Detailed Analysis of Impacts of Management Measures Under Consideration in Amendment 5 to Address River Herring Bycatch

This document provides a detailed technical analysis and assessment of the potential impacts of the management alternatives under consideration in Amendment 5 to address river herring bycatch. Section 5.4 of the Amendment 5 EIS (Volume I) provides a thorough assessment of the impacts of the measures under consideration on each of the five valued ecosystem components (VECs) in Amendment 5 and evaluates the impacts of the options under consideration relative to each other and relative to the no action alternative. This document is intended to supplement the discussion in Section 5.4 and provides the technical details associated with the modeling and analyses conducted by the Herring PDT. This information forms the basis of the discussion presented in Section 5.4 and is incorporated into the Amendment 5 Draft EIS by reference.

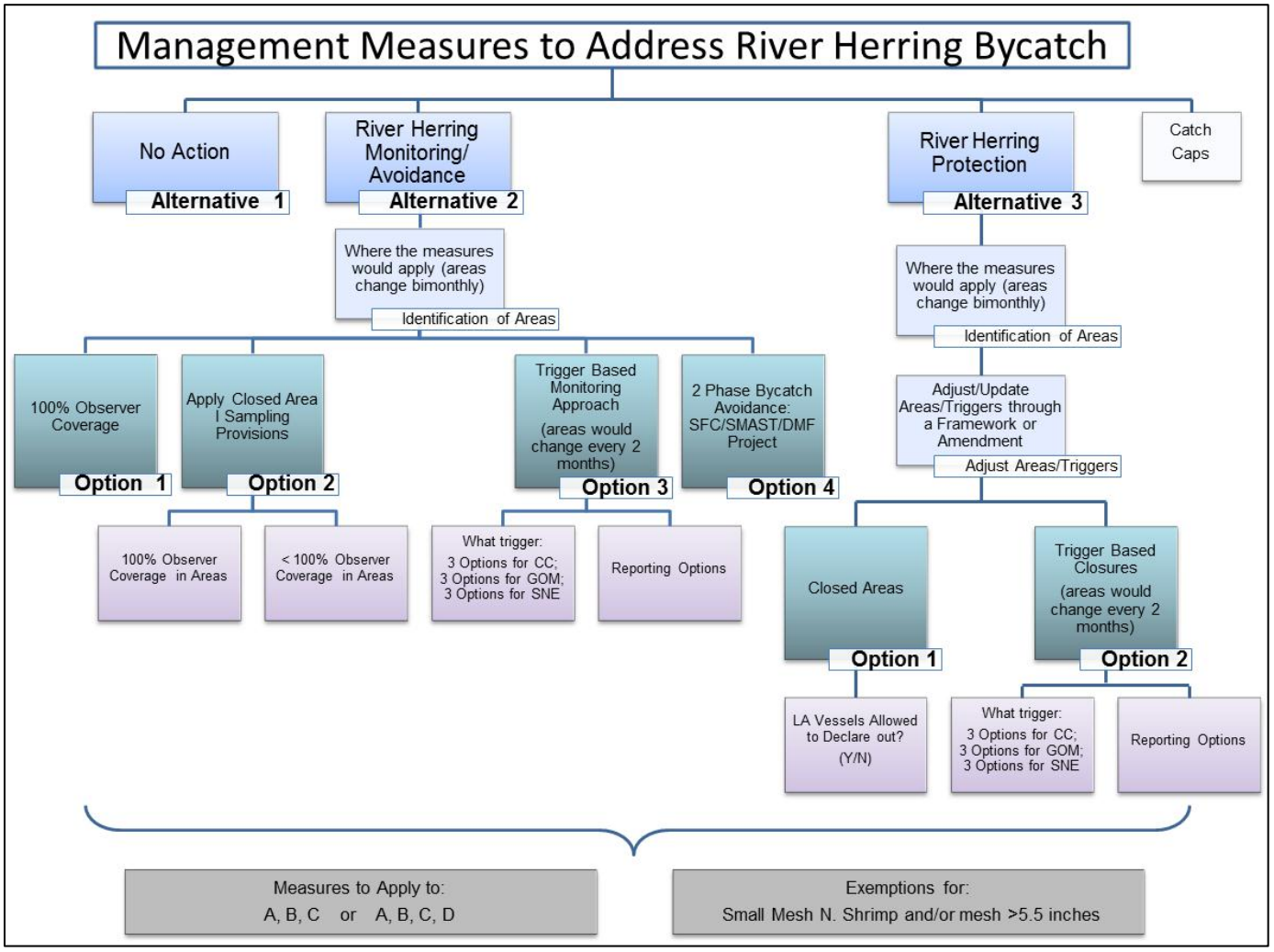
1.0 BACKGROUND

1.1 ALTERNATIVES UNDER CONSIDERATION

- **Alternative 1: No Action (Status Quo, no additional measures to address river herring bycatch in Amendment 5)**
- **Alternative 2: River Herring Monitoring/Avoidance**
    - Establishment of River Herring Monitoring/Avoidance Areas
    - **Option 1:** 100% Observer Coverage in RH Monitoring/Avoidance Areas with sub-options for vessels to which the option applies
    - **Option 2:** Closed Area I Sampling Provisions in RH Monitoring/Avoidance Areas with sub-options for 100% observer coverage or less than 100% coverage, and sub-options for vessels to which the option applies
    - **Option 3:** Trigger-Based Monitoring with sub-options for RH catch triggers and related catch reporting requirements (either Option 1 or Option 2 would apply if/when trigger is reached)
    - **Option 4:**Two-Phase Bycatch Avoidance Approach Based on SFC/SMAST/DMF Project (Phase I in Amendment 5 establishes areas, works with industry to obtain more information, and establishes a mechanism for implementing bycatch avoidance strategies, if appropriate, after the project is completed; Phase II requires a follow-up meeting and determination of appropriate action after the project is completed)
- **Alternative 3: River Herring Protection**
    - Establishment of River Herring Protection Areas
    - **Option 1:** Closed Areas for A/B/C/D permit holders fishing with mesh smaller than 5.5 inches with a sub-option for limited access herring vessels to declare out of the fishery for a period of time
