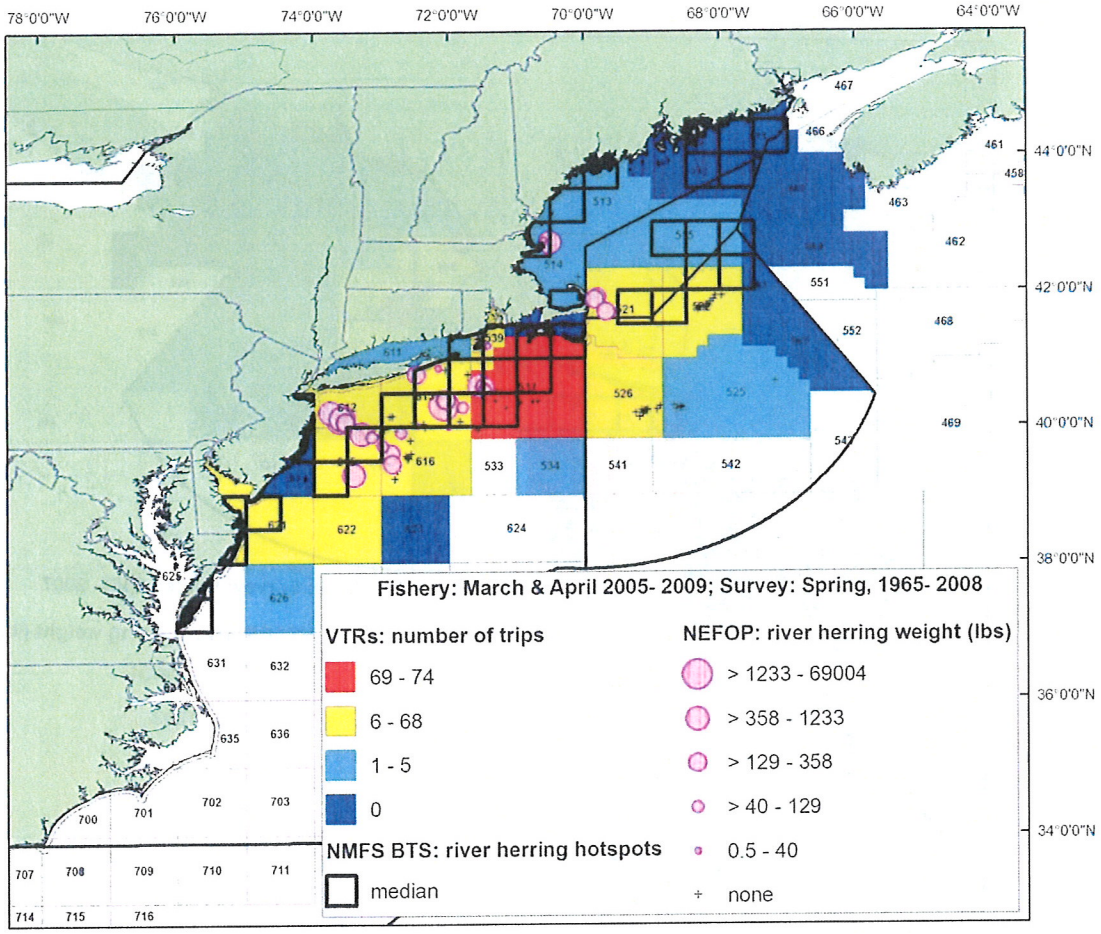


Figure 3: Reported trips (VTR) and observed hauls and sets (NEFOP) during March and April, 2005-2009 for directed herring trips by bottom otter-trawls, purse seines, and mid-water trawls (single and paired). Trips by statistical area are grouped from 69-74 (red), 6-68 (yellow), 1-5 (aqua), and 0 (dark blue) trips. Scaled pink circles represent river herring bycatch (lbs) in observed hauls and sets for directed herring trips. A "+" signifies that an observed haul or set did not catch river herring. Directed herring trips are defined as 2,000 lbs of kept Atlantic herring on a trip. Spring candidate river herring "hot spot" quarter degree squares identified as squares with percent occurrence and median catch in number ≥ the 75th quantiles of both variables (bold outlined quarter degree squares). Sources: VTR Database 2005-2009,. NEFOP Database 2005-2009, and Spring 1965-2008 NMFS bottom-trawl surveys.

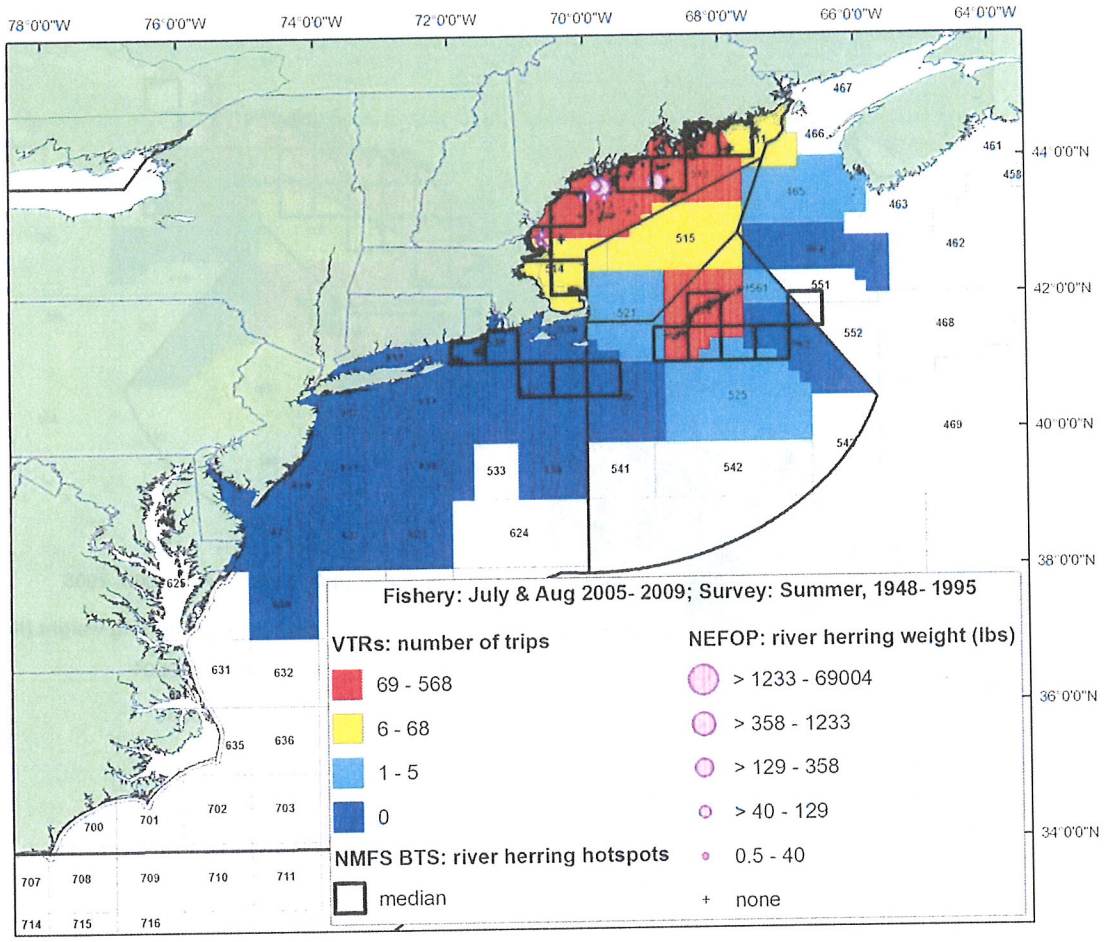


Figure 4: Reported trips (VTR) and observed hauls and sets (NEFOP) during July and August, 2005-2009 for directed herring trips by bottom otter-trawls, purse seines, and mid-water trawls (single and paired). Trips by statistical area are grouped from 69-568 (red), 6-68 (yellow), 1-5 (aqua), and 0 (dark blue) trips. Scaled pink circles represent river herring bycatch (lbs) in observed hauls and sets for directed herring trips. A "+" signifies that an observed haul or set did not catch river herring. Directed herring trips are defined as 2,000 lbs of kept Atlantic herring on a trip. Summer candidate river herring "hot spot" quarter degree squares identified as squares with percent occurrence and median catch in number ≥ the 75th quantiles of both variables (bold outlined quarter degree squares). Sources: VTR Database 2005-2009, NEFOP Database 2005-2009, and Summer 1948-1995 NMFS bottom-trawl surveys.

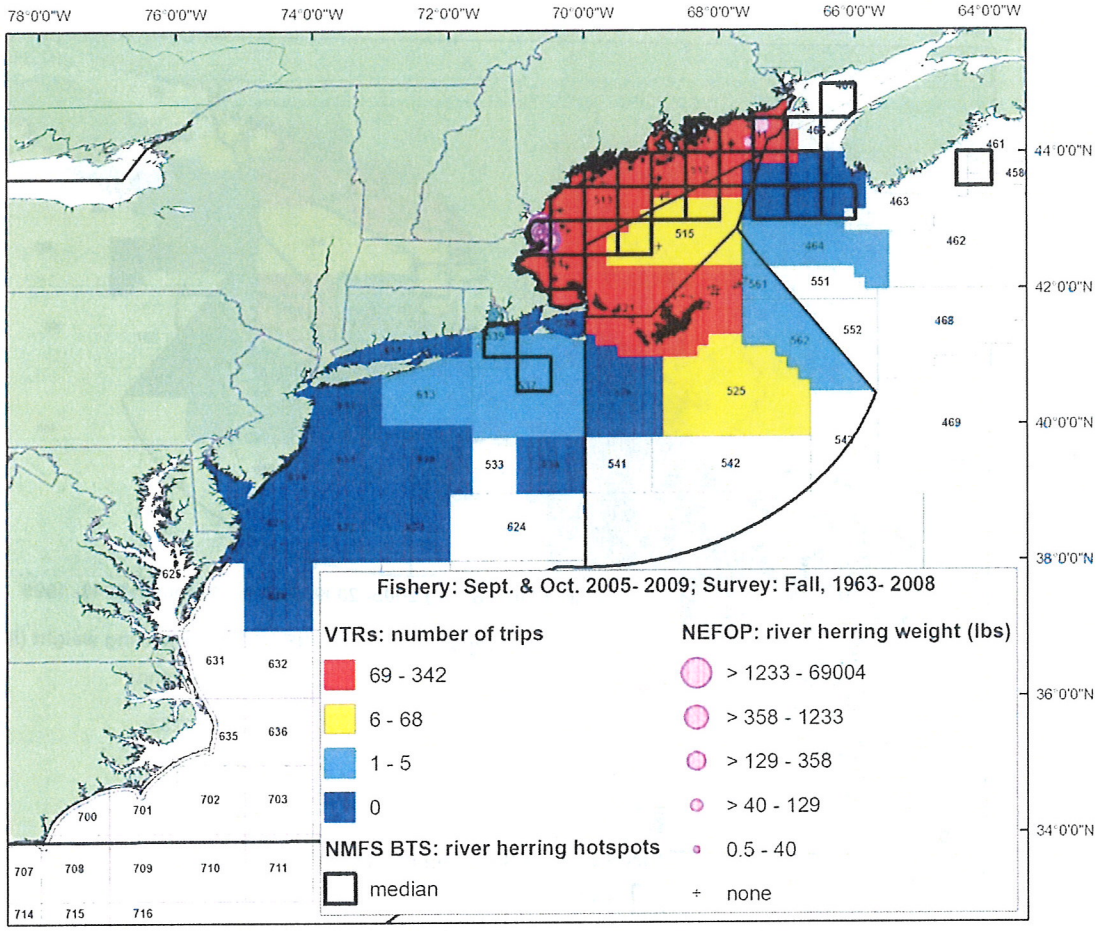


Figure 5: Reported trips (VTR) and observed hauls and sets (NEFOP) during September and October, 2005-2009 for directed herring trips by bottom otter-trawls, purse seines, and mid-water trawls (single and paired). Trips by statistical area are grouped from 69-342(red), 6-68 (yellow), 1-5 (aqua), and 0 (dark blue) trips. Scaled pink circles represent river herring bycatch (lbs) in observed hauls and sets for directed herring trips. A "+" signifies that an observed haul or set did not catch river herring. Directed herring trips are defined as 2,000 lbs of kept Atlantic herring on a trip. Fall candidate river herring "hot spot" quarter degree squares identified as squares with percent occurrence and median catch in number ≥ the 75th quantiles of both variables (bold outlined quarter degree squares). Sources: VTR Database 2005-2009, NEFOP Database 2005-2009, and Fall 1963-2008 NMFS bottom-trawl surveys.

Appendix

Tables

Jan-Feb	Gear Category			
Statistical Area	OT	PR	PS	ALL
464	0	0	0	0
465	0	0	0	0
511	0	0	0	0
512	0	1	0	1
513	0	2	0	2
514	0	14	0	14
515	0	1	0	1
521	1	22	0	23
522	0	2	0	2
525	0	1	0	1
526	0	0	0	0
534	1	1	0	2
537	40	24	0	64
538	2	2	0	4
539	144	103	0	247
561	0	0	0	0
562	0	2	0	2
611	77	31	0	108
612	6	100	0	106
613	20	95	0	115
614	0	1	0	1
615	23	99	0	122
616	19	51	0	70
621	1	3	0	4
622	3	9	0	12
623	0	1	0	1
626	0	2	0	2

Table A1: Number of directed herring trips separated by gear and statistical area for January-February. Directed herring trips defined as 2,000 lbs of kept Atlantic herring on a trip. Gear categories include bottom otter-trawl (OT), purse seine (PS) and mid-water trawl (PR). Mid-water trawl (PR) refers to pair and single mid-water trawls. Source: Vessel Trip Report Database 2005-2009.

Mar-Apr	Gear Category			
Statistical Area	OT	PR	PS	ALL
464	0	0	0	0
465	0	0	0	0
511	0	0	0	0
512	0	0	0	0
513	0	5	0	5
514	0	5	0	5
515	0	1	0	1
521	0	6	0	6
522	0	20	0	20
525	0	2	0	2
526	1	11	0	12
534	0	1	0	1
537	19	55	0	74
538	0	0	0	0
539	24	16	0	40
561	0	0	0	0
562	0	0	0	0
611	3	2	0	5
612	2	32	0	34
613	12	36	0	48
614	0	0	0	0
615	2	29	0	31
616	6	36	0	42
621	1	7	0	8
622	2	15	0	17
623	0	0	0	0
626	0	4	0	4

Table A2: Number of directed herring trips separated by gear and statistical area for March-April. Directed herring trips defined as 2,000 lbs of kept Atlantic herring on a trip. Gear categories include bottom otter-trawl (OT), purse seine (PS) and mid-water trawl (PR). Mid-water trawl (PR) refers to pair and single mid-water trawls. Source: Vessel Trip Report Database 2005-2009.

May-Jun	Gear Category			
Statistical Area	OT	PR	PS	ALL
464	0	0	0	0
465	0	0	0	0
511	0	8	2	10
512	0	10	76	86
513	1	276	121	398
514	0	35	1	36
515	0	34	8	42
521	0	35	2	37
522	0	7	0	7
525	0	0	0	0
526	0	1	0	1
534	0	0	0	0
537	1	20	0	21
538	0	0	0	0
539	2	0	0	2
561	0	0	0	0
562	0	0	0	0
611	1	0	0	1
612	1	0	0	1
613	1	1	0	2
614	0	0	0	0
615	0	0	0	0
616	1	0	0	1
621	0	0	0	0
622	0	0	0	0
623	0	0	0	0
626	0	0	0	0

Table A3: Number of directed herring trips separated by gear and statistical area for May-June. Directed herring trips defined as 2,000 lbs of kept Atlantic herring on a trip. Gear categories include bottom otter-trawl (OT), purse seine (PS) and mid-water trawl (PR). Mid-water trawl (PR) refers to pair and single mid-water trawls. Source: Vessel Trip Report Database 2005-2009.

Jul-Aug	Gear Category			
Statistical Area	OT	PR	PS	ALL
464	0	0	0	0
465	0	0	2	2
511	0	8	60	68
512	3	134	360	497
513	184	160	224	568
514	37	17	5	59
515	0	8	15	23
521	0	1	0	1
522	2	71	1	74
525	0	1	0	1
526	0	0	0	0
534	0	0	0	0
537	0	0	0	0
538	0	0	0	0
539	0	0	0	0
561	0	5	0	5
562	0	0	0	0
611	0	0	0	0
612	0	0	0	0
613	0	0	0	0
614	0	0	0	0
615	0	0	0	0
616	0	0	0	0
621	0	0	0	0
622	0	0	0	0
623	0	0	0	0
626	0	0	0	0

Table A4: Number of directed herring trips separated by gear and statistical area for July-August. Directed herring trips defined as 2,000 lbs of kept Atlantic herring on a trip. Gear categories include bottom otter-trawl (OT), purse seine (PS) and mid-water trawl (PR). Mid-water trawl (PR) refers to pair and single mid-water trawls. Source: Vessel Trip Report Database 2005-2009.

Sep-Oct	Gear Category			
Statistical Area	OT	PR	PS	ALL
464	0	0	1	1
465	0	0	0	0
511	0	24	112	136
512	0	31	77	108
513	69	153	120	342
514	72	115	5	192
515	0	5	6	11
521	1	92	0	93
522	1	153	2	156
525	1	6	0	7
526	0	0	0	0
534	0	0	0	0
537	0	1	0	1
538	0	0	0	0
539	0	1	0	1
561	0	1	0	1
562	0	1	0	1
611	0	0	0	0
612	0	0	0	0
613	0	3	0	3
614	0	0	0	0
615	0	0	0	0
616	0	0	0	0
621	0	0	0	0
622	0	0	0	0
623	0	0	0	0
626	0	0	0	0

Table A5: Number of directed herring trips separated by gear and statistical area for September-October. Directed herring trips defined as 2,000 lbs of kept Atlantic herring on a trip. Gear categories include bottom otter-trawl (OT), purse seine (PS) and mid-water trawl (PR). Mid-water trawl (PR) refers to pair and single mid-water trawls. Source: Vessel Trip Report Database 2005-2009.

Nov-Dec	Gear Category			
Statistical Area	OT	PR	PS	ALL
464	0	0	0	0
465	0	1	0	1
511	0	1	0	1
512	0	1	0	1
513	2	35	5	42
514	9	118	6	133
515	0	0	0	0
521	6	120	0	126
522	0	12	0	12
525	0	0	0	0
526	0	1	0	1
534	0	0	0	0
537	2	19	0	21
538	0	0	0	0
539	93	21	0	114
561	0	1	0	1
562	0	0	0	0
611	43	10	0	53
612	2	1	0	3
613	8	3	0	11
614	1	0	0	1
615	0	0	0	0
616	0	0	0	0
621	0	0	0	0
622	0	0	0	0
623	0	0	0	0
626	0	0	0	0

Table A6: Number of directed herring trips separated by gear and statistical area for November-December. Directed herring trips defined as 2,000 lbs of kept Atlantic herring on a trip. Gear categories include bottom otter-trawl (OT), purse seine (PS) and mid-water trawl (PR). Mid-water trawl (PR) refers to pair and single mid-water trawls. Source: Vessel Trip Report Database 2005-2009.

Quarter degree square	Percent occurrence	Count of tows	Mean	Total catch numbers	25th quantile	median	75th quantile	90th quantile	Maximum catch
38753	91.1%	45	22.5	1013	2.0	11.0	23.0	50.4	266
37754	87.5%	24	77.6	1862	1.0	7.0	33.0	129.9	1213
40714	86.8%	114	36.2	4123	2.0	8.0	24.8	58.0	1002
40712	85.6%	90	46.1	4145	3.0	12.0	43.5	112.1	671
40741	84.6%	13	24.4	317	1.0	4.0	32.0	66.8	92
41684	83.6%	61	22.0	1343	3.0	7.0	18.0	60.0	200
41703	83.1%	83	44.1	3662	1.0	11.0	41.5	105.6	685
41712	81.2%	69	36.0	2481	2.0	7.0	15.0	92.6	843
40723	80.9%	251	26.5	6652	1.0	5.0	18.0	64.0	646
40713	80.0%	90	24.3	2185	1.0	7.5	19.5	38.0	408
40721	79.2%	96	51.1	4907	1.0	7.5	37.3	112.5	886
38751	79.1%	86	31.4	2701	1.0	4.0	19.3	52.5	483
42704	79.0%	62	67.0	4157	1.3	14.5	38.8	146.8	1202
44672	78.5%	79	16.5	1306	1.0	3.0	12.0	33.4	261
39743	74.6%	122	19.1	2336	0.3	3.0	7.8	39.9	584
39733	74.0%	73	27.6	2018	0.0	3.0	12.0	77.2	326
40722	73.7%	76	15.0	1139	0.0	3.0	7.3	44.0	185
41711	73.5%	83	26.5	2199	0.0	3.0	11.5	54.8	426
37752	73.1%	171	15.0	2561	0.0	2.0	8.0	26.0	713
38744	72.1%	233	14.5	3367	0.0	2.0	8.0	23.0	852
40711	71.2%	118	28.5	3365	0.0	2.0	14.8	64.3	892
43701	70.2%	94	18.2	1711	0.0	2.0	9.0	50.1	227
39732	70.0%	60	17.6	1057	0.0	2.0	13.3	29.3	366
43683	69.2%	78	16.0	1245	0.0	3.0	10.0	43.3	215
43694	68.8%	16	15.9	254	0.0	4.0	14.0	46.0	105

Table A7: Spring candidate "hot spot" quarter degree squares identified as squares with percent occurrence and mean catch in number ≥ the 75th quantiles of both variables. Source: Spring 1968-2008 NMFS bottom-trawl surveys.

Quarter degree square	Percent occurrence	Count of tows	Mean	Total catch numbers	25th quantile	median	75th quantile	90th quantile	Maximum catch
38753	91.1%	45	22.5	1013	2.0	11.0	23.0	50.4	266
37754	87.5%	24	77.6	1862	1.0	7.0	33.0	129.9	1213
40714	86.8%	114	36.2	4123	2.0	8.0	24.8	58.0	1002
40712	85.6%	90	46.1	4145	3.0	12.0	43.5	112.1	671
40741	84.6%	13	24.4	317	1.0	4.0	32.0	66.8	92
44671	84.4%	64	5.5	352	1.0	3.0	8.3	15.7	29
41684	83.6%	61	22.0	1343	3.0	7.0	18.0	60.0	200
41703	83.1%	83	44.1	3662	1.0	11.0	41.5	105.6	685
40704	81.5%	65	13.1	851	1.0	4.0	12.0	20.0	264
41712	81.2%	69	36.0	2481	2.0	7.0	15.0	92.6	843
40723	80.9%	251	26.5	6652	1.0	5.0	18.0	64.0	646
40713	80.0%	90	24.3	2185	1.0	7.5	19.5	38.0	408
41702	79.2%	53	11.4	603	1.0	2.0	10.0	29.8	139
42674	79.2%	53	3.0	157	1.0	2.0	4.0	7.8	12
42683	79.2%	53	5.2	277	1.0	3.0	8.0	11.8	37
40721	79.2%	96	51.1	4907	1.0	7.5	37.3	112.5	886
38751	79.1%	86	31.4	2701	1.0	4.0	19.3	52.5	483
42704	79.0%	62	67.0	4157	1.3	14.5	38.8	146.8	1202
44672	78.5%	79	16.5	1306	1.0	3.0	12.0	33.4	261
39743	74.6%	122	19.1	2336	0.3	3.0	7.8	39.9	584
42672	74.5%	94	7.6	718	0.3	3.0	9.0	21.4	73
42681	74.1%	58	12.6	733	0.3	4.0	11.8	25.9	150
39733	74.0%	73	27.6	2018	0.0	3.0	12.0	77.2	326
40722	73.7%	76	15.0	1139	0.0	3.0	7.3	44.0	185
41711	73.5%	83	26.5	2199	0.0	3.0	11.5	54.8	426
44681	73.3%	15	11.4	171	1.0	5.0	8.0	24.6	84
37752	73.1%	171	15.0	2561	0.0	2.0	8.0	26.0	713
38744	72.1%	233	14.5	3367	0.0	2.0	8.0	23.0	852
43674	72.1%	43	12.0	516	0.0	2.0	8.5	27.8	157
40711	71.2%	118	28.5	3365	0.0	2.0	14.8	64.3	892
41693	70.7%	82	11.0	906	0.0	4.0	12.0	29.8	131
43701	70.2%	94	18.2	1711	0.0	2.0	9.0	50.1	227
42684	70.1%	77	8.9	683	0.0	3.0	11.0	24.8	66
39732	70.0%	60	17.6	1057	0.0	2.0	13.3	29.3	366
43683	69.2%	78	16.0	1245	0.0	3.0	10.0	43.3	215
41701	69.0%	42	6.0	252	0.0	2.0	4.0	20.5	44
43694	68.8%	16	15.9	254	0.0	4.0	14.0	46.0	105

Table A8: Spring candidate "hot spot" quarter degree squares identified as squares with percent occurrence and median catch in number ≥ the 75th quantiles of both variables. Source: Spring 1968-2008 NMFS bottom-trawl surveys.

Quarter degree square	Percent occurrence	Count of tows	Mean	Total catch numbers	25th quantile	median	75th quantile	90th quantile	Maximum catch
38753	91.1%	45	22.5	1013	2.0	11.0	23.0	50.4	266
37754	87.5%	24	77.6	1862	1.0	7.0	33.0	129.9	1213
40714	86.8%	114	36.2	4123	2.0	8.0	24.8	58.0	1002
40712	85.6%	90	46.1	4145	3.0	12.0	43.5	112.1	671
40741	84.6%	13	24.4	317	1.0	4.0	32.0	66.8	92
41684	83.6%	61	22.0	1343	3.0	7.0	18.0	60.0	200
41703	83.1%	83	44.1	3662	1.0	11.0	41.5	105.6	685
40704	81.5%	65	13.1	851	1.0	4.0	12.0	20.0	264
41712	81.2%	69	36.0	2481	2.0	7.0	15.0	92.6	843
40723	80.9%	251	26.5	6652	1.0	5.0	18.0	64.0	646
40713	80.0%	90	24.3	2185	1.0	7.5	19.5	38.0	408
41702	79.2%	53	11.4	603	1.0	2.0	10.0	29.8	139
40721	79.2%	96	51.1	4907	1.0	7.5	37.3	112.5	886
38751	79.1%	86	31.4	2701	1.0	4.0	19.3	52.5	483
42704	79.0%	62	67.0	4157	1.3	14.5	38.8	146.8	1202
44672	78.5%	79	16.5	1306	1.0	3.0	12.0	33.4	261
42672	74.5%	94	7.6	718	0.3	3.0	9.0	21.4	73
42681	74.1%	58	12.6	733	0.3	4.0	11.8	25.9	150
39733	74.0%	73	27.6	2018	0.0	3.0	12.0	77.2	326
41711	73.5%	83	26.5	2199	0.0	3.0	11.5	54.8	426
40711	71.2%	118	28.5	3365	0.0	2.0	14.8	64.3	892
41693	70.7%	82	11.0	906	0.0	4.0	12.0	29.8	131
43701	70.2%	94	18.2	1711	0.0	2.0	9.0	50.1	227
42684	70.1%	77	8.9	683	0.0	3.0	11.0	24.8	66
39732	70.0%	60	17.6	1057	0.0	2.0	13.3	29.3	366
43683	69.2%	78	16.0	1245	0.0	3.0	10.0	43.3	215
43694	68.8%	16	15.9	254	0.0	4.0	14.0	46.0	105

Table A9: Spring candidate "hot spot" quarter degree squares identified as squares with percent occurrence and catch in number ≥ the 75th quantiles of both variables. Source: Spring 1968-2008 NMFS bottom-trawl surveys.

Quarter degree square	Percent occurrence	Count of tows	Mean	Total catch numbers	25th quantile	median	75th quantile	90th quantile	Maximum catch
44672	65.0%	20	15.0	299	0.0	3.0	14.5	45.7	81
44681	60.0%	15	8.3	124	0.0	3.0	7.0	23.2	58
40703	53.8%	26	26.0	676	0.0	1.0	3.0	29.5	520
43693	50.0%	14	72.2	1011	0.0	1.0	46.5	199.1	610
41682	38.2%	34	5.2	178	0.0	0.0	3.0	15.4	65
41672	34.4%	32	36.7	1175	0.0	0.0	25.3	123.2	298
40704	33.3%	15	5.2	78	0.0	0.0	4.0	18.4	37
41711	33.3%	12	21.4	257	0.0	0.0	4.3	17.6	224
40694	28.6%	28	111.6	3124	0.0	0.0	1.8	77.7	2431
41683	25.8%	31	6.1	190	0.0	0.0	0.5	6.0	62
41664	25.0%	20	7.9	157	0.0	0.0	2.0	19.8	86
41671	25.0%	24	9.3	223	0.0	0.0	0.5	8.7	181
41681	24.1%	29	22.4	650	0.0	0.0	0.0	86.6	178

Table A10: Summer candidate "hot spot" quarter degree squares identified as squares with percent occurrence and mean catch in number ≥ the 75th quantiles of both variables. Source: Summer 1948-1995 NMFS bottom-trawl surveys.

Quarter degree square	Percent occurrence	Count of tows	Mean	Total catch numbers	25th quantile	median	75th quantile	90th quantile	Maximum catch
44672	65.0%	20	15.0	299	0.0	3.0	14.5	45.7	81
44681	60.0%	15	8.3	124	0.0	3.0	7.0	23.2	58
40703	53.8%	26	26.0	676	0.0	1.0	3.0	29.5	520
43693	50.0%	14	72.2	1011	0.0	1.0	46.5	199.1	610
42704	46.2%	26	3.7	97	0.0	0.0	4.0	10.0	37
43684	38.5%	26	3.5	90	0.0	0.0	2.8	6.0	54
41682	38.2%	34	5.2	178	0.0	0.0	3.0	15.4	65
41672	34.4%	32	36.7	1175	0.0	0.0	25.3	123.2	298
43701	34.1%	41	2.0	84	0.0	0.0	2.0	5.0	30
40704	33.3%	15	5.2	78	0.0	0.0	4.0	18.4	37
41711	33.3%	12	21.4	257	0.0	0.0	4.3	17.6	224
41712	29.4%	17	1.1	18	0.0	0.0	1.0	3.4	8
40694	28.6%	28	111.6	3124	0.0	0.0	1.8	77.7	2431
41683	25.8%	31	6.1	190	0.0	0.0	0.5	6.0	62
41664	25.0%	20	7.9	157	0.0	0.0	2.0	19.8	86
41671	25.0%	24	9.3	223	0.0	0.0	0.5	8.7	181
41681	24.1%	29	22.4	650	0.0	0.0	0.0	86.6	178
42701	24.1%	58	3.0	176	0.0	0.0	0.0	6.0	99

Table A11: Summer candidate "hot spot" quarter degree squares identified as squares with percent occurrence and median catch in number ≥ the 75th quantiles of both variables. Source: Summer 1948-1995 NMFS bottom-trawl surveys.

Quarter degree square	Percent occurrence	Count of tows	Mean	Total catch numbers	25th quantile	median	75th quantile	90th quantile	Maximum catch
44672	65.0%	20	15.0	299	0.0	3.0	14.5	45.7	81
44681	60.0%	15	8.3	124	0.0	3.0	7.0	23.2	58
40703	53.8%	26	26.0	676	0.0	1.0	3.0	29.5	520
43693	50.0%	14	72.2	1011	0.0	1.0	46.5	199.1	610
42704	46.2%	26	3.7	97	0.0	0.0	4.0	10.0	37
43684	38.5%	26	3.5	90	0.0	0.0	2.8	6.0	54
41682	38.2%	34	5.2	178	0.0	0.0	3.0	15.4	65
41672	34.4%	32	36.7	1175	0.0	0.0	25.3	123.2	298
43701	34.1%	41	2.0	84	0.0	0.0	2.0	5.0	30
40704	33.3%	15	5.2	78	0.0	0.0	4.0	18.4	37
41711	33.3%	12	21.4	257	0.0	0.0	4.3	17.6	224
41712	29.4%	17	1.1	18	0.0	0.0	1.0	3.4	8
40694	28.6%	28	111.6	3124	0.0	0.0	1.8	77.7	2431
41683	25.8%	31	6.1	190	0.0	0.0	0.5	6.0	62
41664	25.0%	20	7.9	157	0.0	0.0	2.0	19.8	86
41671	25.0%	24	9.3	223	0.0	0.0	0.5	8.7	181
41681	24.1%	29	22.4	650	0.0	0.0	0.0	86.6	178
42701	24.1%	58	3.0	176	0.0	0.0	0.0	6.0	99

Table A12: Summer candidate "hot spot" quarter degree squares identified as squares with percent occurrence and catch in number ≥ the 75th quantiles of both variables. Source: Summer 1948-1995 NMFS bottom-trawl surveys.

Quarter degree square	Percent occurrence	Count of tows	Mean	Total catch numbers	25th quantile	median	75th quantile	90th quantile	Maximum catch
44681	90.9%	22	21.0	462	2.0	5.0	30.3	74.7	110
41703	68.4%	76	49.0	3727	0.0	2.0	25.0	158.0	787
42704	67.7%	62	82.9	5139	0.0	3.0	35.3	84.6	1865
44672	64.9%	74	27.0	1999	0.0	2.0	14.3	59.3	533
43694	59.1%	22	5.8	128	0.0	2.0	5.8	13.4	38
42702	58.8%	51	45.7	2330	0.0	1.0	20.0	145.0	449
43684	55.0%	60	12.5	752	0.0	1.0	7.5	31.1	167
43693	50.0%	38	5.7	218	0.0	0.5	6.3	19.0	73
43683	48.4%	95	7.0	669	0.0	0.0	4.0	12.6	320
43643	47.4%	19	1.9	37	0.0	0.0	3.5	5.6	8
42701	43.3%	180	13.3	2401	0.0	0.0	3.0	11.3	452
43701	40.2%	107	4.0	427	0.0	0.0	3.0	11.4	80
44662	39.2%	79	2.8	223	0.0	0.0	3.0	6.2	58
43664	39.1%	110	4.4	483	0.0	0.0	4.0	14.1	62
43673	33.8%	80	4.4	348	0.0	0.0	1.0	3.1	227
44671	33.3%	81	2.7	216	0.0	0.0	1.0	6.0	53
43681	32.7%	55	2.2	120	0.0	0.0	1.0	4.8	36
43674	28.3%	60	1.8	107	0.0	0.0	1.0	3.0	57
42703	26.5%	132	2.3	306	0.0	0.0	1.0	3.0	93
41711	23.9%	71	14.4	1020	0.0	0.0	0.0	14.0	646

Table A13: Fall candidate "hot spot" quarter degree squares identified as squares with percent occurrence and mean catch in number ≥ the 75th quantiles of both variables. Source: Fall 1963-2008 NMFS bottom-trawl surveys.

Quarter degree square	Percent occurrence	Count of tows	Mean	Total catch numbers	25th quantile	median	75th quantile	90th quantile	Maximum catch
44681	90.9%	22	21.0	462	2.0	5.0	30.3	74.7	110
41703	68.4%	76	49.0	3727	0.0	2.0	25.0	158.0	787
42704	67.7%	62	82.9	5139	0.0	3.0	35.3	84.6	1865
44672	64.9%	74	27.0	1999	0.0	2.0	14.3	59.3	533
43694	59.1%	22	5.8	128	0.0	2.0	5.8	13.4	38
42702	58.8%	51	45.7	2330	0.0	1.0	20.0	145.0	449
43684	55.0%	60	12.5	752	0.0	1.0	7.5	31.1	167
43693	50.0%	38	5.7	218	0.0	0.5	6.3	19.0	73
43683	48.4%	95	7.0	669	0.0	0.0	4.0	12.6	320
43643	47.4%	19	1.9	37	0.0	0.0	3.5	5.6	8
42701	43.3%	180	13.3	2401	0.0	0.0	3.0	11.3	452
43701	40.2%	107	4.0	427	0.0	0.0	3.0	11.4	80
44662	39.2%	79	2.8	223	0.0	0.0	3.0	6.2	58
43664	39.1%	110	4.4	483	0.0	0.0	4.0	14.1	62
43673	33.8%	80	4.4	348	0.0	0.0	1.0	3.1	227
44671	33.3%	81	2.7	216	0.0	0.0	1.0	6.0	53
43681	32.7%	55	2.2	120	0.0	0.0	1.0	4.8	36
43674	28.3%	60	1.8	107	0.0	0.0	1.0	3.0	57
43662	28.2%	71	1.2	87	0.0	0.0	1.0	2.0	25
43671	28.1%	57	0.8	46	0.0	0.0	1.0	3.4	9
44663	27.3%	11	0.5	6	0.0	0.0	0.5	2.0	3
42703	26.5%	132	2.3	306	0.0	0.0	1.0	3.0	93
41711	23.9%	71	14.4	1020	0.0	0.0	0.0	14.0	646
43691	23.5%	81	1.3	108	0.0	0.0	0.0	2.0	37
42693	23.3%	90	1.0	88	0.0	0.0	0.0	3.1	17
43682	22.1%	95	1.3	124	0.0	0.0	0.0	4.0	18
42694	21.7%	92	1.0	88	0.0	0.0	0.0	2.0	23
43661	21.1%	19	0.7	14	0.0	0.0	0.0	2.0	9
40704	19.8%	81	1.1	93	0.0	0.0	0.0	2.0	31

Table A14: Fall candidate "hot spot" quarter degree squares identified as squares with percent occurrence and median catch in number ≥ the 75th quantiles of both variables. Source: Fall 1963-2008 NMFS bottom-trawl surveys.

Quarter degree square	Percent occurrence	Count of tows	Mean	Total catch numbers	25th quantile	median	75th quantile	90th quantile	Maximum catch
44681	90.9%	22	21.0	462	2.0	5.0	30.3	74.7	110
41703	68.4%	76	49.0	3727	0.0	2.0	25.0	158.0	787
42704	67.7%	62	82.9	5139	0.0	3.0	35.3	84.6	1865
44672	64.9%	74	27.0	1999	0.0	2.0	14.3	59.3	533
43694	59.1%	22	5.8	128	0.0	2.0	5.8	13.4	38
42702	58.8%	51	45.7	2330	0.0	1.0	20.0	145.0	449
43684	55.0%	60	12.5	752	0.0	1.0	7.5	31.1	167
43693	50.0%	38	5.7	218	0.0	0.5	6.3	19.0	73
43683	48.4%	95	7.0	669	0.0	0.0	4.0	12.6	320
43643	47.4%	19	1.9	37	0.0	0.0	3.5	5.6	8
42701	43.3%	180	13.3	2401	0.0	0.0	3.0	11.3	452
43701	40.2%	107	4.0	427	0.0	0.0	3.0	11.4	80
44662	39.2%	79	2.8	223	0.0	0.0	3.0	6.2	58
43664	39.1%	110	4.4	483	0.0	0.0	4.0	14.1	62
43673	33.8%	80	4.4	348	0.0	0.0	1.0	3.1	227
44671	33.3%	81	2.7	216	0.0	0.0	1.0	6.0	53
43681	32.7%	55	2.2	120	0.0	0.0	1.0	4.8	36
43674	28.3%	60	1.8	107	0.0	0.0	1.0	3.0	57
43662	28.2%	71	1.2	87	0.0	0.0	1.0	2.0	25
43671	28.1%	57	0.8	46	0.0	0.0	1.0	3.4	9
44663	27.3%	11	0.5	6	0.0	0.0	0.5	2.0	3
42703	26.5%	132	2.3	306	0.0	0.0	1.0	3.0	93
41711	23.9%	71	14.4	1020	0.0	0.0	0.0	14.0	646
43691	23.5%	81	1.3	108	0.0	0.0	0.0	2.0	37
42693	23.3%	90	1.0	88	0.0	0.0	0.0	3.1	17
43682	22.1%	95	1.3	124	0.0	0.0	0.0	4.0	18
42694	21.7%	92	1.0	88	0.0	0.0	0.0	2.0	23
43661	21.1%	19	0.7	14	0.0	0.0	0.0	2.0	9
40704	19.8%	81	1.1	93	0.0	0.0	0.0	2.0	31

Table A15: Fall candidate "hot spot" quarter degree squares identified as squares with percent occurrence and catch in number ≥ the 75th quantiles of both variables. Source: Fall 1963-2008 NMFS bottom-trawl surveys.

Quarter degree square	Percent occurrence	Count of tows	Mean	Total catch numbers	25th quantile	median	75th quantile	90th quantile	Maximum catch
40713	91.3%	46	29.9	1376	2.3	6.0	28.0	49.5	326
39741	90.9%	22	23.4	515	2.5	7.0	22.3	45.6	197
40721	87.9%	33	13.1	431	3.0	7.0	15.0	32.8	58
38744	82.6%	23	30.0	690	2.0	5.0	23.5	74.8	261
40714	80.9%	47	29.0	1362	1.0	8.0	29.0	93.0	274
40732	79.2%	24	10.7	257	1.0	2.0	6.3	17.5	115
40722	77.8%	27	15.3	413	1.0	3.0	9.5	54.2	99
39734	77.4%	31	13.6	422	1.0	4.0	18.5	46.0	71
40704	71.4%	35	11.0	385	0.0	2.0	9.5	18.6	187
40724	69.6%	23	9.9	227	0.0	3.0	7.5	25.0	67
39733	69.2%	39	14.1	550	0.0	3.0	23.0	32.8	139
40712	69.0%	42	20.6	864	0.0	3.0	19.8	42.0	239

Table A16: Winter candidate "hot spot" quarter degree squares identified as squares with percent occurrence and mean catch in number ≥ the 75th quantiles of both variables. Source: Winter 1964-2007 NMFS bottom-trawl surveys.

Quarter degree square	Percent occurrence	Count of tows	Mean	Total catch numbers	25th quantile	median	75th quantile	90th quantile	Maximum catch
40713	91.3%	46	29.9	1376	2.3	6.0	28.0	49.5	326
39741	90.9%	22	23.4	515	2.5	7.0	22.3	45.6	197
40721	87.9%	33	13.1	431	3.0	7.0	15.0	32.8	58
38744	82.6%	23	30.0	690	2.0	5.0	23.5	74.8	261
40714	80.9%	47	29.0	1362	1.0	8.0	29.0	93.0	274
37753	80.0%	20	7.6	152	1.0	3.5	12.5	15.3	39
40732	79.2%	24	10.7	257	1.0	2.0	6.3	17.5	115
40722	77.8%	27	15.3	413	1.0	3.0	9.5	54.2	99
39734	77.4%	31	13.6	422	1.0	4.0	18.5	46.0	71
40723	75.0%	52	7.9	410	0.8	3.0	9.5	19.9	95
40704	71.4%	35	11.0	385	0.0	2.0	9.5	18.6	187
40724	69.6%	23	9.9	227	0.0	3.0	7.5	25.0	67
39733	69.2%	39	14.1	550	0.0	3.0	23.0	32.8	139
40712	69.0%	42	20.6	864	0.0	3.0	19.8	42.0	239
40703	66.7%	39	9.3	362	0.0	2.0	4.0	25.6	79
40733	66.7%	12	3.8	45	0.0	2.5	5.0	5.9	20

Table A17: Winter candidate "hot spot" quarter degree squares identified as squares with percent occurrence and median catch in number ≥ the 75th quantiles of both variables. Source: Winter 1964-2007 NMFS bottom-trawl surveys.