    - **Option 2:** Trigger-Based Protection Areas with sub-options for RH catch triggers and related catch reporting requirements (Protection Areas would be implemented if/when trigger is reached)
- **Mechanism for Adjusting/Updating River Herring Areas/Triggers**

- **River Herring Catch Caps** (mechanism to implement catch caps through a framework adjustment or the specifications process, following completion of a stock assessment by ASMFC); technical analyses related to river herring catch caps are provided in *Appendix V*; river herring catch caps are therefore not analyzed further in this document.

Figure 1 Summary of Amendment 5 Measures Under Consideration to Address River Herring Bycatch



1.2 RELATIONSHIP TO GOALS AND OBJECTIVES

The management measures under consideration in Amendment 5 to address river herring bycatch relate to the overall goal of Amendment 5: - to develop an amendment to the Herring FMP to improve catch monitoring and ensure compliance with the Magnuson-Stevens Fishery Conservation and Management Act (MSA). These measures also directly address the first three objectives of Amendment 5: (1) to implement measures to improve the long-term monitoring of catch (landings and bycatch) in the herring fishery; (2) to implement other management measures as necessary to ensure compliance with the MSA; and (3) to implement management measures to address bycatch in the Atlantic herring fishery.

Some of the measures under consideration to address river herring bycatch are likely to improve catch monitoring across the herring fishery and particularly in areas where river herring encounters may be expected and may therefore address the more specific goals and objectives of the Amendment 5 catch monitoring program. Moreover, the measures under consideration directly address MSA National Standard 9 (bycatch) – *Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.*

1.3 COINCIDENCE OF RIVER HERRING AND SHAD

Much work has been done to evaluate and minimize the impact of the Atlantic herring fishery on river herring species. There has been comparatively little discussion about the impact upon shad species. Since shad and river herring are closely related and share similar life histories, the question has arisen as to whether management measures enacted to protect river herring might also extend substantial protection to shad.

For the purposes of the analysis within this sub-section, American shad (*Alosa sapidissima*) and hickory shad (*Alosa mediocris*) were grouped together as "shad" and alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*) were grouped together as "river herring."