Quarter degree square	Percent occurrence	Count of tows	Mean	Total catch numbers	25th quantile	median	75th quantile	90th quantile	Maximum catch
40713	91.3%	46	29.9	1376	2.3	6.0	28.0	49.5	326
39741	90.9%	22	23.4	515	2.5	7.0	22.3	45.6	197
40721	87.9%	33	13.1	431	3.0	7.0	15.0	32.8	58
38744	82.6%	23	30.0	690	2.0	5.0	23.5	74.8	261
40714	80.9%	47	29.0	1362	1.0	8.0	29.0	93.0	274
37753	80.0%	20	7.6	152	1.0	3.5	12.5	15.3	39
40722	77.8%	27	15.3	413	1.0	3.0	9.5	54.2	99
39734	77.4%	31	13.6	422	1.0	4.0	18.5	46.0	71
40723	75.0%	52	7.9	410	0.8	3.0	9.5	19.9	95
40704	71.4%	35	11.0	385	0.0	2.0	9.5	18.6	187
40724	69.6%	23	9.9	227	0.0	3.0	7.5	25.0	67
40711	69.4%	49	9.1	444	0.0	1.0	7.0	20.4	180
39733	69.2%	39	14.1	550	0.0	3.0	23.0	32.8	139
40712	69.0%	42	20.6	864	0.0	3.0	19.8	42.0	239

Table A18: Winter candidate "hot spot" quarter degree squares identified as squares with percent occurrence and catch in number ≥ the 75th quantiles of both variables. Source: Winter 1964-2007 NMFS bottom-trawl surveys.

Table A19: Migration patterns of alewife, blueback, and American shad in state fresh waters (following three pages). Note that New Jersey is currently a place holder and will be updated. "SA" indicates some activity and "PA" indicates peak activity. ASMFC Shad and River herring Technical Committee 2010.

ALEWIFE

SA: Some Activity; PA: Peak Activity

		January		February		March		April		May		June		July		August		September		October		November		December	
		1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30
Maine	adult immigration					SA	SA	SA	PA	PA	PA	PA	SA												
	adult emmigration										SA	SA	PA	PA	SA	SA	SA	SA	SA	SA	SA	SA			
	spawning								SA	SA	PA	PA	PA	SA											
	incubation								SA	SA	PA	PA	PA	SA											
	juvenile freshwater residence								SA	SA	PA	PA	PA	PA	PA	PA	PA	PA	PA	PA	PA	SA	SA		
	juvenile emigration													SA	SA	PA	PA	PA	PA	PA	PA	SA	SA	SA	
New Hampshire	adult immigration									SA	PA	PA	SA	SA											
	adult emmigration										SA	PA	PA	SA											
	spawning									SA	PA	PA	PA	SA											
	incubation										SA	PA	PA	SA											
	juvenile freshwater residence										SA	PA	PA	PA	PA	PA	SA	SA	SA	SA	SA				
	juvenile emigration															SA	SA	SA	SA	SA	SA				
Massachusetts	adult immigration					SA	SA	PA	PA	PA	SA														
	adult emigration								SA	SA	PA	PA	SA	SA											
	spawning						SA	SA	PA	PA	SA	SA													
	incubation							SA	PA	PA	PA	SA													
	juvenile freshwater residence							SA	SA	PA	PA	PA	PA	PA	PA	PA	SA	SA	SA	SA	SA	SA	SA		
	juvenile emigration												SA	PA	PA	SA	SA	PA	PA	PA	PA	SA	SA	SA	
Rhode Island	adult immigration					SA	SA	PA	PA	PA	SA														
	adult emmigration							SA	PA	PA	SA	SA	SA												
	spawning						SA	PA	PA	PA	SA														
	incubation						SA	PA	PA	PA	PA	SA													
	juvenile freshwater residence								SA	PA	PA	PA	PA	PA	PA	PA	PA	PA	PA	SA	SA	SA	SA		
	juvenile emigration											SA	SA	SA	SA	SA	SA	SA	PA	PA	PA	SA	SA		
Connecticut	adult immigration			SA	SA	PA	PA	PA	PA	SA															
	adult emmigration			SA	SA	SA	SA	PA	PA	SA															
	spawning			SA	SA	SA	SA	SA	SA	SA															
	incubation					SA	PA																		
	juvenile freshwater residence							SA	SA	PA	PA	SA	SA	SA	SA	SA	SA	SA	SA	SA					
	juvenile emigration									SA	PA	PA	SA	SA	SA	SA	SA	SA	SA	SA					
New York	adult immigration						SA	PA	PA	PA	SA														
	adult emmigration							SA	SA	PA	SA	SA													
	spawning							SA	PA	PA	PA	SA													
	incubation							SA	PA	PA	PA	SA													
	juvenile freshwater residence							SA	SA	PA	PA	PA	PA	PA	PA	PA	SA	SA	SA						
	juvenile emigration													SA	SA	SA	SA	SA	SA	SA	SA				
New Jersey	adult immigration																								
	adult emmigration																								
	spawning																								
	incubation																								
	juvenile freshwater residence																								
	juvenile emigration																								

BLUEBACK HERRING

SA: Some Activity; PA: Peak Activity

		January		February		March		April		May		June		July		August		September		October		November		December	
		1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30
Maine	adult immigration							SA	SA	SA	SA	PA	PA	PA	SA										
	adult emmigration											SA	SA	PA	PA	PA	SA								
	spawning									SA	PA	PA	PA	SA											
	incubation										SA	PA	PA	SA											
	juvenile freshwater residence										SA	PA	PA	PA	PA	PA	PA	PA	PA	PA	PA	SA			
	juvenile emigration													SA	SA	PA	PA	PA	PA	PA	PA	SA	SA		
New Hampshire	adult immigration								SA	PA	PA	SA													
	adult emmigration									SA	PA	PA	SA	SA											
	spawning									PA	PA	SA													
	incubation									SA	PA	PA	SA												
	juvenile freshwater residence										SA	PA	PA	PA	PA	PA	SA	SA	SA	SA	SA				
	juvenile emigration													SA	SA	SA	SA	SA	SA	SA	SA				
Massachusetts	adult immigration								SA	SA	PA	PA	SA	SA											
	adult emigration										SA	PA	PA	SA	SA										
	spawning									SA	PA	PA	SA	SA											
	incubation									SA	SA	PA	PA	PA	SA										
	juvenile freshwater residence									SA	PA	PA	PA	PA	PA	PA	SA	SA	SA	SA	SA	SA			
	juvenile emigration													SA	SA	SA	PA	PA	PA	SA	SA	SA	SA		
Rhode Island	adult immigration							SA	PA	PA															
	adult emmigration																								
	spawning																								
	incubation																								
	juvenile freshwater residence																								
	juvenile emigration																								
Connecticut	adult immigration							SA	SA	PA	PA	SA	SA												
	adult emmigration										SA	SA	PA	PA	SA										
	spawning									SA	PA	PA	SA												
	incubation									SA	PA	PA	SA	SA											
	juvenile freshwater residence											SA	SA	PA	PA	PA	PA	PA	PA	SA	SA	SA			
	juvenile emigration													SA	SA	PA	PA	PA	PA	PA	SA	SA			
New York	adult immigration							SA	PA	PA	SA	SA													
	adult emmigration								SA	PA	SA	SA	SA												
	spawning							SA	PA	PA	PA	SA	SA												
	incubation							SA	PA	PA	PA	SA	SA												
	juvenile freshwater residence							SA	SA	PA	PA	PA	PA	PA	PA	PA	SA	SA	SA						
	juvenile emigration													SA	SA	SA	SA	SA	SA	SA	SA				
New Jersey	adult immigration																								
	adult emmigration																								
	spawning																								
	incubation																								
	juvenile freshwater residence																								
	juvenile emigration																								

AMERICAN SHAD

SA: Some Activity; PA: Peak Activity

		January		February		March		April		May		June		July		August		September		October		November		December	
		1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30
Maine	adult immigration						SA	SA	SA	PA	PA	PA	PA	PA	PA	SA									
	adult emmigration												SA	SA	PA	PA	SA								
	spawning										SA	SA	PA	PA	PA	SA									
	incubation										SA	SA	PA	PA	PA	SA									
	juvenile freshwater residence											SA	PA	PA	PA	PA	PA	PA	PA	PA	SA	SA			
	juvenile emigration													SA	SA	SA	PA	PA	PA	PA	SA	SA			
New Hampshire	adult immigration									SA	PA	PA	SA												
	adult emmigration																								
	spawning																								
	incubation																								
	juvenile freshwater residence											PA	PA	PA	PA	SA	SA	SA	SA	SA	SA				
	juvenile emigration															SA	SA	SA	SA	SA	SA				
Massachusetts	adult immigration								SA	SA	PA	PA	PA	SA	SA										
	adult emmigration									SA	PA	PA	PA	SA	SA										
	spawning									SA	PA	PA	PA	SA	SA										
	incubation									SA	SA	PA	PA	PA	SA										
	juvenile freshwater residence										SA	PA	PA	PA	PA	PA	PA	SA	SA	SA					
	juvenile emigration													SA	SA	SA	PA	PA	SA	SA	SA				
Rhode Island	adult immigration							SA	SA	PA	PA	PA	SA												
	adult emmigration									SA	SA	PA	PA	SA	SA										
	spawning									SA	SA	PA	PA	PA	SA										
	incubation									SA	SA	PA	PA	PA	SA										
	juvenile freshwater residence										SA	SA	SA	PA	PA	PA	PA	PA	PA	SA	SA	SA	SA		
	juvenile emigration													SA	SA	SA	SA	SA	PA	PA	PA	SA	SA		
Connecticut	adult immigration							SA	SA	PA	PA	SA	SA												
	adult emmigration										SA	SA	PA	PA	SA										
	spawning									SA	PA	PA	SA												
	incubation									SA	PA	PA	SA	SA											
	juvenile freshwater residence											SA	SA	PA	PA	PA	PA	PA	PA	SA	SA	SA			
	juvenile emigration													SA	SA	SA	SA	PA	PA	PA	SA	SA			
New York	adult immigration							SA	PA	PA	SA	SA													
	adult emmigration								SA	PA	PA	SA													
	spawning								SA	PA	PA	SA													
	incubation								SA	PA	PA	SA													
	juvenile freshwater residence										PA	PA	PA	PA	PA	PA	SA	SA	SA	SA					
	juvenile emigration													SA	SA	SA	SA	SA	SA	SA	SA				
New Jersey	adult immigration																								
	adult emmigration																								
	spawning																								
	incubation																								
	juvenile freshwater residence																								
	juvenile emigration																								

Figures

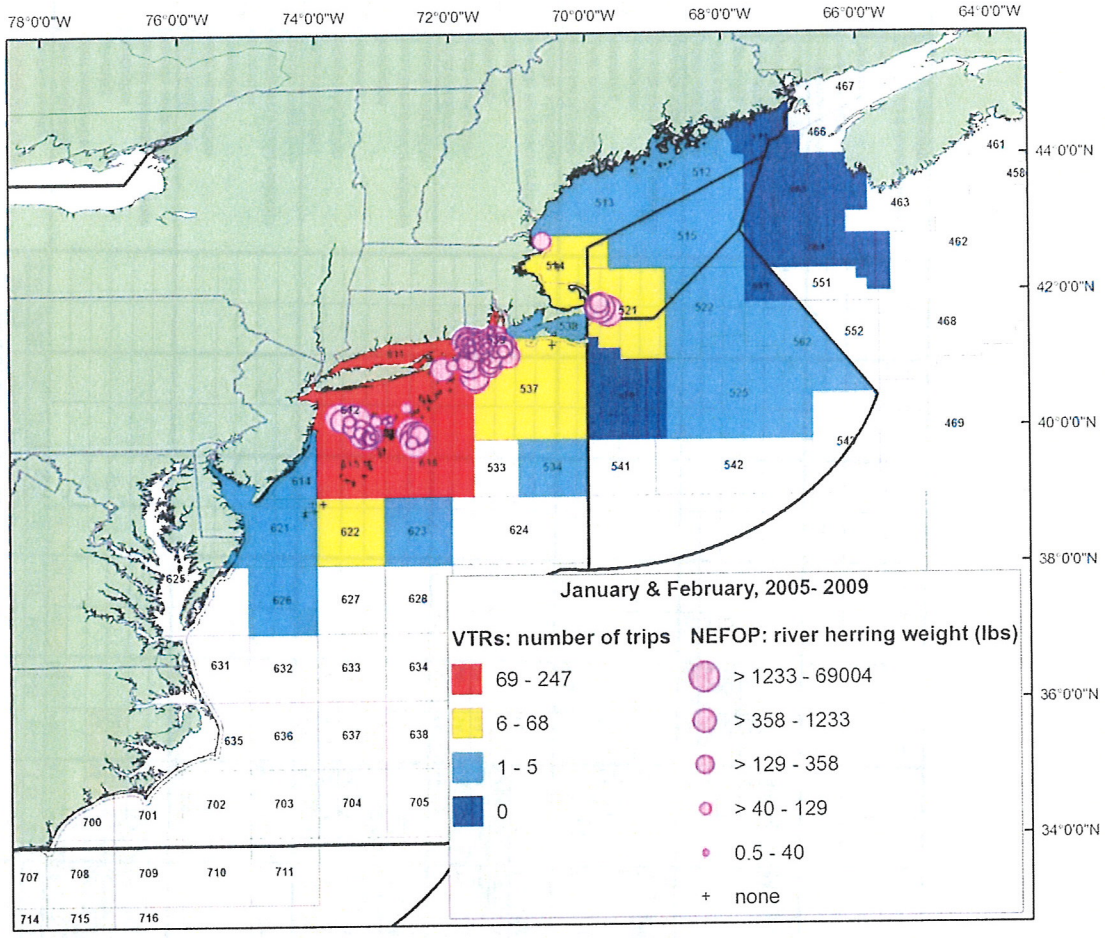


Figure A1: Reported trips (VTR) and observed hauls and sets (NEFOP) during January and February, 2005-2009 for directed herring trips by bottom otter-trawls, purse seines, and mid-water trawls (single and paired). Trips by statistical area are grouped from 69-247 (red), 6-68 (yellow), 1-5 (aqua), and 0 (dark blue) trips. Scaled pink circles represent river herring bycatch (lbs) in observed hauls and sets for directed herring trips. A "+" signifies that an observed haul or set did not catch river herring. Directed herring trips are defined as 2,000 lbs of kept Atlantic herring on a trip. Sources: VTR Database 2005-2009 and NEFOP Database 2005-2009.

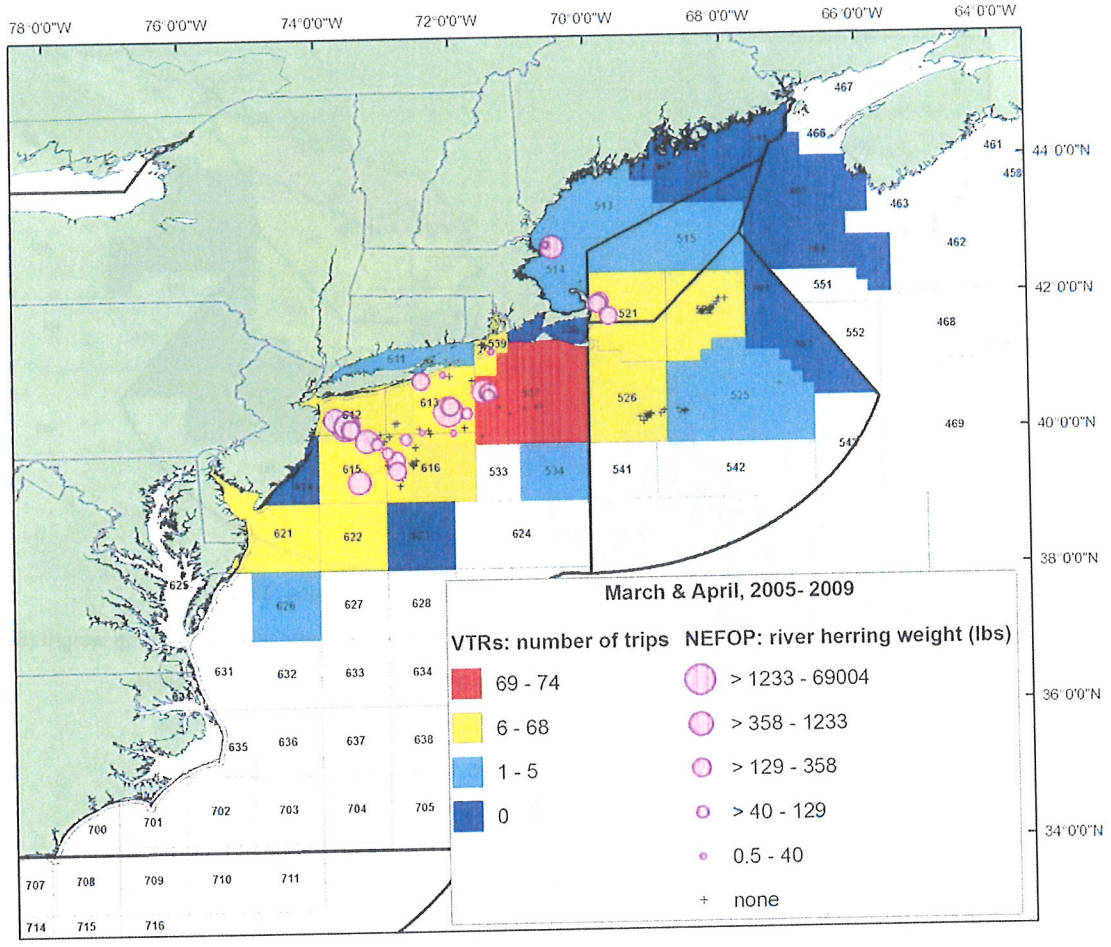


Figure A2: Reported trips (VTR) and observed hauls and sets (NEFOP) during March and April, 2005-2009 for directed herring trips by bottom otter-trawls, purse seines, and mid-water trawls (single and paired). Trips by statistical area are grouped from 69-74 (red), 6-68 (yellow), 1-5 (aqua), and 0 (dark blue) trips. Scaled pink circles represent river herring bycatch (lbs) in observed hauls and sets for directed herring trips. A "+" signifies that an observed haul or set did not catch river herring. Directed herring trips are defined as 2,000 lbs of kept Atlantic herring on a trip. Sources: VTR Database 2005-2009 and NEFOP Database 2005-2009.

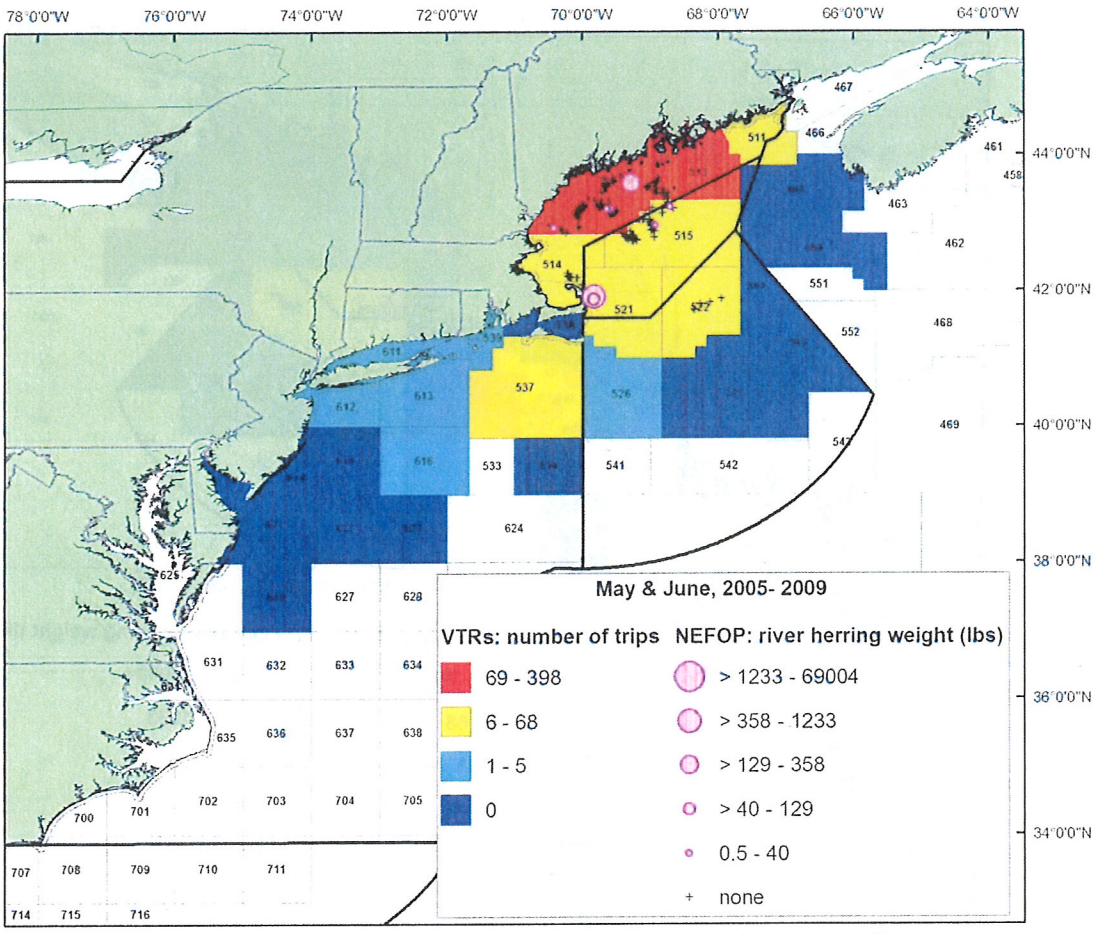


Figure A3: Reported trips (VTR) and observed hauls and sets (NEFOP) during May and June, 2005-2009 for directed herring trips by bottom otter-trawls, purse seines, and mid-water trawls (single and paired). Trips by statistical area are grouped from 69-398 (red), 6-68 (yellow), 1-5 (aqua), and 0 (dark blue) trips. Scaled pink circles represent river herring bycatch (lbs) in observed hauls and sets for directed herring trips. A "+" signifies that an observed haul or set did not catch river herring. Directed herring trips are defined as 2,000 lbs of kept Atlantic herring on a trip. Sources: VTR Database 2005-2009 and NEFOP Database 2005-2009.

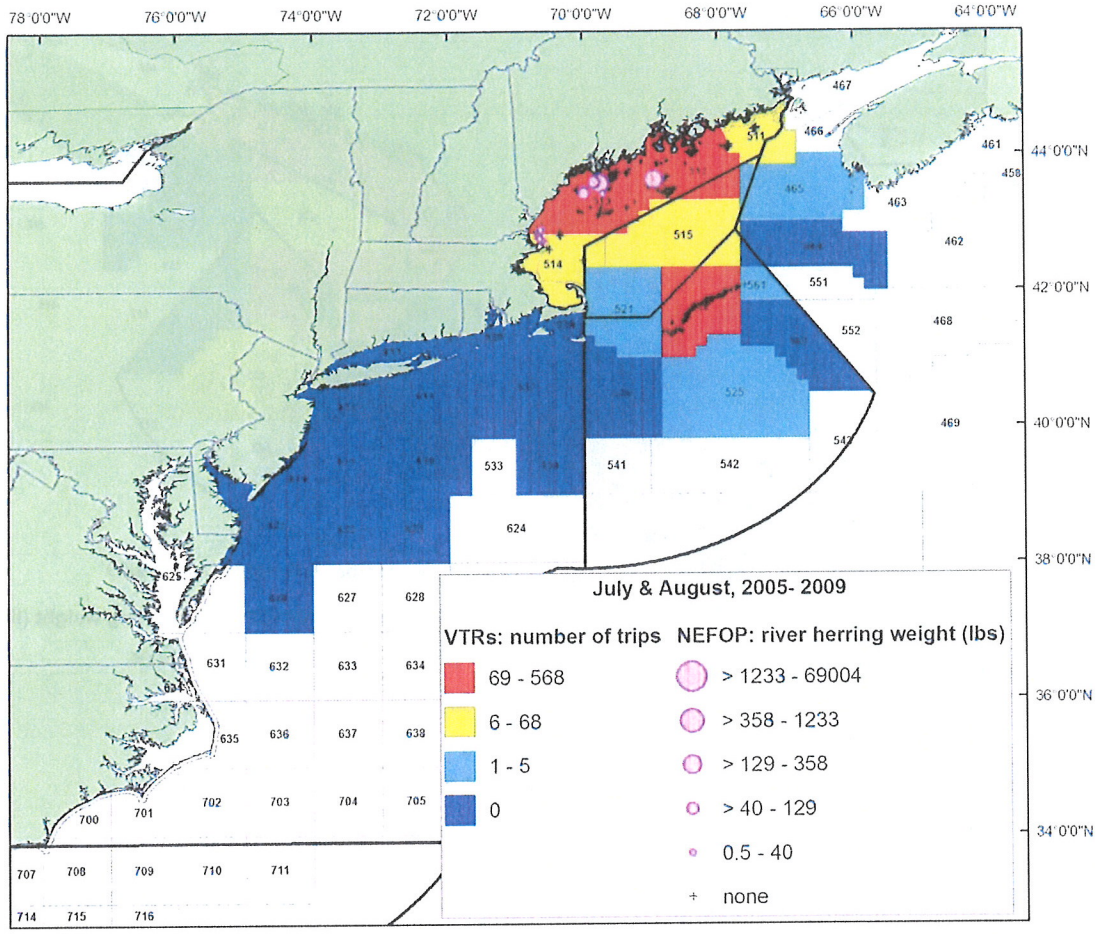


Figure A4: Reported trips (VTR) and observed hauls and sets (NEFOP) during July and August, 2005-2009 for directed herring trips by bottom otter-trawls, purse seines, and mid-water trawls (single and paired). Trips by statistical area are grouped from 69-568 (red), 6-68 (yellow), 1-5 (aqua), and 0 (dark blue) trips. Scaled pink circles represent river herring bycatch (lbs) in observed hauls and sets for directed herring trips. A "+" signifies that an observed haul or set did not catch river herring. Directed herring trips are defined as 2,000 lbs of kept Atlantic herring on a trip. Sources: VTR Database 2005-2009 and NEFOP Database 2005-2009.

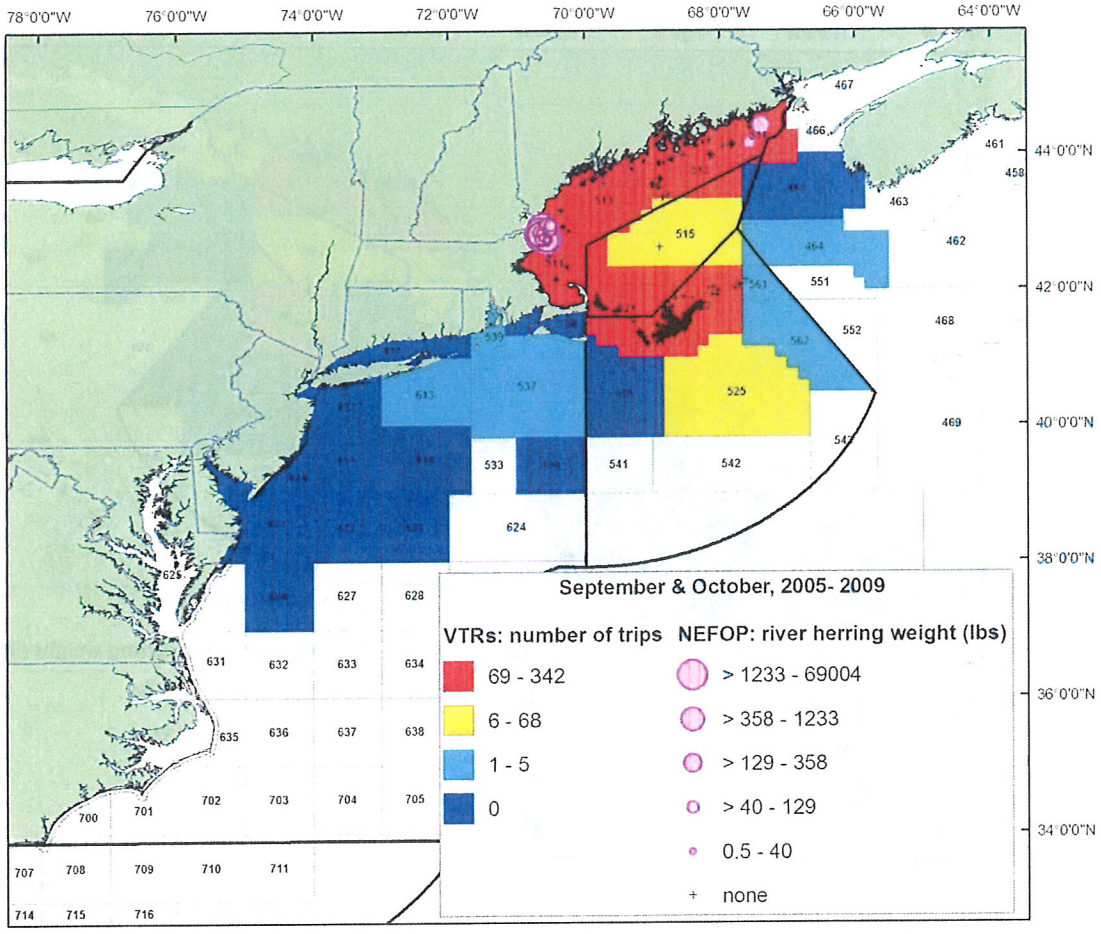


Figure A5: Reported trips (VTR) and observed hauls and sets (NEFOP) during September and October, 2005-2009 for directed herring trips by bottom otter-trawls, purse seines, and mid-water trawls (single and paired). Trips by statistical area are grouped from 69-342 (red), 6-68 (yellow), 1-5 (aqua), and 0 (dark blue) trips. Scaled pink circles represent river herring bycatch (lbs) in observed hauls and sets for directed herring trips. A "+" signifies that an observed haul or set did not catch river herring. Directed herring trips are defined as 2,000 lbs of kept Atlantic herring on a trip. Sources: VTR Database 2005-2009 and NEFOP Database 2005-2009.

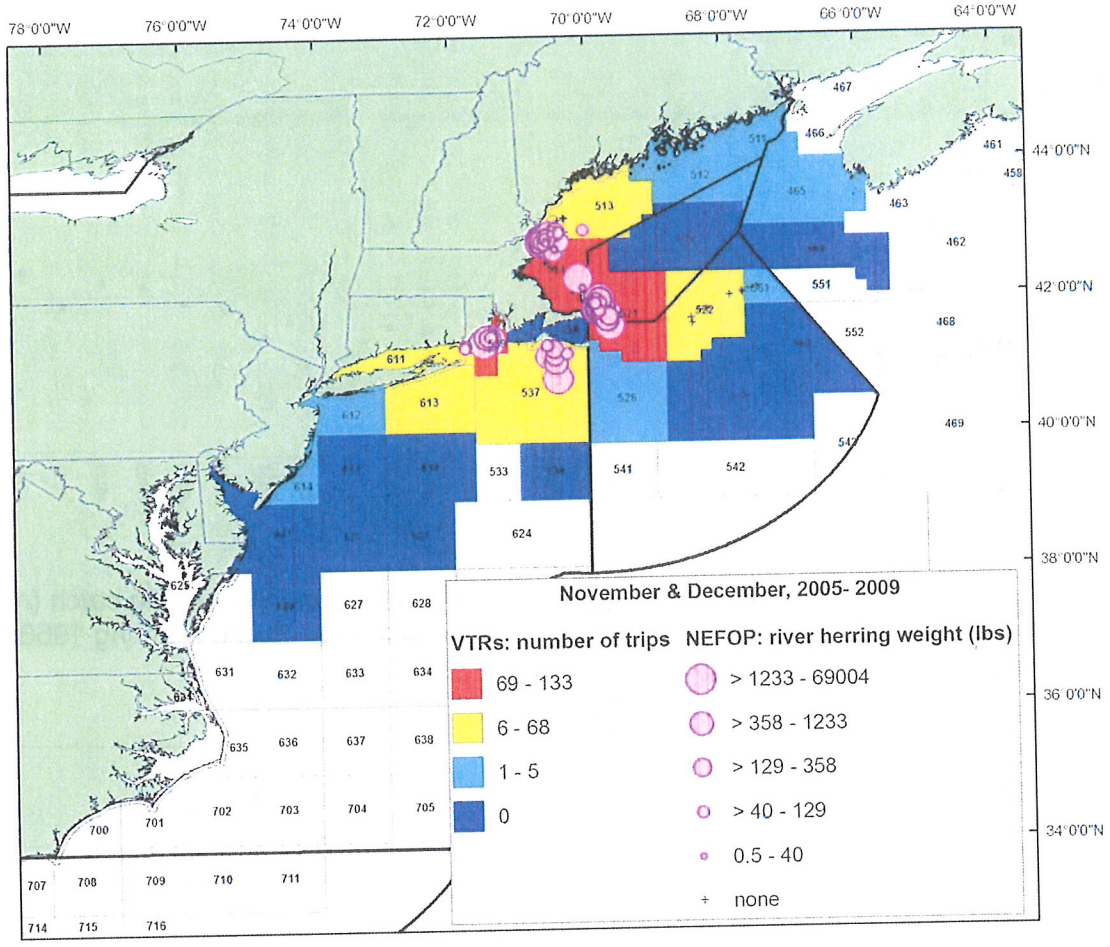


Figure A6: Reported trips (VTR) and observed hauls and sets (NEFOP) during November and December, 2005-2009 for directed herring trips by bottom otter-trawls, purse seines, and mid-water trawls (single and paired). Trips by statistical area are grouped from 69-133 (red), 6-68 (yellow), 1-5 (aqua), and 0 (dark blue) trips. Scaled pink circles represent river herring bycatch (lbs) in observed hauls and sets for directed herring trips. A "+" signifies that an observed haul or set did not catch river herring. Directed herring trips are defined as 2,000 lbs of kept Atlantic herring on a trip. Sources: VTR Database 2005-2009 and NEFOP Database 2005-2009.

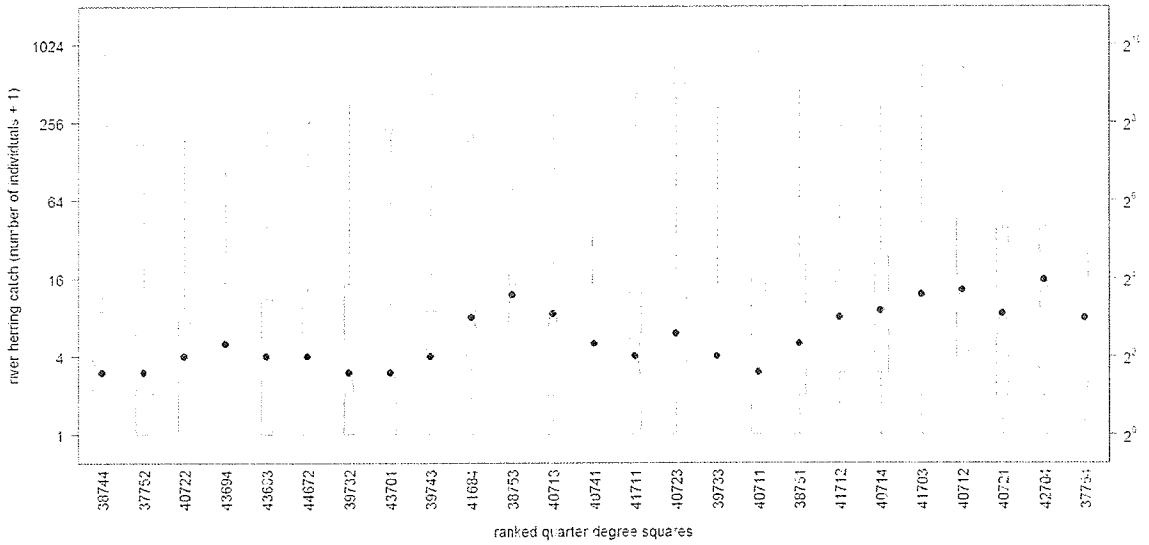


Figure A7: Spring quarter degree squares ranked by mean river herring catch (number of individuals +1). Note the logarithmic scale on the y-axis. Source: Spring 1968-2008 NMFS bottom-trawl surveys.

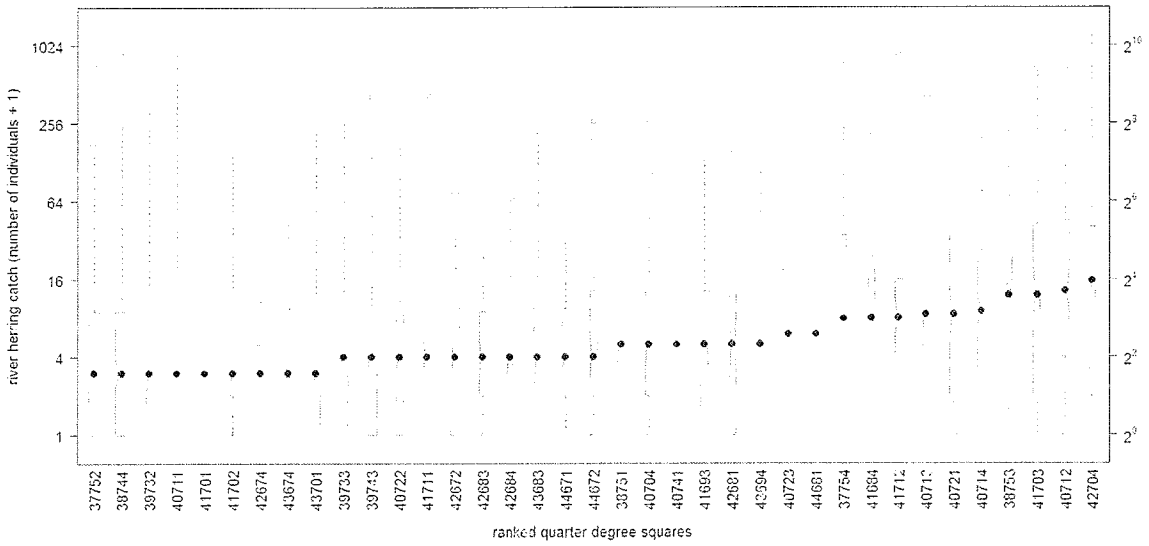


Figure A8: Spring quarter degree squares ranked by median river herring catch (number of individuals +1). Note the logarithmic scale on the y-axis. Source: Spring 1968-2008 NMFS bottom-trawl surveys.

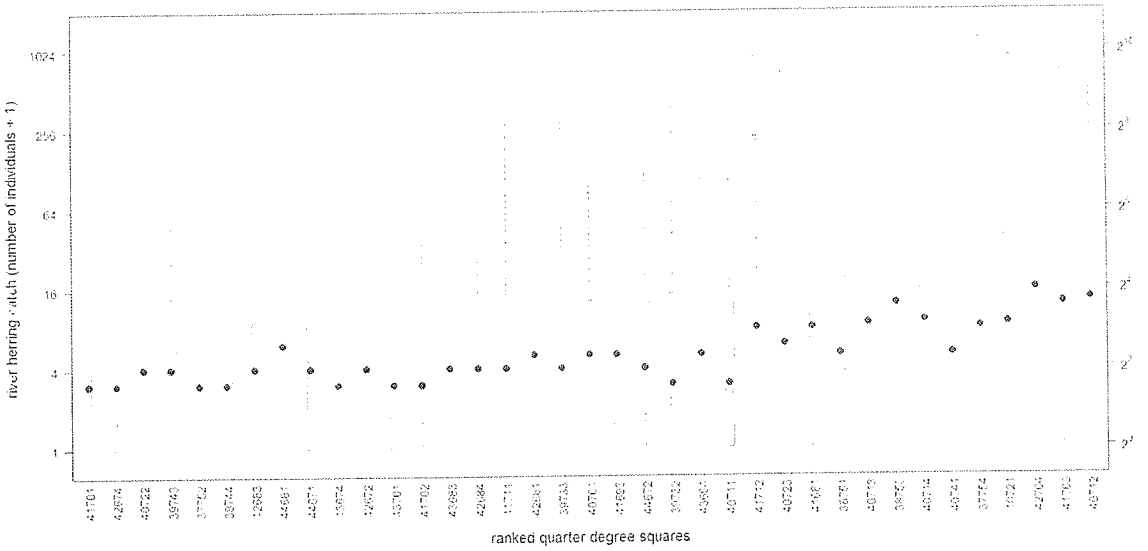


Figure A9: Spring quarter degree squares ranked by 75th quantile of river herring catch (number of individuals +1). Note the logarithmic scale on the y-axis. Source: Spring 1968-2008 NMFS bottom-trawl surveys.

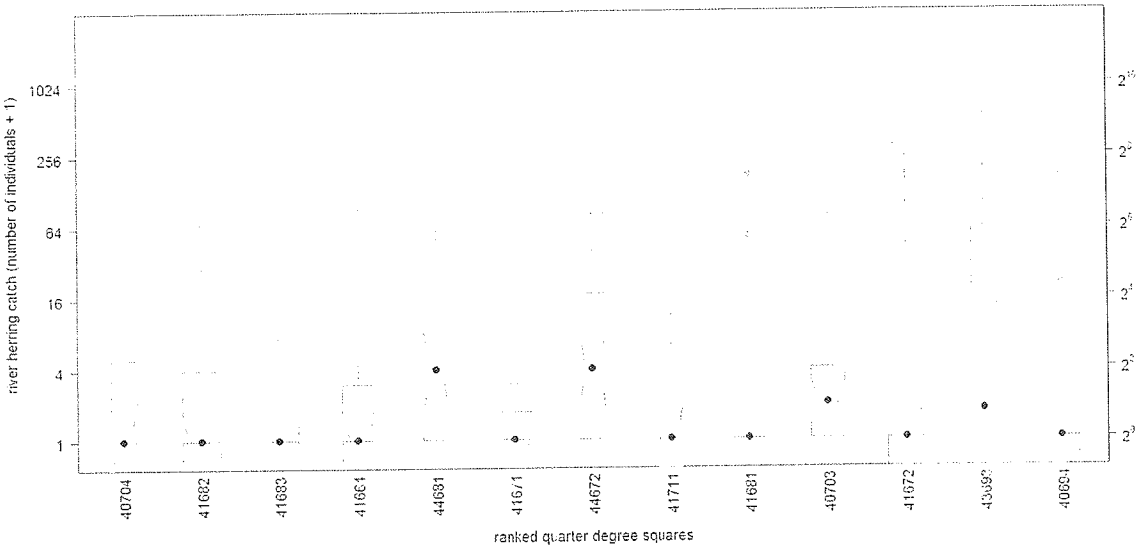


Figure A10: Summer quarter degree squares ranked by mean river herring catch (number of individuals +1). Note the logarithmic scale on the y-axis. Source: Summer 1948-1995 NMFS bottom-trawl surveys.

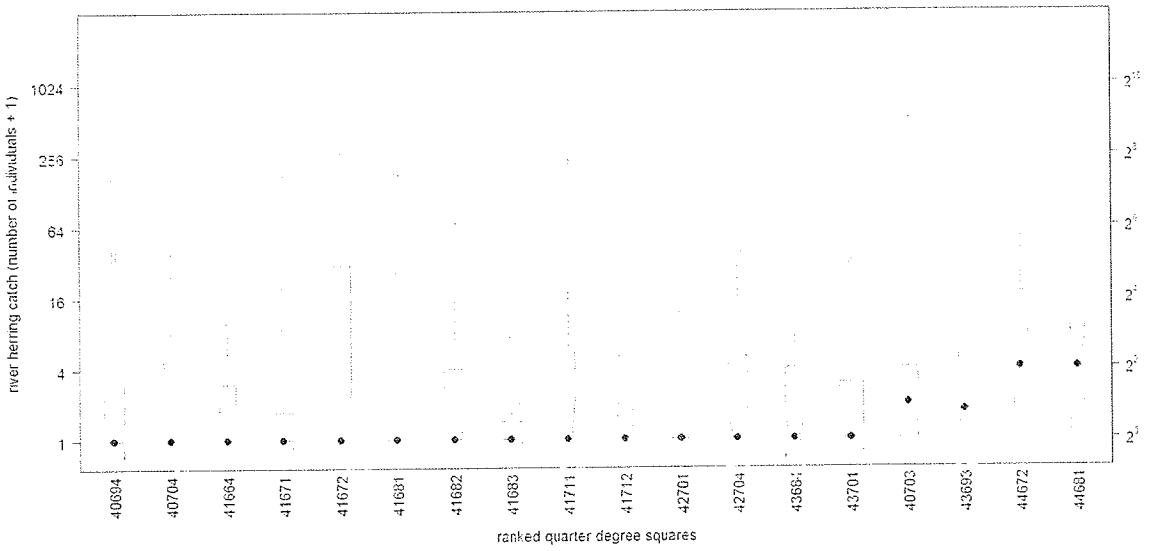


Figure A11: Summer quarter degree squares ranked by median river herring catch (number of individuals +1). Note the logarithmic scale on the y-axis. Source: Summer 1948-1995 NMFS bottom-trawl surveys.