To evaluate the coincidence of shad and river herring in bycatch from the Atlantic herring fishery, bycatch estimates from NEFOP observed trips that landed over 2000 pounds of Atlantic herring from 2005 to 2009 were examined. Of the 1,099 individual hauls that were observed, 287 (26%) encountered river herring and 102 (9%) encountered shad (Table 1). Almost two-thirds of the hauls that caught shad also caught river herring, and over 80% of the shad catch came from hauls that also caught river herring (Table 2). The level of coincidence between the two species groups is even greater when the spatial distribution of bycatch events is considered. Only 4% of the ten-minute squares with observed tows had shad bycatch and no river herring bycatch (Table 3, Figure 2, Figure 3, Figure 4). Furthermore, the shad caught from those areas only account for 1% of the total shad bycatch. Therefore, it appears safe to assume that area-based management actions designed to protect river herring will likely also protect shad.

Table 1 Numbers of NEFOP Observed Hauls with River Herring (RHERR) and/or Shad on Trips that Landed Over 2,000 lbs. of Atlantic Herring, 2005-2009

	Bottom Trawl	Midwater Trawl	Purse Seine	Total
total observed hauls	169	768	162	1,099
hauls with RHERR	102	178	7	287
hauls with SHAD	17	84	1	102
hauls with both RHERR and SHAD	8	57	1	66
hauls with SHAD, but no RHERR	9	27	-	36

Source: MA DMF

Table 2 Estimated River Herring (RHERR) and Shad Bycatch from NEFOP Observed Trips that Landed over 2,000 lbs. of Atlantic Herring, 2005-2009

Estimated Bycatch (pounds)	Bottom Trawl	Midwater Trawl	Purse Seine	Total
total RHERR bycatch	44,319	540,771	1,041	586,131
total SHAD bycatch	1,974	45,587	128	47,689
total SHAD from hauls with no RHERR	1,165	6,790	-	7,955