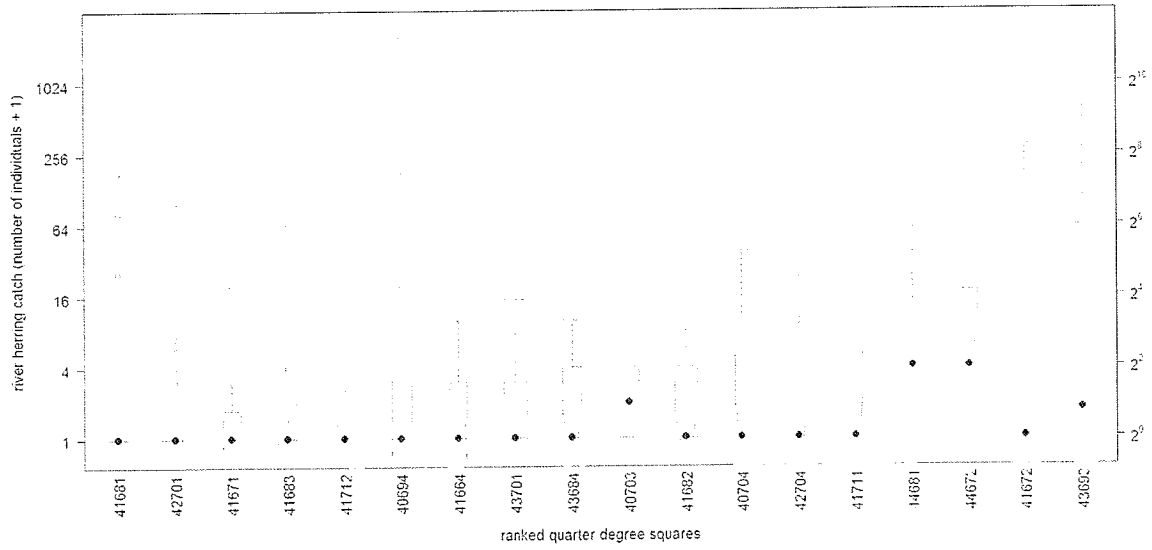


Figure A12: Summer quarter degree squares ranked by 75th quantile of river herring catch (number of individuals +1). Note the logarithmic scale on the y-axis. Source: Summer 1948-1995 NMFS bottom-trawl surveys.

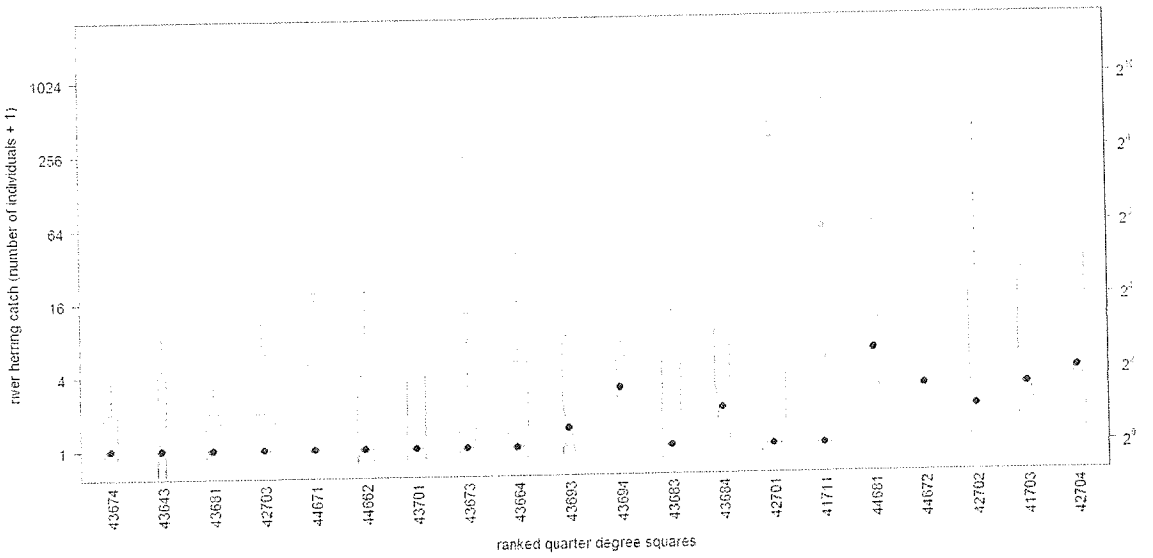


Figure A13: Fall quarter degree squares ranked by mean river herring catch (number of individuals +1). Note the logarithmic scale on the y-axis. Source: Fall 1963-2008 NMFS bottom-trawl surveys.

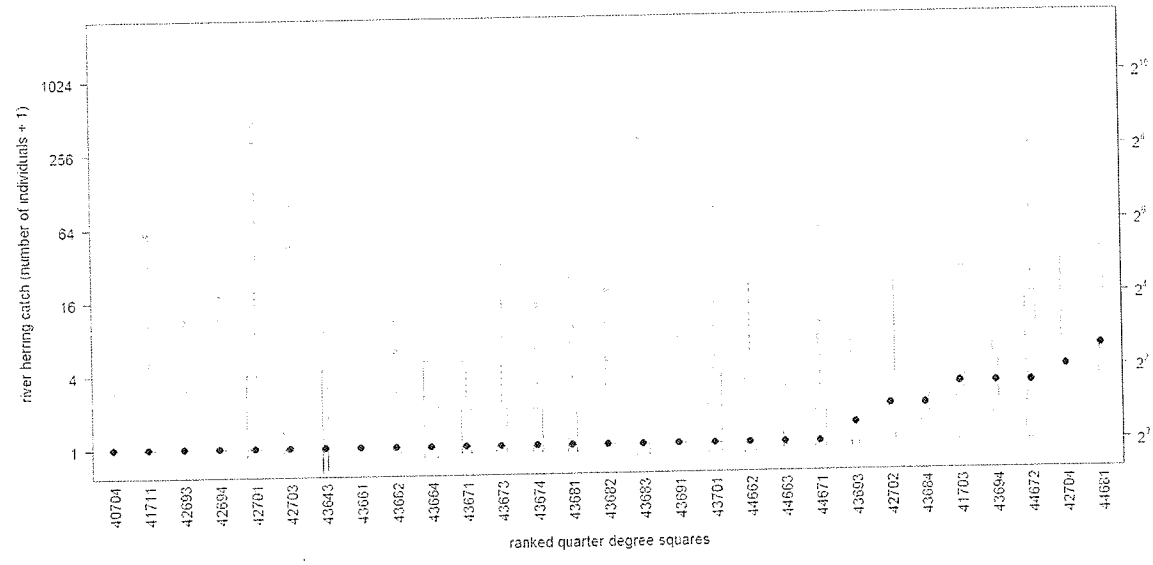


Figure A14: Fall quarter degree squares ranked by median river herring catch (number of individuals +1). Note the logarithmic scale on the y-axis. Source: Fall 1963-2008 NMFS bottom-trawl surveys.

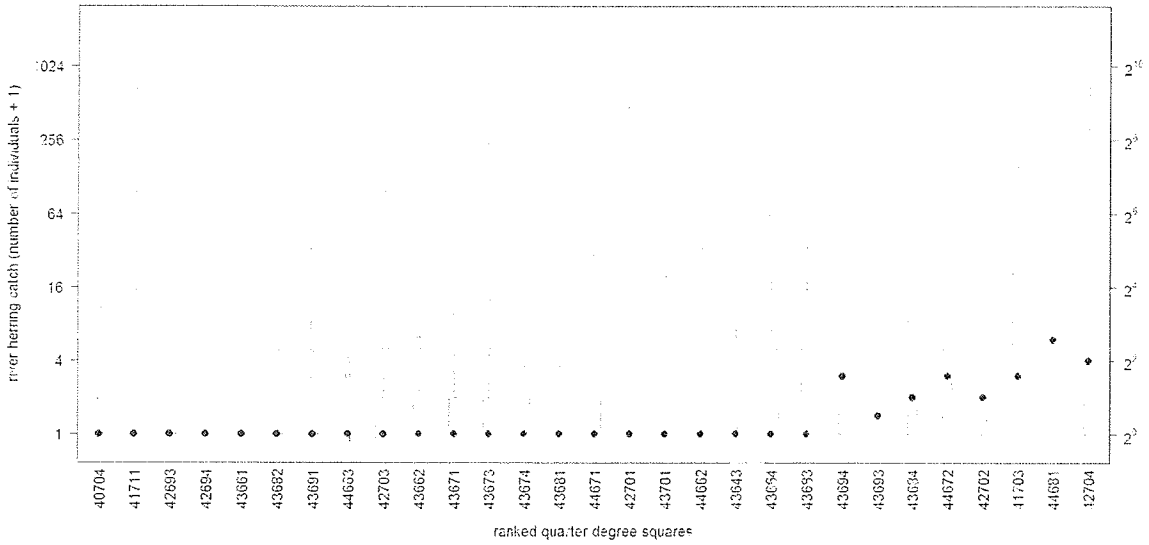


Figure A15: Fall quarter degree squares ranked by 75th quantile of river herring catch (number of individuals +1). Note the logarithmic scale on the y-axis. Source: Fall 1963-2008 NMFS bottom-trawl surveys.

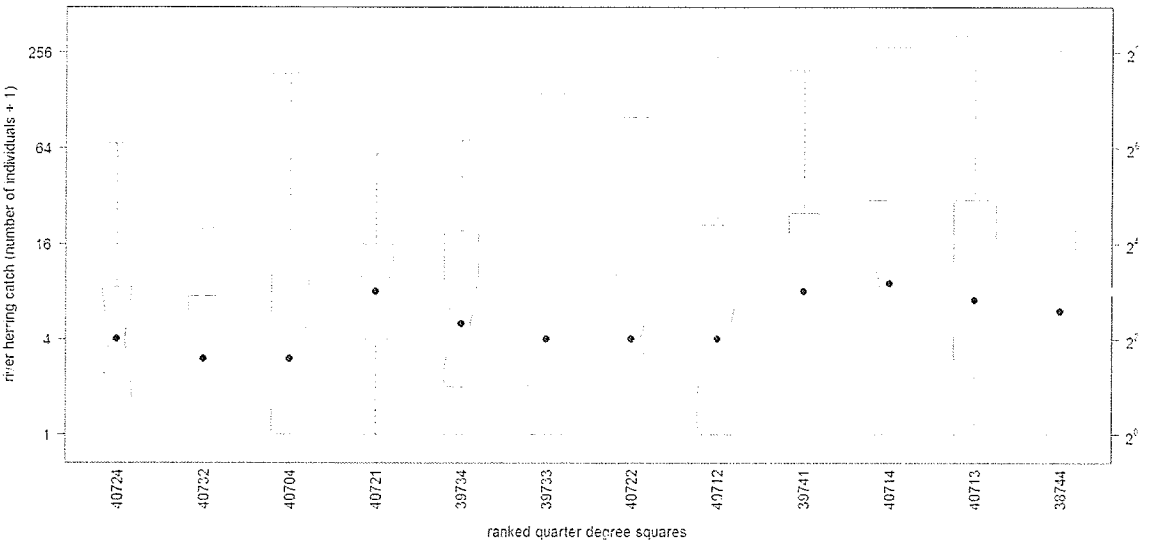


Figure A16: Winter quarter degree squares ranked by mean river herring catch (number of individuals +1). Note the logarithmic scale on the y-axis. Source: Winter 1964-2007 NMFS bottom-trawl surveys.

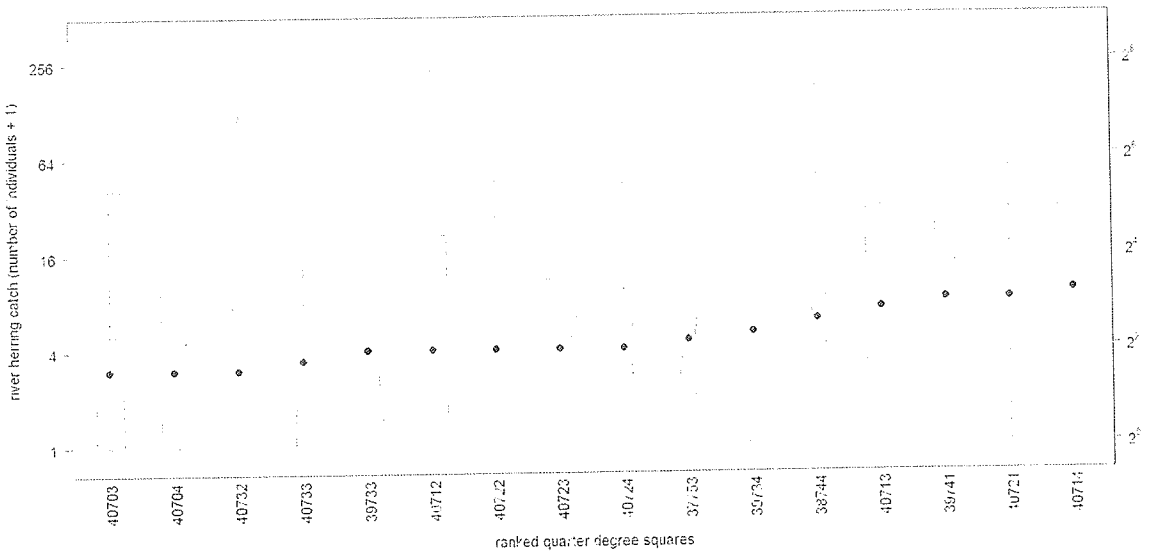


Figure A17: Winter quarter degree squares ranked by median river herring catch (number of individuals +1). Note the logarithmic scale on the y-axis. Source: Winter 1964-2007 NMFS bottom-trawl surveys.

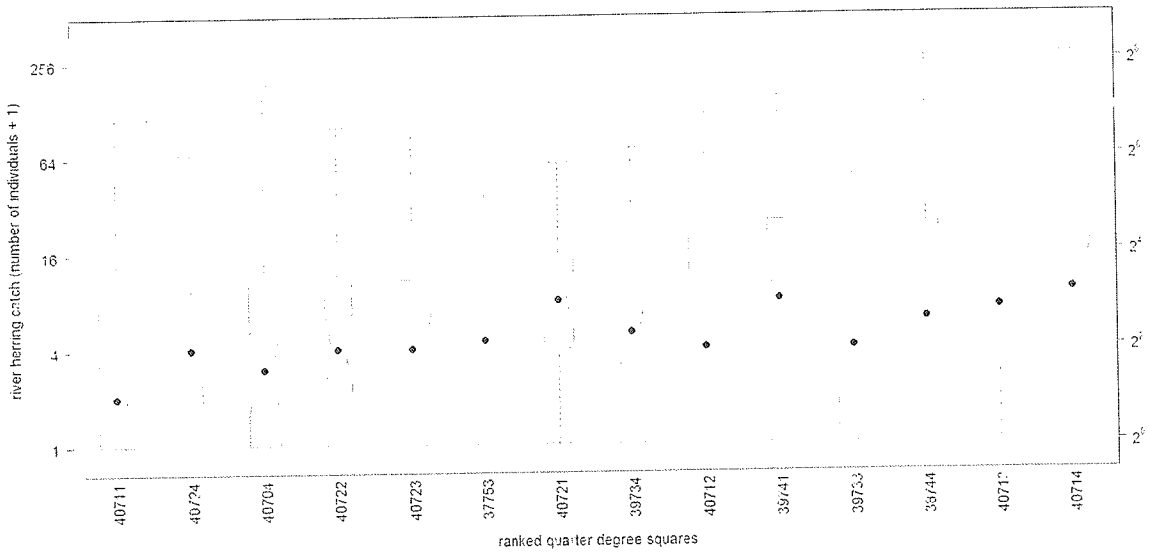


Figure A18: Winter quarter degree squares ranked by 75th quantile of river herring catch (number of individuals +1). Note the logarithmic scale on the y-axis. Source: Winter 1964-2007 NMFS bottom-trawl surveys.

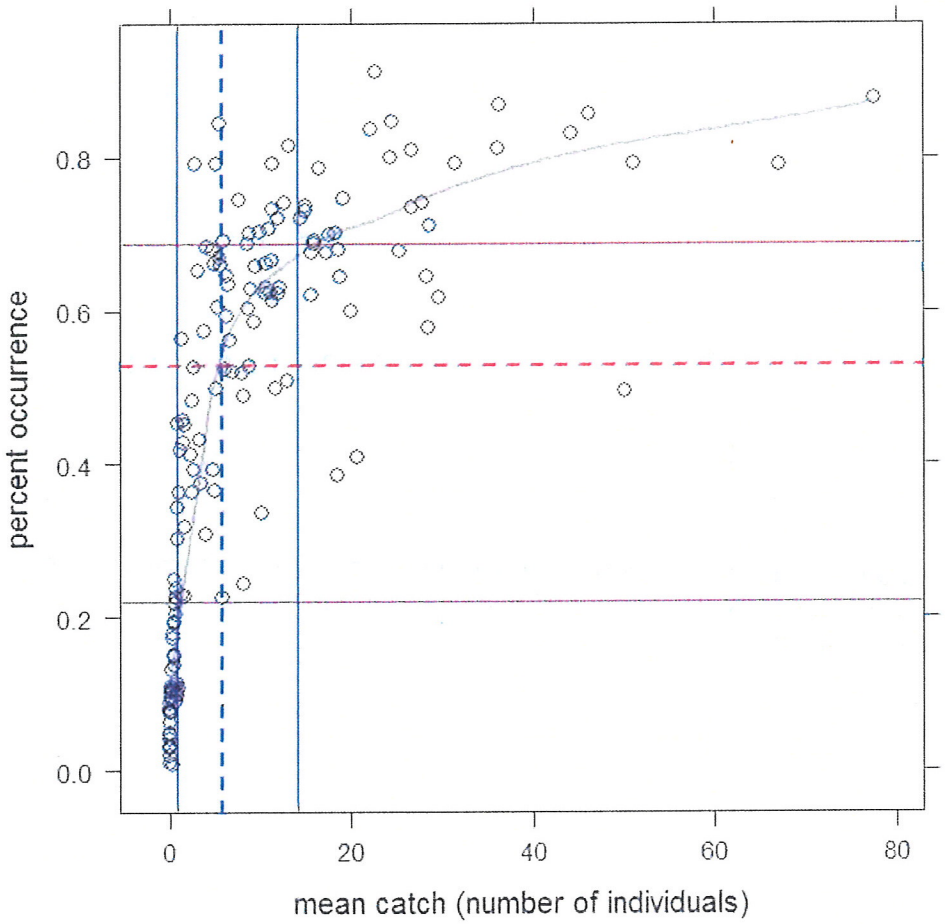


Figure A19: Spring percent occurrence against mean catch in number for quarter degree square (dark blue circles). Solid lines are 25th and 75th quantiles (red=percent occurrence, blue=mean catch in number. Dashed lines are medians (red=percent occurrence, blue=mean catch in number. Hot spots are defined as squares having percent occurrence and mean catch in number ≥ 75th quantiles for each variable. Source: Spring 1968-2008 NMFS bottom-trawl surveys.

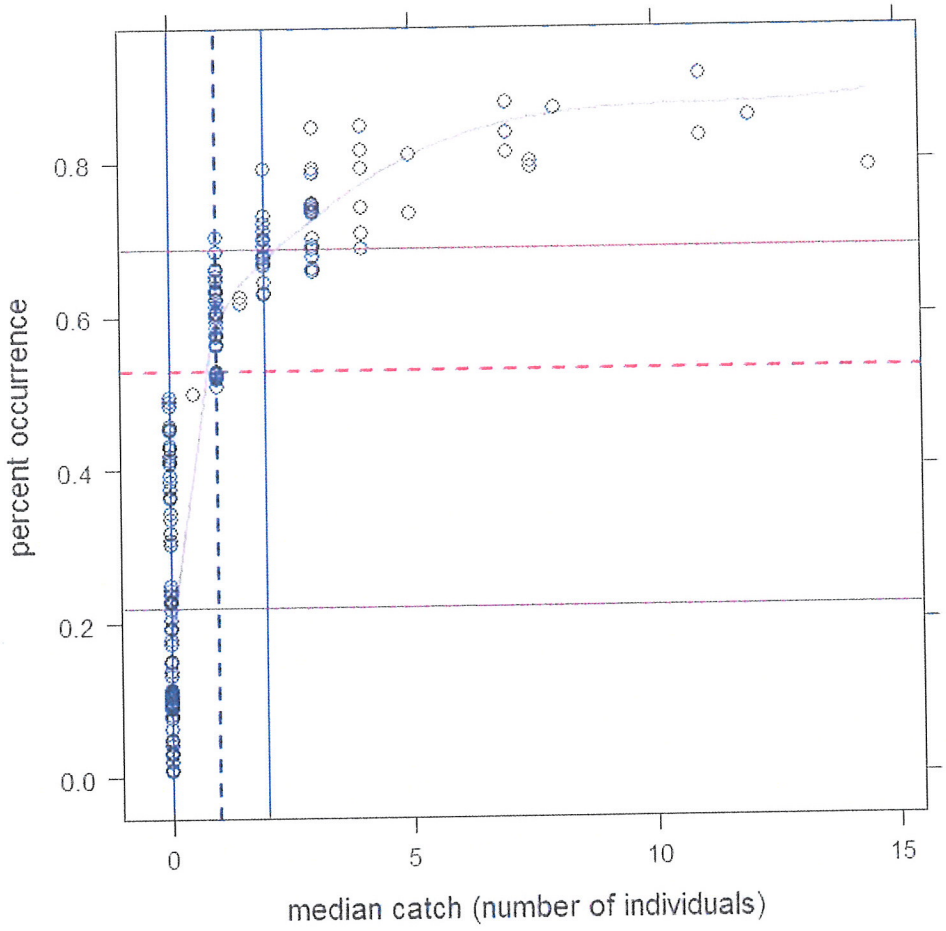


Figure A20: Spring percent occurrence against median catch in number for quarter degree square (dark blue circles). Solid lines are 25th and 75th quantiles (red=percent occurrence, blue=median catch in number. Dashed lines are medians (red=percent occurrence, blue=median catch in number. Hot spots are defined as squares having percent occurrence and median catch in number ≥ 75th quantiles for each variable. Source: Spring 1968-2008 NMFS bottom-trawl surveys.

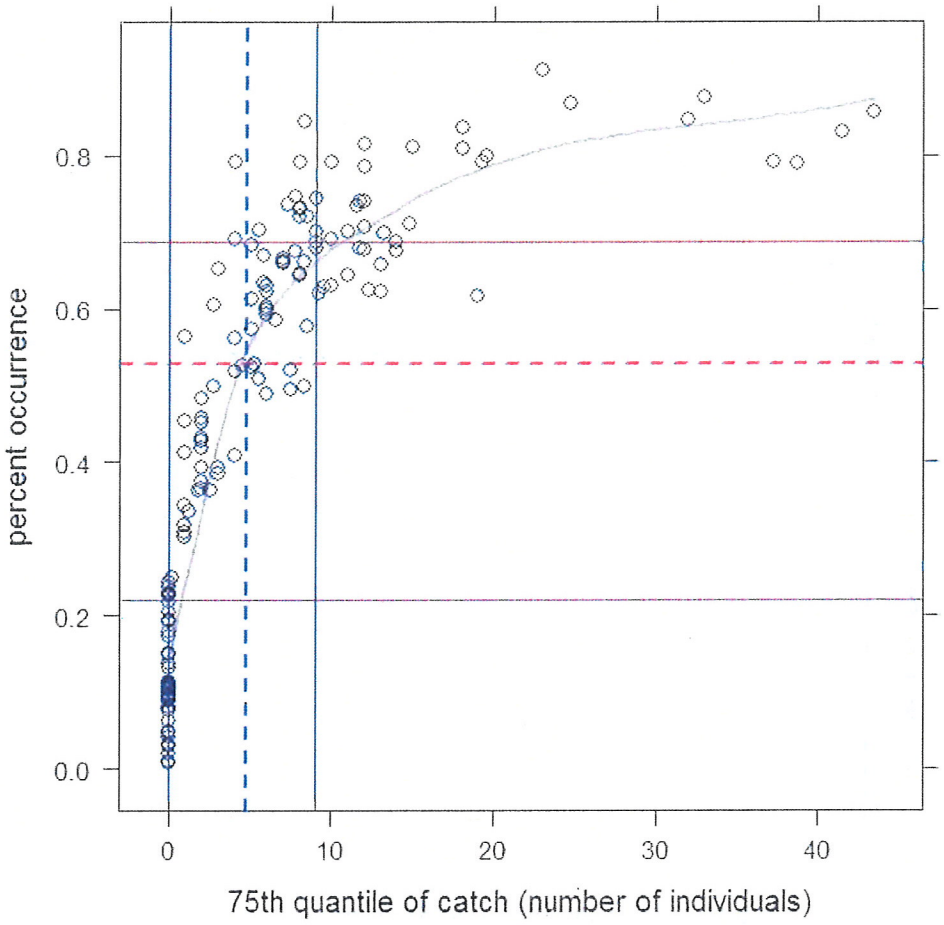


Figure A21: Spring percent occurrence against 75th quantile of catch in number for quarter degree square (dark blue circles). Solid lines are 25th and 75th quantiles (red=percent occurrence, blue=75th quantile of catch in number. Dashed lines are medians (red=percent occurrence, blue=75th quantile of catch in number. Hot spots are defined as squares having percent occurrence and 75th quantile of catch in number ≥ 75th quantiles for each variable. Source: Spring 1968-2008 NMFS bottom-trawl surveys.

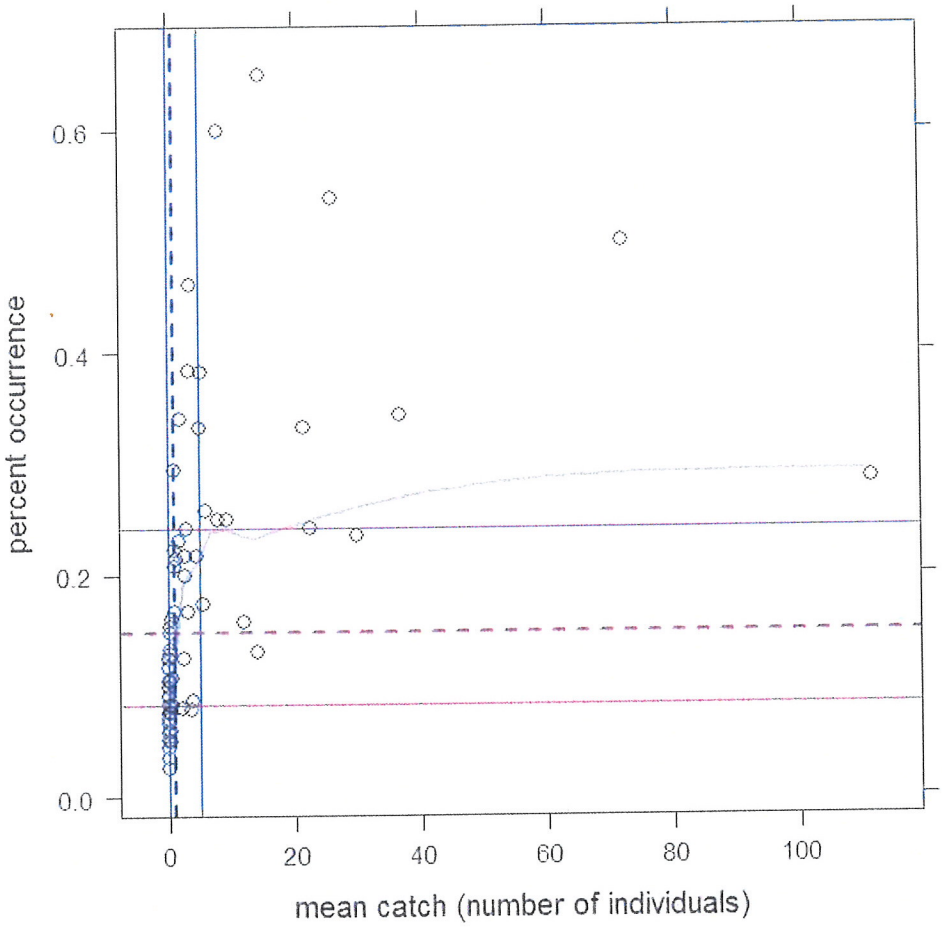


Figure A22: Summer percent occurrence against mean catch in number for quarter degree square (dark blue circles). Solid lines are 25th and 75th quantiles (red=percent occurrence, blue=mean catch in number. Dashed lines are medians (red=percent occurrence, blue=mean catch in number. Hot spots are defined as squares having percent occurrence and mean catch in number ≥ 75th quantiles for each variable. Source: Summer 1948-1995 NMFS bottom-trawl surveys.

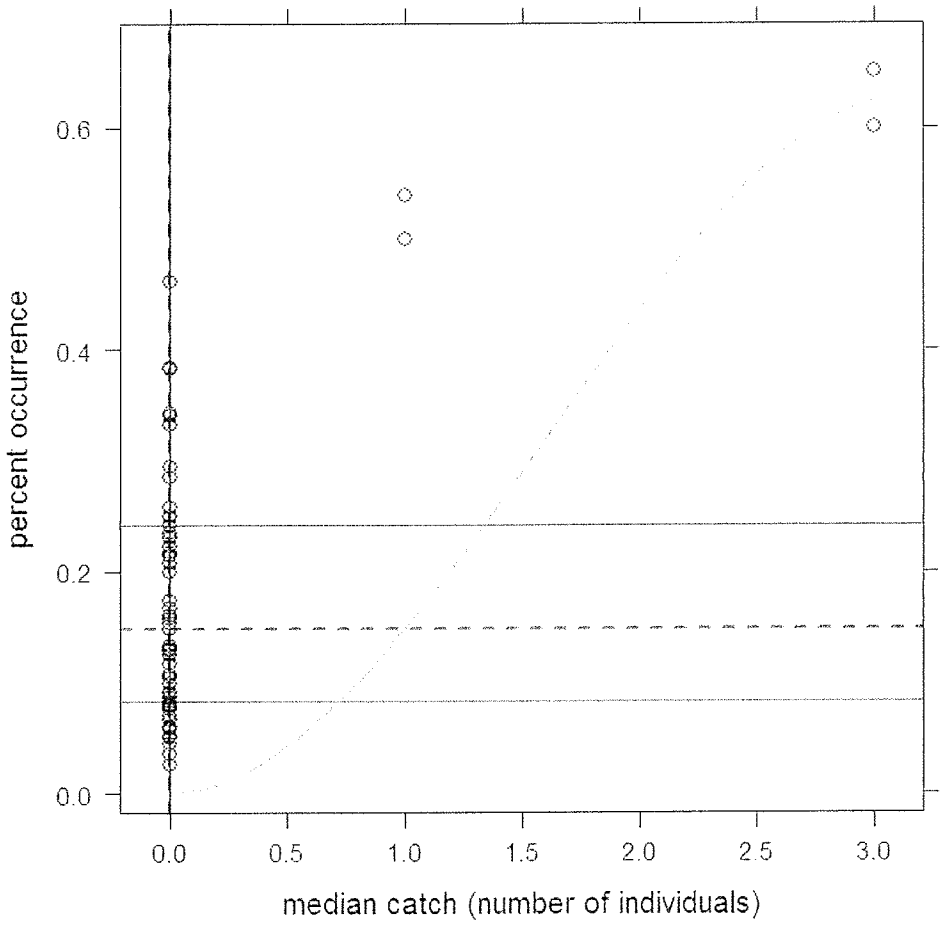


Figure A23: Summer percent occurrence against median catch in number for quarter degree square (dark blue circles). Solid lines are 25th and 75th quantiles (red=percent occurrence, blue=median catch in number. Dashed lines are medians (red=percent occurrence, blue=median catch in number. Hot spots are defined as squares having percent occurrence and median catch in number ≥ 75th quantiles for each variable. Source: Summer 1948-1995 NMFS bottom-trawl surveys.

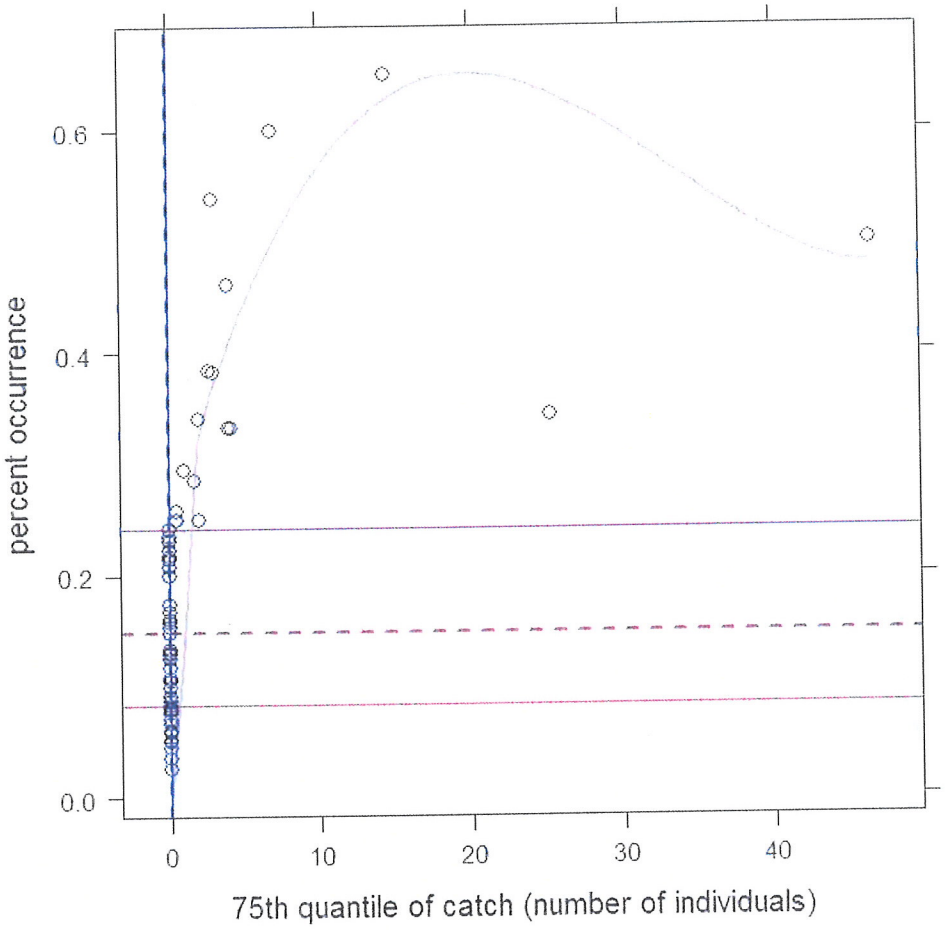


Figure A24: Summer percent occurrence against 75th quantile of catch in number for quarter degree square (dark blue circles). Solid lines are 25th and 75th quantiles (red=percent occurrence, blue=75th quantile of catch in number. Dashed lines are medians (red=percent occurrence, blue=75th quantile of catch in number. Hot spots are defined as squares having percent occurrence and 75th quantile of catch in number ≥ 75th quantiles for each variable. Source: Summer 1948-1995 NMFS bottom-trawl surveys.

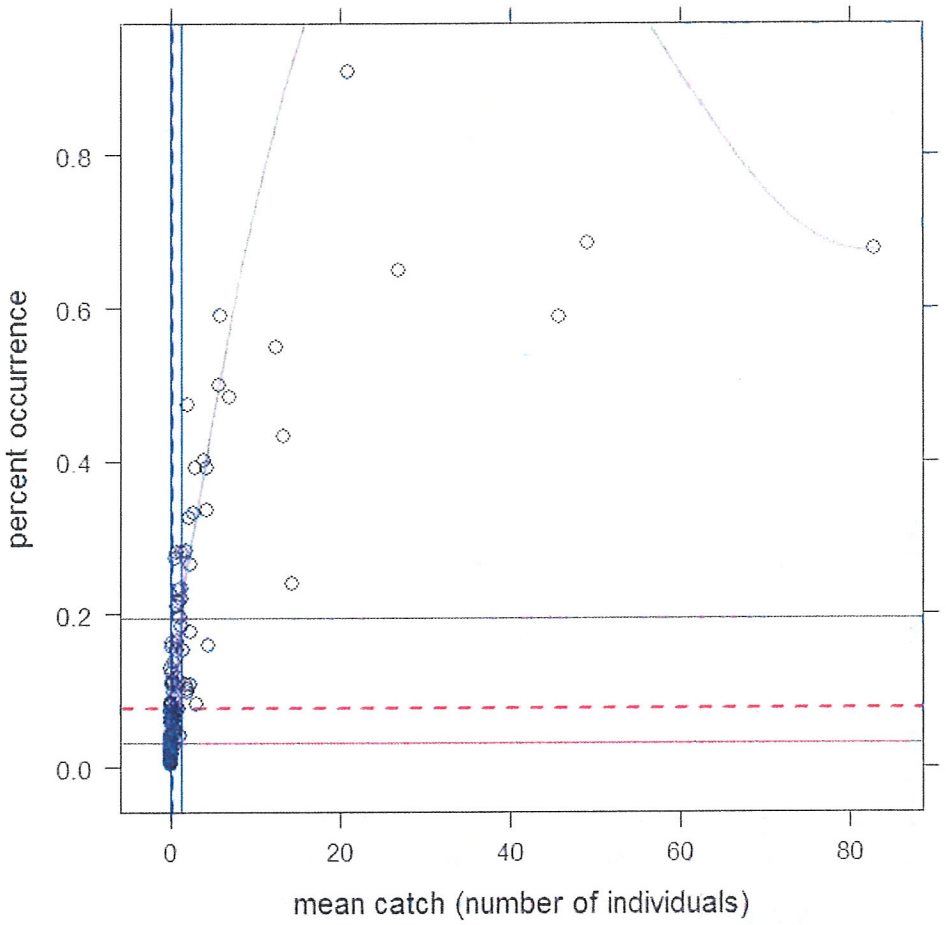


Figure A25: Fall percent occurrence against mean catch in number for quarter degree square (dark blue circles). Solid lines are 25th and 75th quantiles (red=percent occurrence, blue=mean catch in number. Dashed lines are medians (red=percent occurrence, blue=mean catch in number. Hot spots are defined as squares having percent occurrence and mean catch in number ≥ 75th quantiles for each variable. Source: Fall 1963-2008 NMFS bottom-trawl surveys.

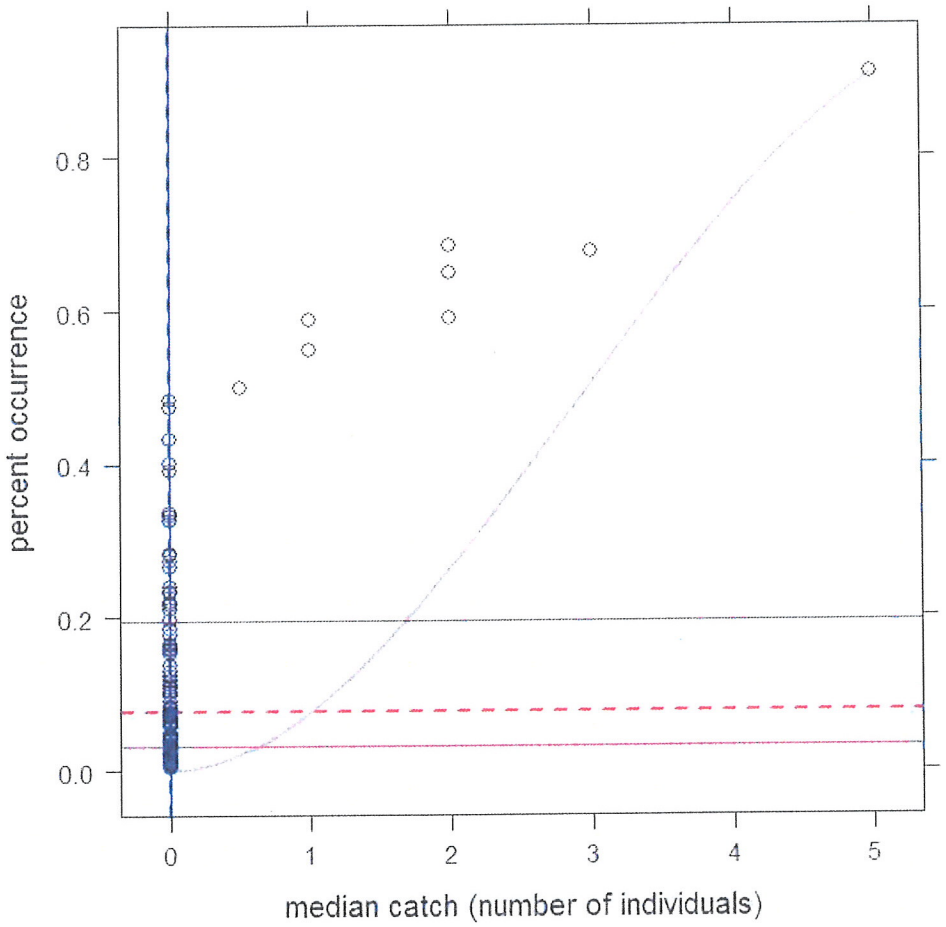


Figure A26: Fall percent occurrence against median catch in number for quarter degree square (dark blue circles). Solid lines are 25th and 75th quantiles (red=percent occurrence, blue=median catch in number. Dashed lines are medians (red=percent occurrence, blue=median catch in number. Hot spots are defined as squares having percent occurrence and median catch in number ≥ 75th quantiles for each variable. Source: Fall 1963-2008 NMFS bottom-trawl surveys.

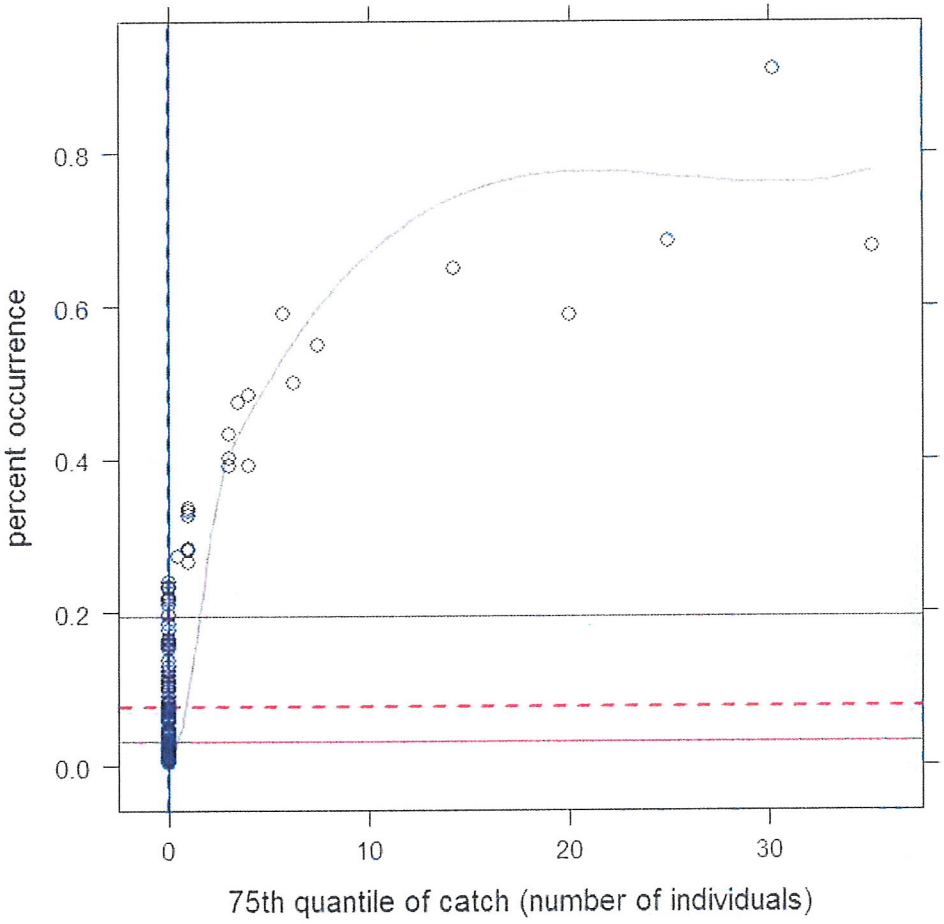


Figure A27: Fall percent occurrence against 75th quantile of catch in number for quarter degree square (dark blue circles). Solid lines are 25th and 75th quantiles (red=percent occurrence, blue=75th quantile of catch in number. Dashed lines are medians (red=percent occurrence, blue=75th quantile of catch in number. Hot spots are defined as squares having percent occurrence and 75th quantile of catch in number ≥ 75th quantiles for each variable. Source: Fall 1963-2008 NMFS bottom-trawl surveys.