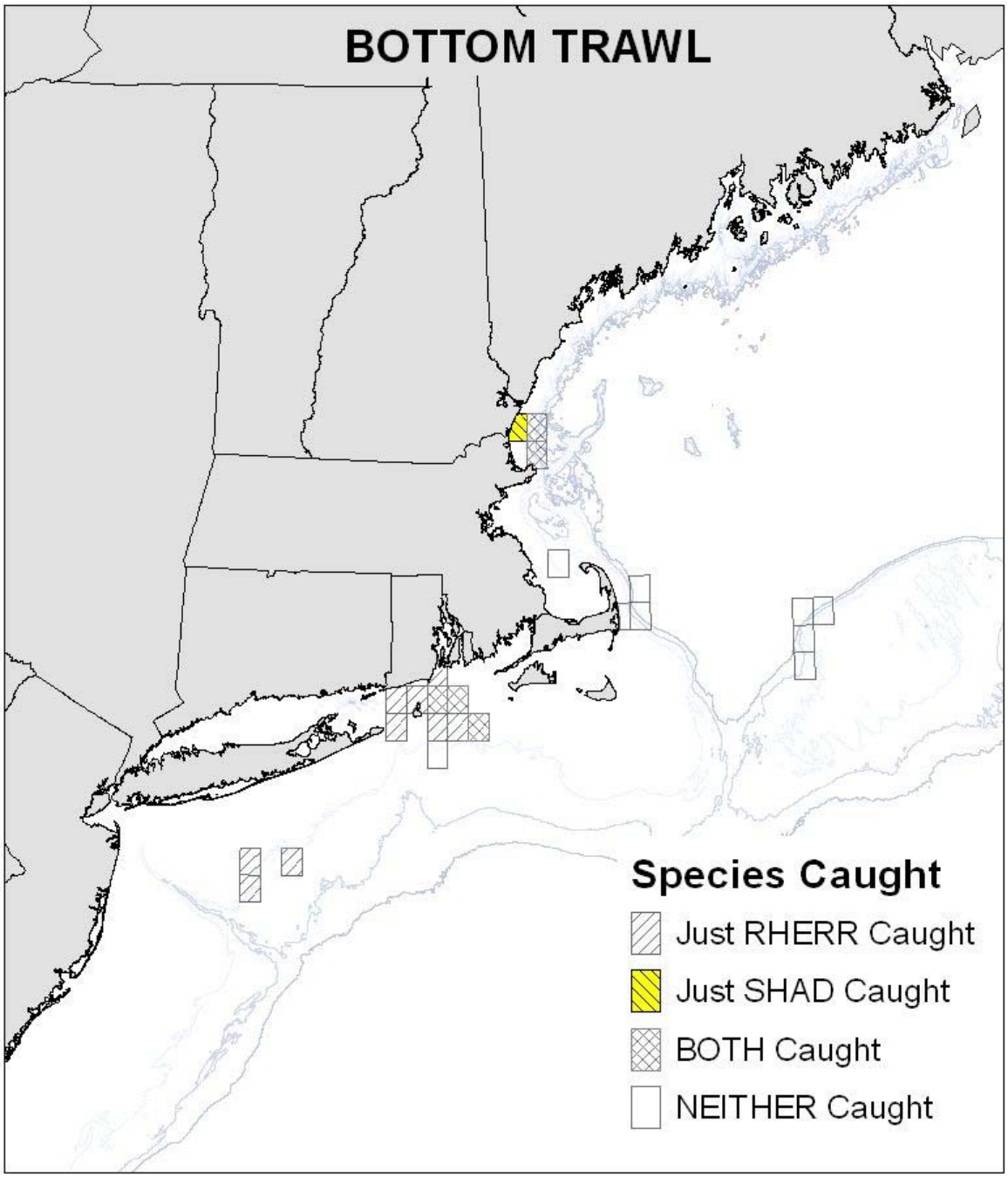
Source: MA DMF

Table 3 Numbers of 10-Minute Squares with Observed Hauls that Encountered Shad, but Not River Herring (RHERR)

	Bottom Trawl	Midwater Trawl	Purse Seine	Total
10-min squares with observed hauls	24	175	29	194
10-min squares with SHAD but no RHERR	1	6	0	7
Shad bycatch (lbs.) from 10-min squares with no RHERR	300	222	0	522

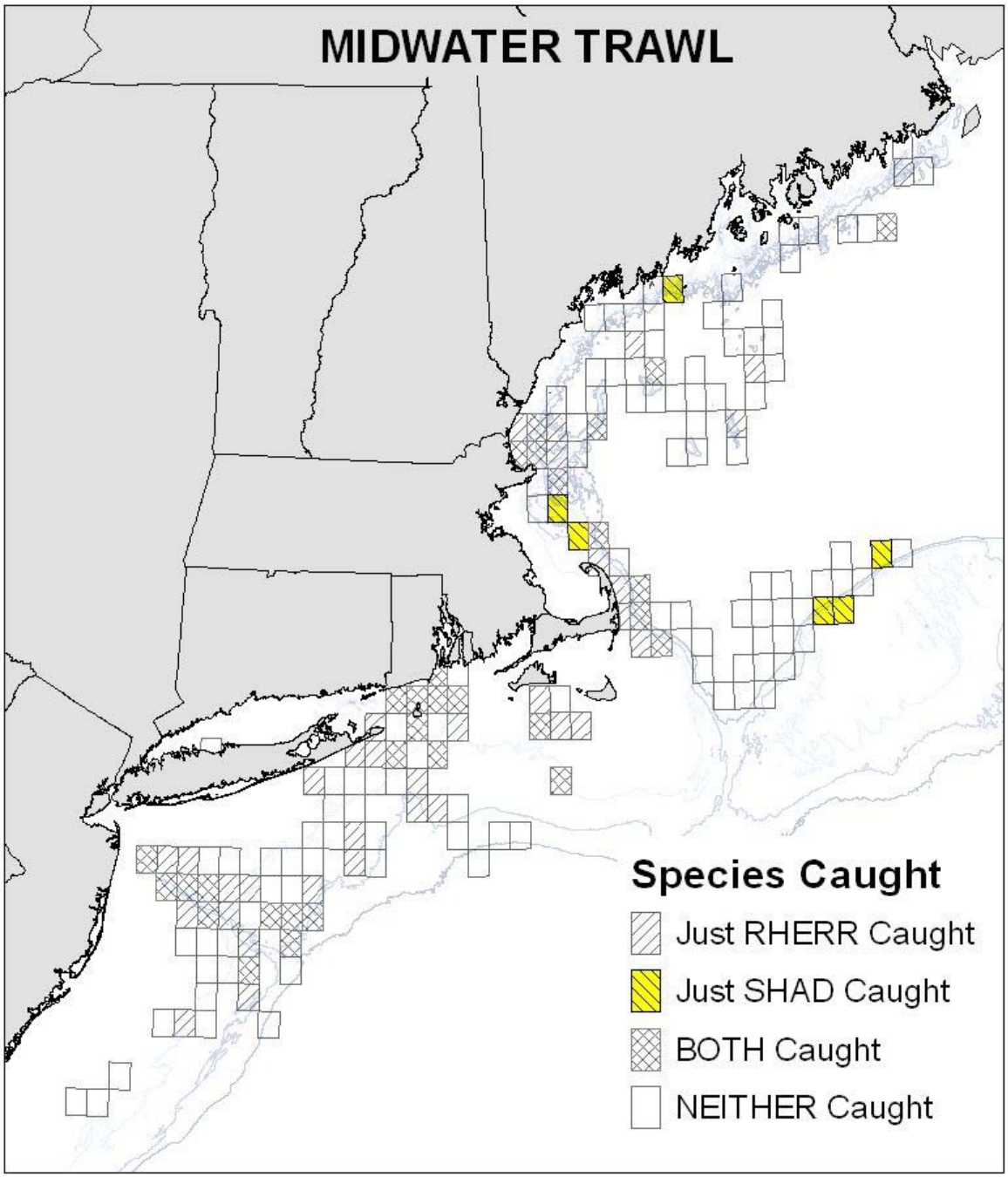
Source: MA DMF

Figure 2 Map of Overlap of Species Caught (Shad and River Herring) by Bottom Trawl Vessel