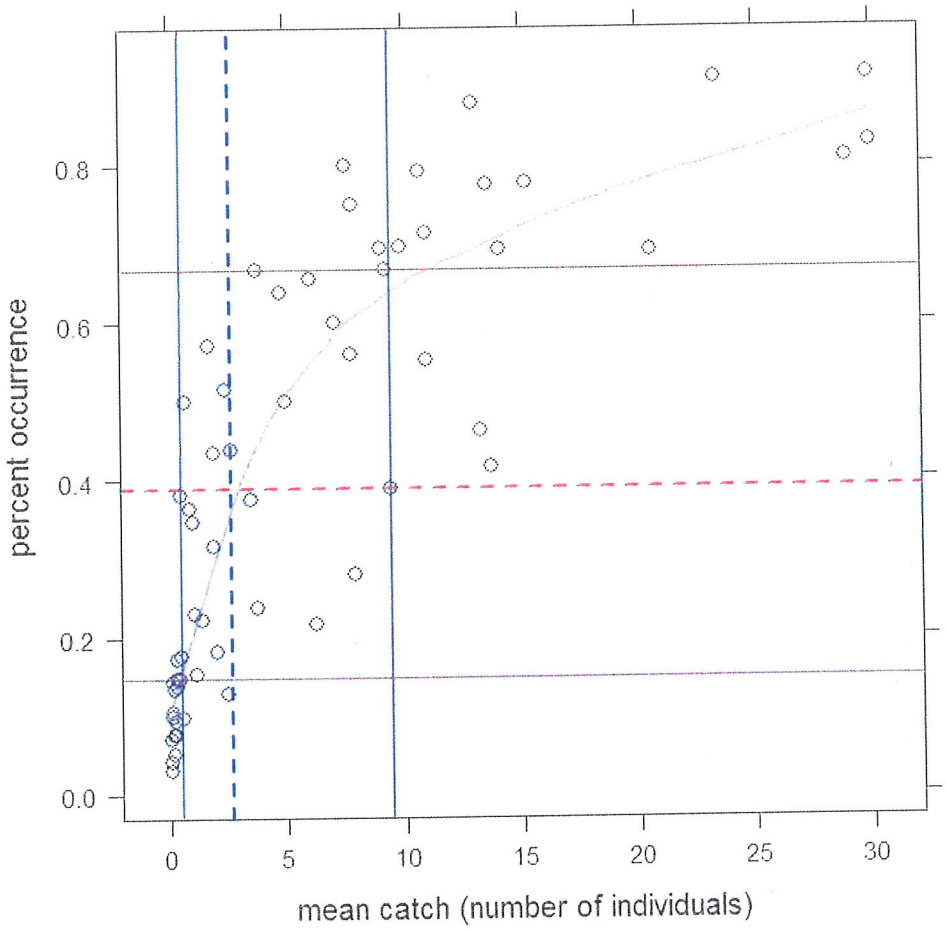


Figure A28: Winter percent occurrence against mean catch in number for quarter degree square (dark blue circles). Solid lines are 25th and 75th quantiles (red=percent occurrence, blue=mean catch in number. Dashed lines are medians (red=percent occurrence, blue=mean catch in number. Hot spots are defined as squares having percent occurrence and mean catch in number ≥ 75th quantiles for each variable. Source: Winter 1964-2007 NMFS bottom-trawl surveys.

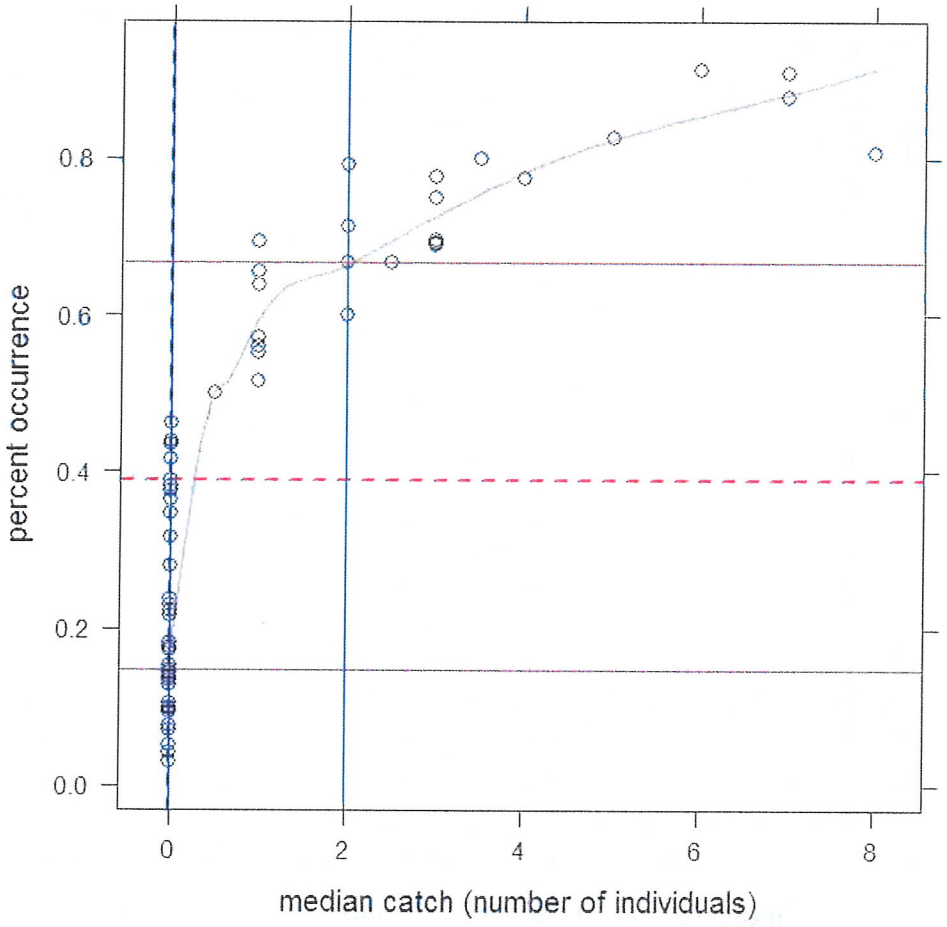


Figure A29: Winter percent occurrence against median catch in number for quarter degree square (dark blue circles). Solid lines are 25th and 75th quantiles (red=percent occurrence, blue=median catch in number. Dashed lines are medians (red=percent occurrence, blue=median catch in number. Hot spots are defined as squares having percent occurrence and median catch in number ≥ 75th quantiles for each variable. Source: Winter 1964-2007 NMFS bottom-trawl surveys.

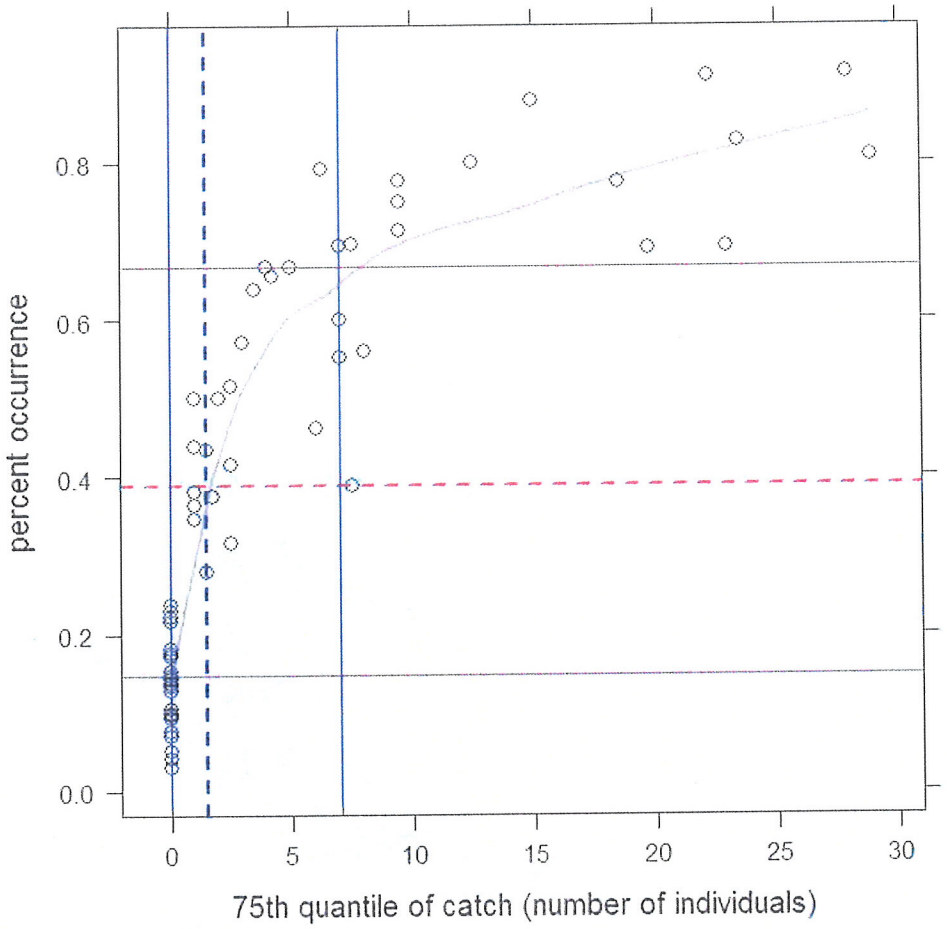


Figure A30: Winter percent occurrence against 75th quantile of catch in number for quarter degree square (dark blue circles). Solid lines are 25th and 75th quantiles (red=percent occurrence, blue=75th quantile of catch in number. Dashed lines are medians (red=percent occurrence, blue=75th quantile of catch in number. Hot spots are defined as squares having percent occurrence and 75th quantile of catch in number ≥ 75th quantiles for each variable. Source: Winter 1964-2007 NMFS bottom-trawl surveys.

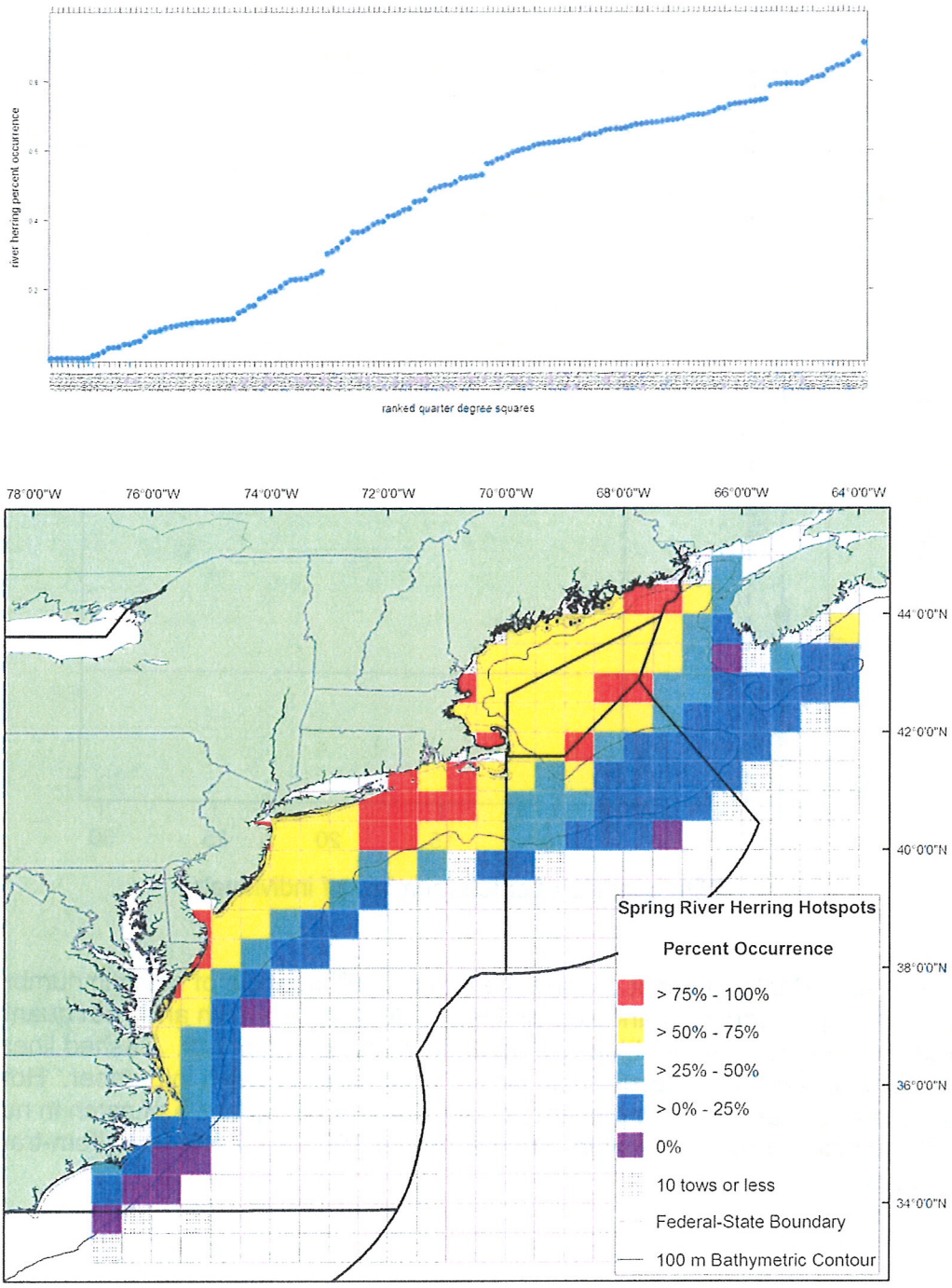
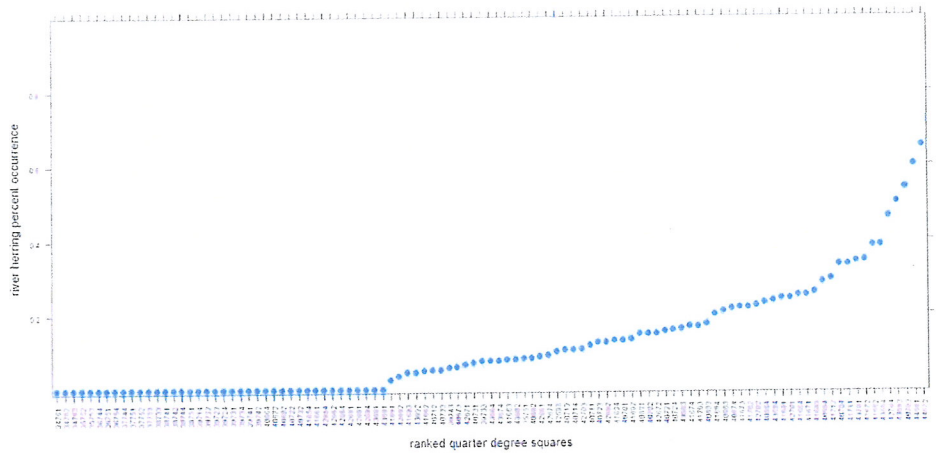


Figure A31: Percent occurrence of river herring in spring research surveys by statistical area ranked from lowest to highest (top). Map of corresponding river herring percent occurrence by quarter degree squares grouped from > 75% - 100% (red), > 50% - 75% (yellow), > 25% - 50% (aqua), > 0 - 25% (blue) and 0% (purple) (bottom). Source: Spring 1968-2008 NMFS bottom-trawl surveys.



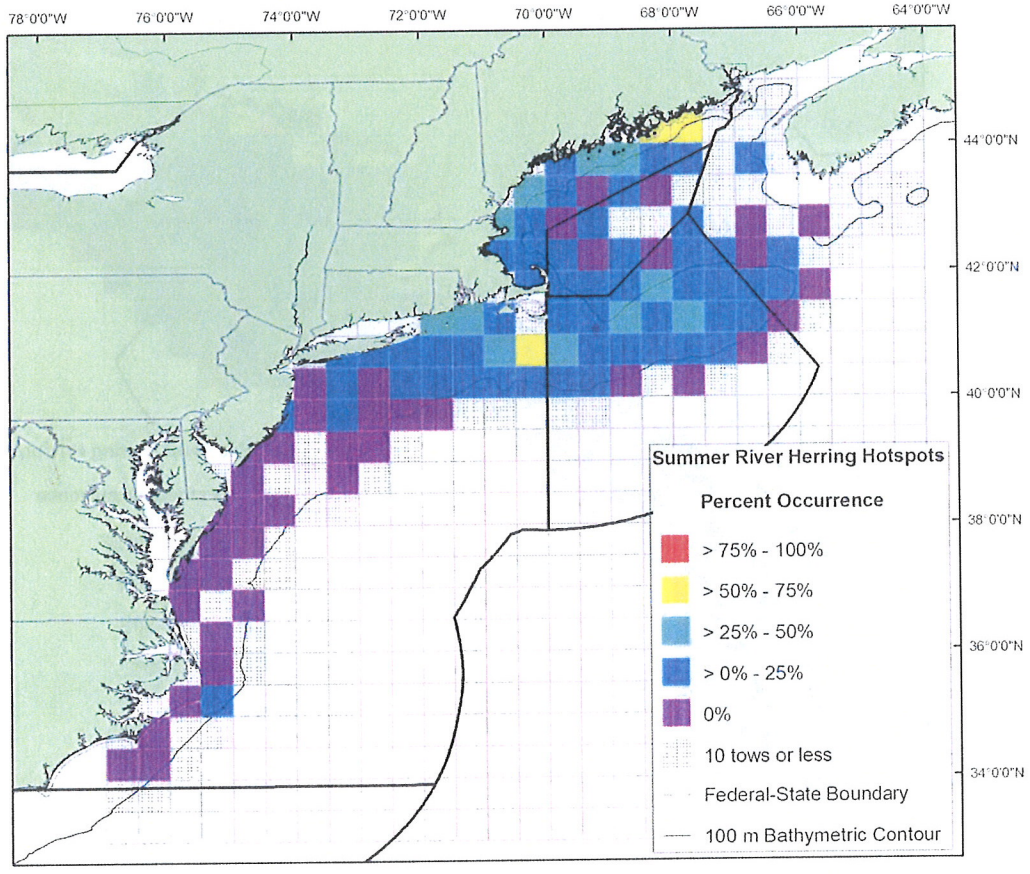
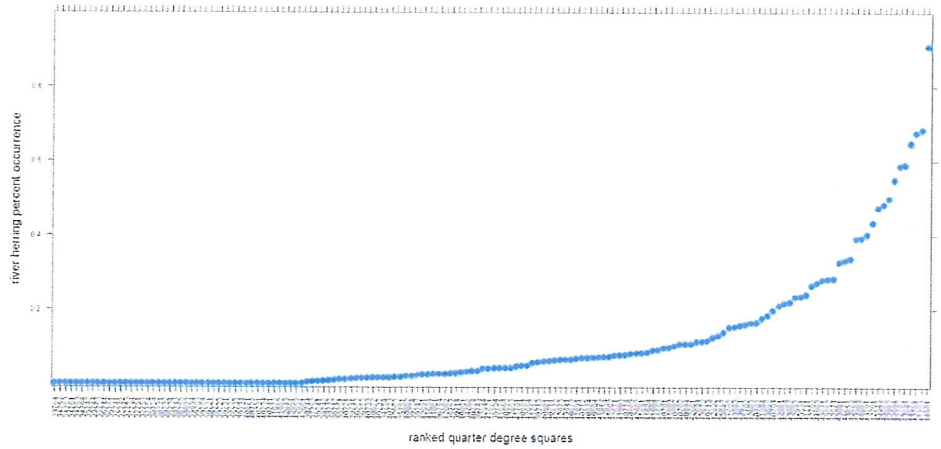


Figure A32: Percent occurrence of river herring in summer research surveys by statistical area ranked from lowest to highest (top). Map of corresponding river herring percent occurrence by quarter degree squares grouped from > 75% - 100% (red), > 50% - 75% (yellow), > 25% - 50% (aqua), > 0 - 25% (blue) and 0% (purple) (bottom). Source: Summer 1948-1995 NMFS bottom-trawl surveys.



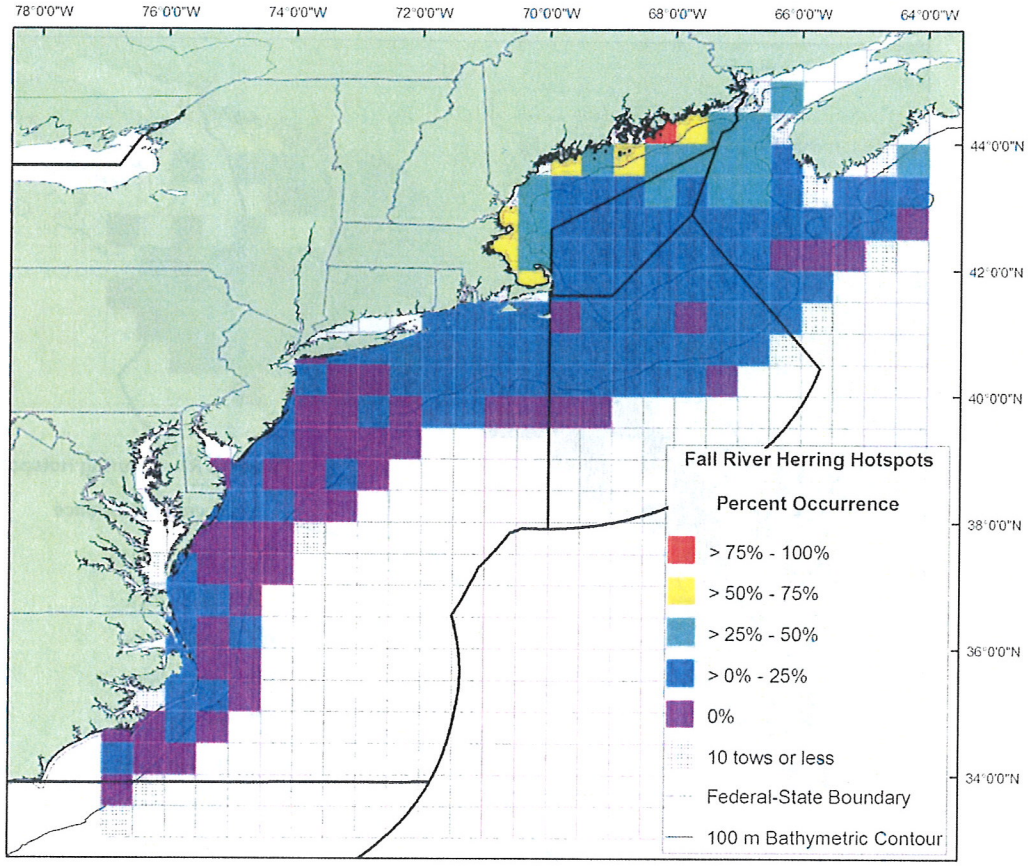
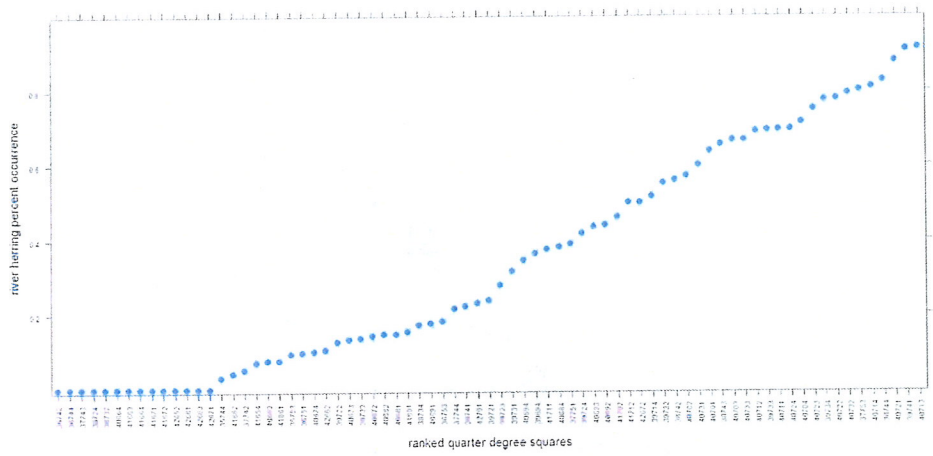


Figure A33: Percent occurrence of river herring in fall research surveys by statistical area ranked from lowest to highest (top). Map of corresponding river herring percent occurrence by quarter degree squares grouped from > 75% - 100% (red), > 50% - 75% (yellow), > 25% - 50% (aqua), > 0 - 25% (blue) and 0% (purple) (bottom). Source: Fall 1963-2008 NMFS bottom-trawl surveys.



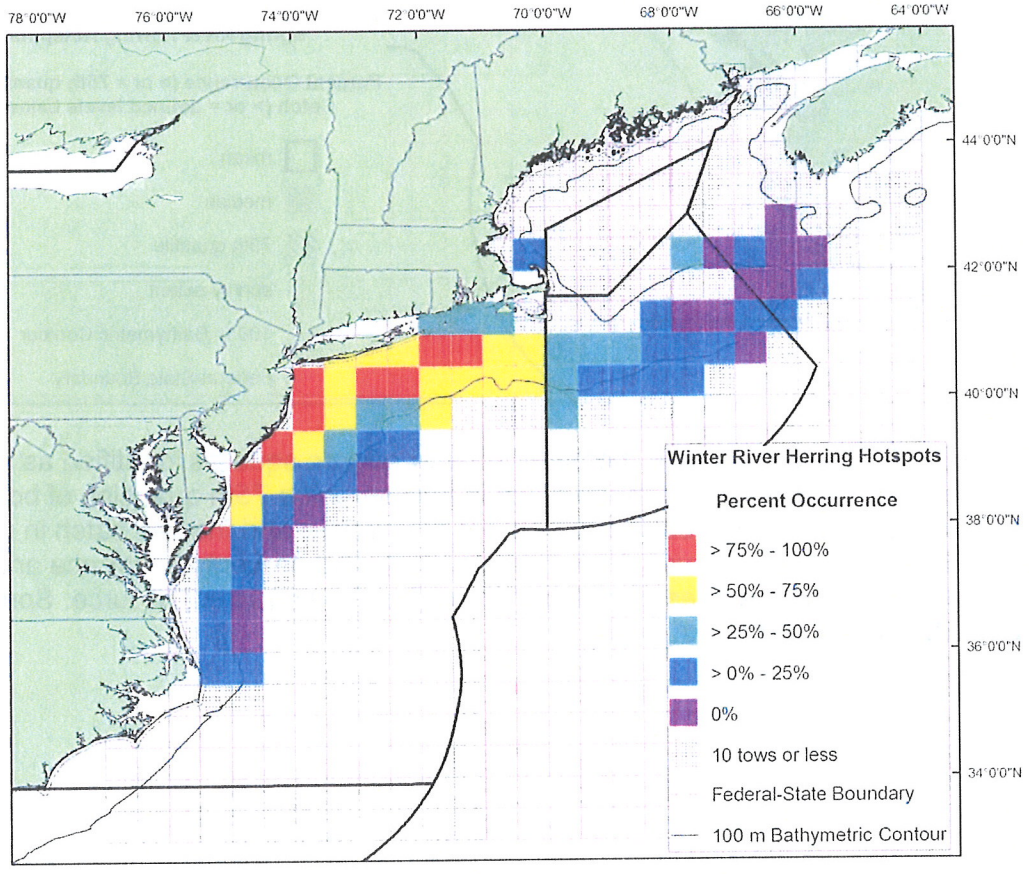


Figure A34: Percent occurrence of river herring in winter research surveys by statistical area ranked from lowest to highest (top). Map of corresponding river herring percent occurrence by quarter degree squares grouped from > 75% - 100% (red), > 50% - 75% (yellow), > 25% - 50% (aqua), > 0 - 25% (blue) and 0% (purple) (bottom). Source: Winter 1964-2007 NMFS bottom-trawl surveys.

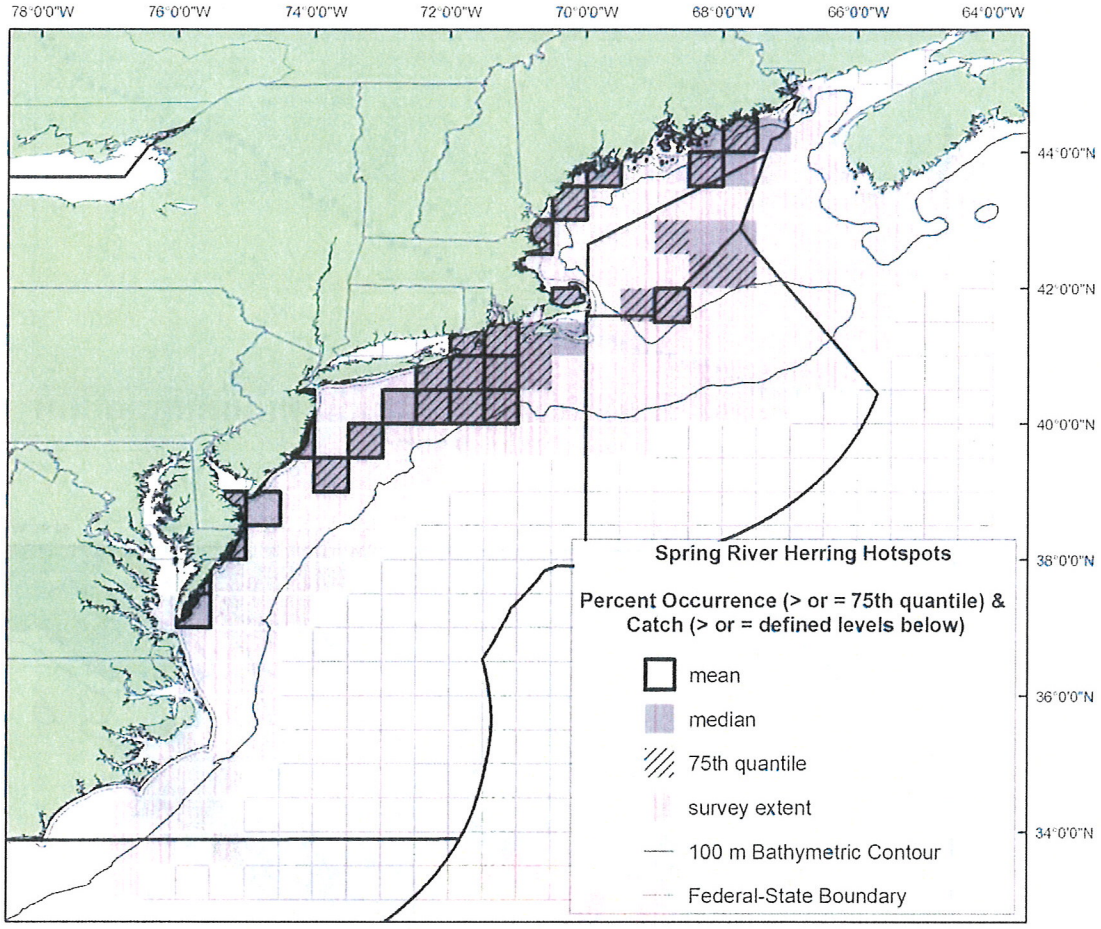


Figure A35: Spring candidate "hot spot" quarter degree squares identified as squares with percent occurrence and mean catch in number ≥ the 75th quantiles of both variables (yellow outlined squares), percent occurrence and median catch in number ≥ the 75th quantiles of both variables (red squares), and percent occurrence and catch in number ≥ the 75th quantiles of both variables (hatched squares). Source: Spring 1968-2008 NMFS bottom-trawl surveys.

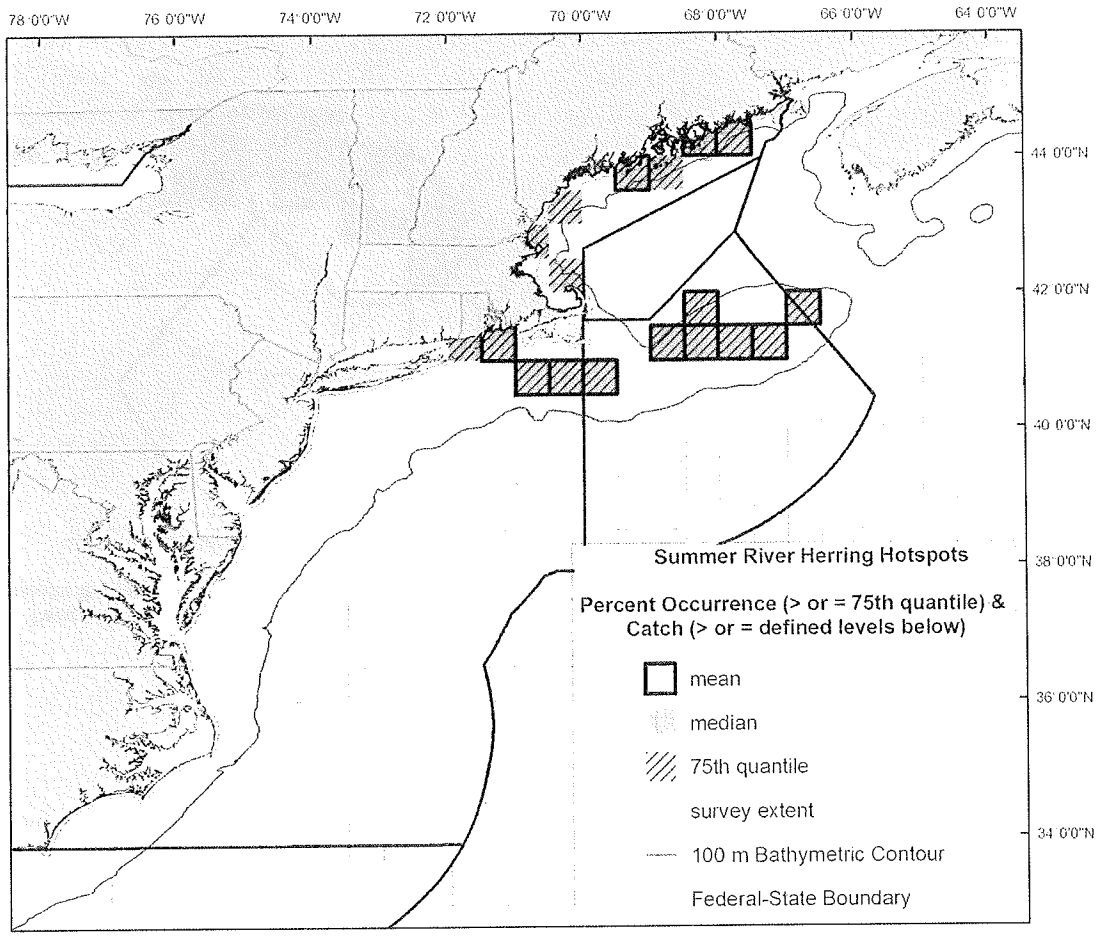


Figure A36: Summer candidate "hot spot" quarter degree squares identified as squares with percent occurrence and mean catch in number ≥ the 75th quantiles of both variables (yellow outlined squares), percent occurrence and median catch in number ≥ the 75th quantiles of both variables (red squares), and percent occurrence and catch in number ≥ the 75th quantiles of both variables (hatched squares). Source: Summer 1948-1995 NMFS bottom-trawl surveys.

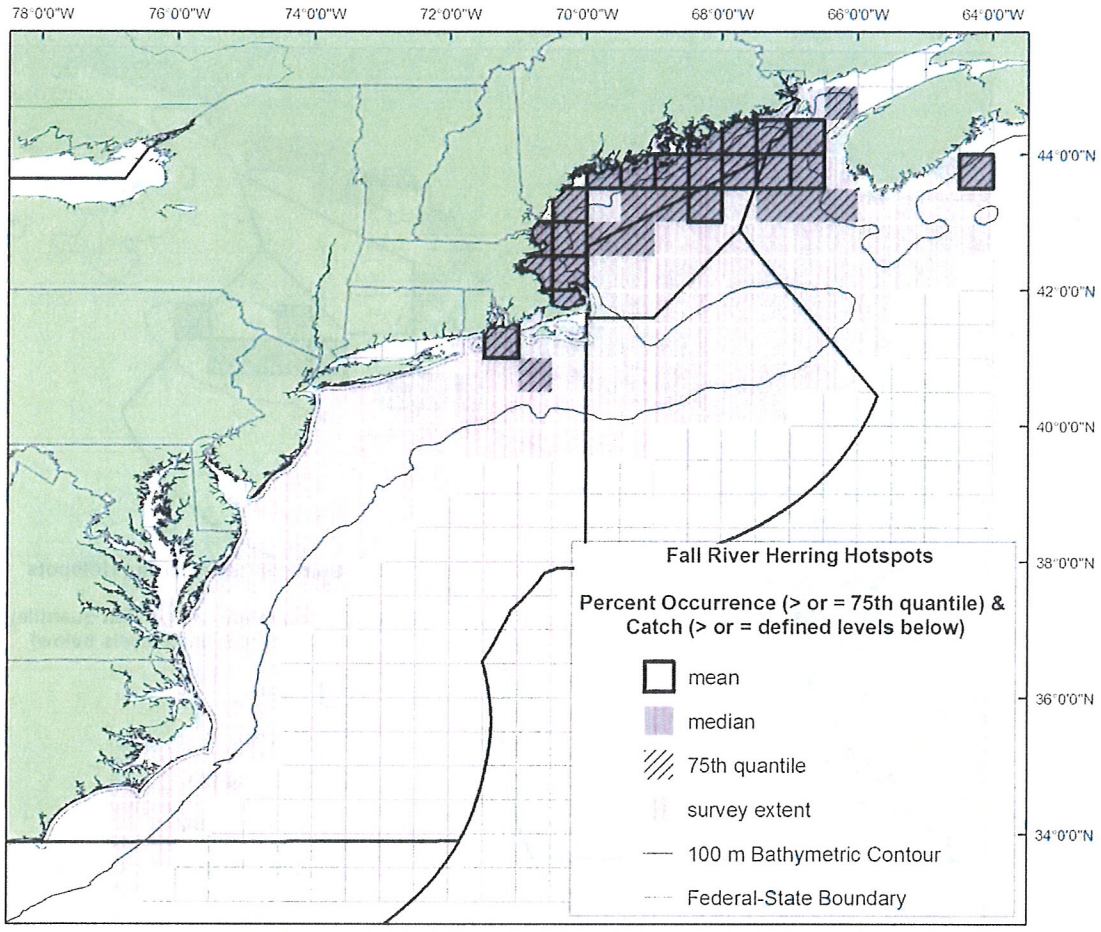


Figure A37: Fall candidate "hot spot" quarter degree squares identified as squares with percent occurrence and mean catch in number ≥ the 75th quantiles of both variables (yellow outlined squares), percent occurrence and median catch in number ≥ the 75th quantiles of both variables (red squares), and percent occurrence and catch in number ≥ the 75th quantiles of both variables (hatched squares). Source: Fall 1963-2008 NMFS bottom-trawl surveys.

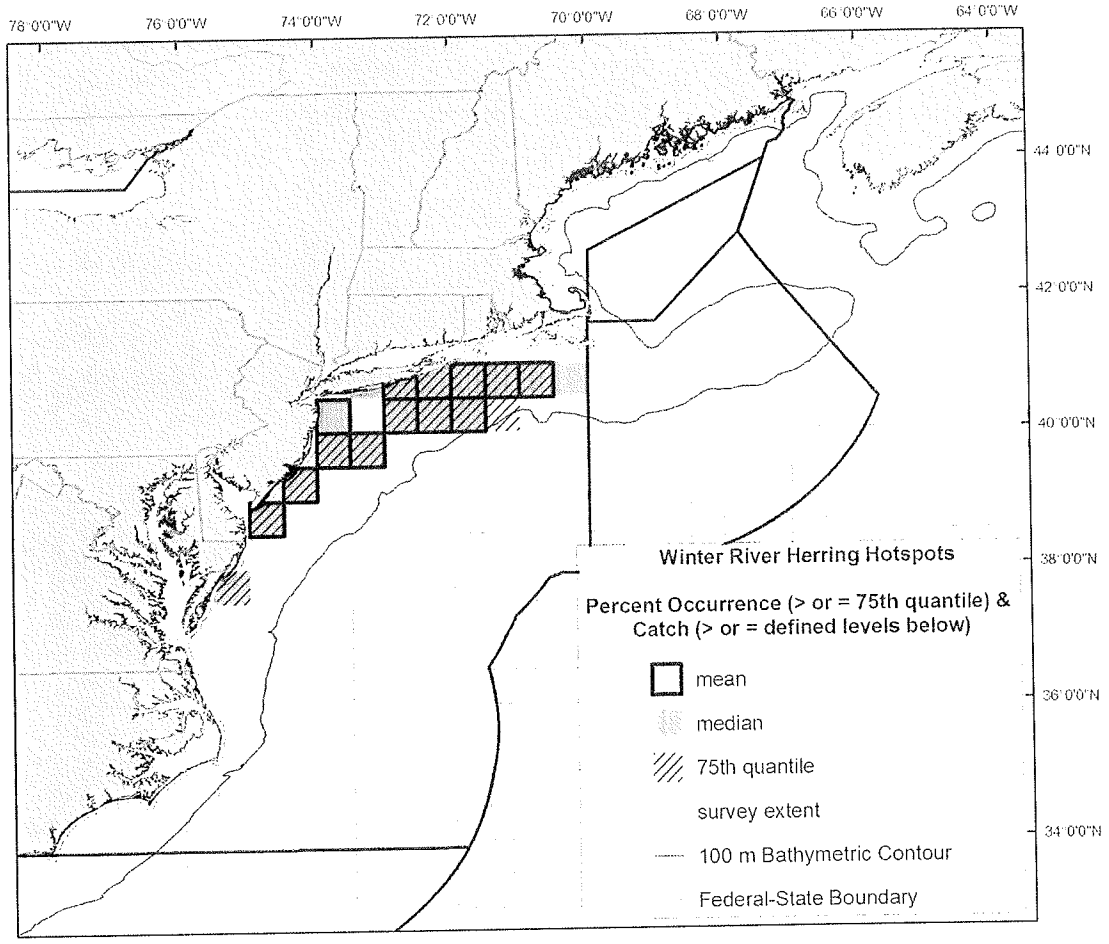


Figure A38: Winter candidate "hot spot" quarter degree squares identified as squares with percent occurrence and mean catch in number ≥ the 75th quantiles of both variables (yellow outlined squares), percent occurrence and median catch in number ≥ the 75th quantiles of both variables (red squares), and percent occurrence and catch in number ≥ the 75th quantiles of both variables (hatched squares). Source: Winter 1963-2007 NMFS bottom-trawl surveys.