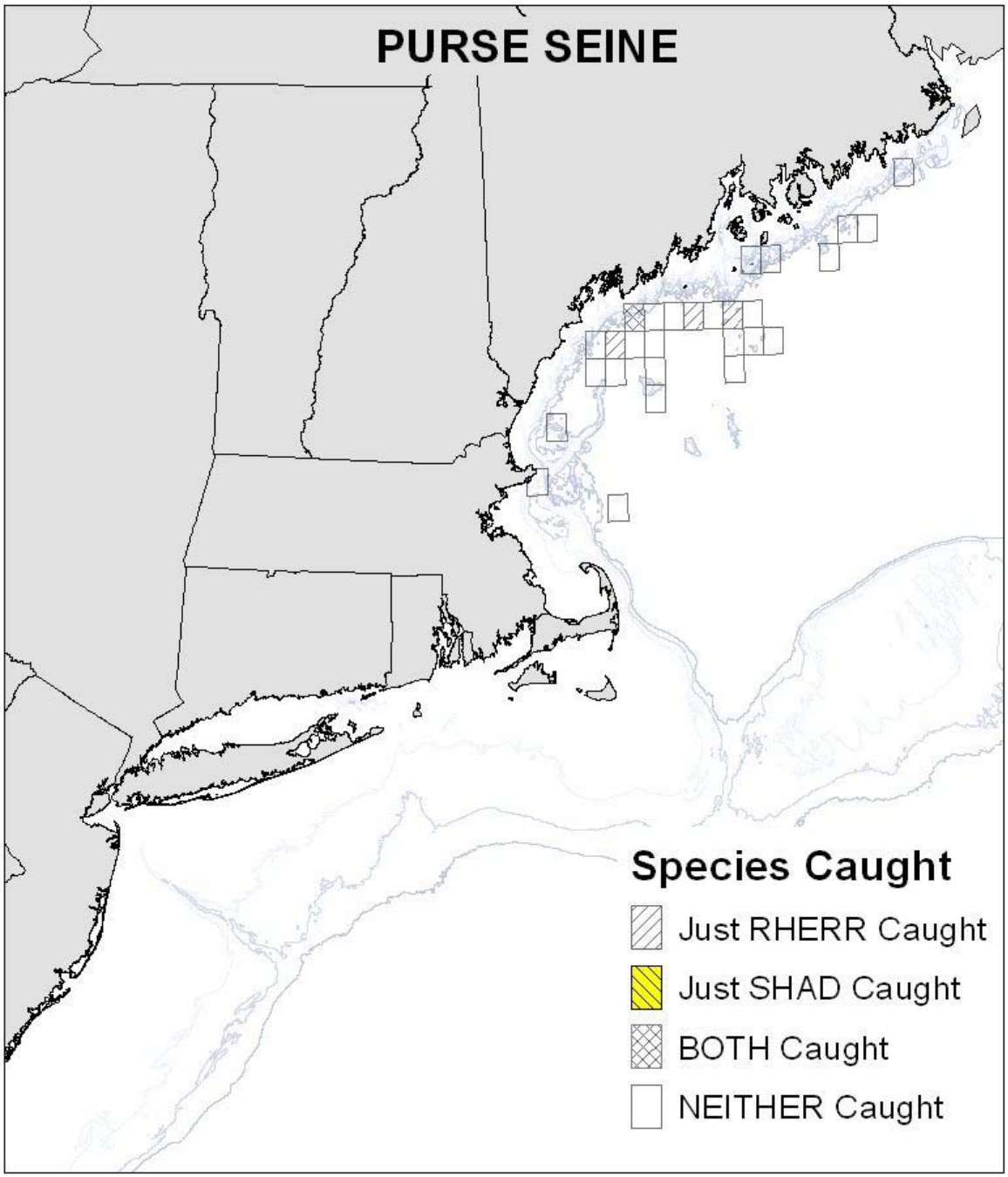
Source: MA DMF

Figure 3 Map of Overlap of Species Caught (shad and river herring) by Midwater Trawl Vessels



Source: MA DMF

Figure 4 Map of Overlap of Species Caught (shad and river herring) by Bottom Trawl Gear



Source: MA DMF

2.0 RIVER HERRING CATCH COMPARISON

To place the most recent (2010) Atlantic herring fishery river herring catch estimate into perspective, a catch estimate comparison was completed. This included summarizing all available published and unpublished studies on at-sea river herring catch (Table 4). Reported river herring catch estimates included data from 1989-2010, although estimates for the directed Atlantic herring fishery were not available for all years. Each study had a different purpose, stratification, and estimation method that should be considered when comparing across different studies. Notably, some studies used kept river herring catch, discarded river herring catch, or both kept and discarded river herring catch in their estimates.

Table 6 compares the most recent estimated river herring catch by the directed Atlantic herring fishery (165,915 lbs.) to that estimated for all at-sea fleets (531,314 lbs.) and the directed in-river fishery for alewife in Maine (1,342,293 lbs.). However, reviewing estimates from years prior to 2010, at-sea river herring catch estimates are highly variable year-to-year as well as associated CVs (Table 4 and Table 5). For example, estimated river herring catch across all at-sea fleets was as a high of 3.6 million lbs. in 1997 for estimates from 1989-2010 (Table 5, Hendrickson and Curti 2011). While estimated river herring catch in the directed Atlantic herring fishery was a high of 1.9 mil lbs. in 2007, for estimates from 2005-2010 (Table 5, Cournane et al. 2010, Cieri 2011).

Table 4 Comparison of Research Studies Estimating At-Sea River Herring Catch

Reference	Catch Type	Years	Management	Fishery	Data Sources	Gear Types	Strata	Sampling Unit	Approach	Ratio
Harrington et al. 2005	K, D	2000, 2003		AH listed as a target species	NEFMC, ASMFC, NMFS herring stock assessment and fishery reports, NEFSC commercial landings, NEFOP	mid-water trawl (single and paired), purse seine	gear, year, species	trips	Extrapolation using discards to landings ratio and the reported level of landings	$D_{ALE\ or\ BBH}/L_{AH}$; $K_{ALE\ or\ BBH}/L_{AH}$
Cieri et al. 2008	K + D	2005-2007	ASMFC RH and Shad FMP A2; NEFMC AH FMP A5	Directed AH fishery, trips with > 2,000 lbs of herring kept or landed	NEFOP, State Portside Sampling Programs (MA, ME)	single midwater trawl, paired midwater trawl , purse seine, bottom-trawl	gear, year, area, quarter	trips	Extrapolation from observer ratio to portside landings	$(D_{RH} + K_{RH})/L_{AH}$
Wigley et al. 2009	D	June 2008-July 2009	SBRM	22 fleets with RH discards	NEFOP, VTR, NEFSC commercial landings database, NOAA MRIP	longline, otter trawl, shrimp trawl, scallop trawl, gillnet, purse seine, scallop dredge, midwater trawl (single and paired), traps	quarter, region, gear type, mesh, access area, and trip category	trips	Estimated discard rate of each fleet multiplied by the corresponding fleet landings in the VTR database, and then summing over fleets	$D_{RH}/K_{all\ species}$
Cournane et al. 2010	K + D	2005-2009	NEFMC AH FMP A5	Directed AH fishery, trips with > 2,000 lbs of herring kept or landed	NEFOP, VTR	midwater trawl (single and paired), purse seine, bottom-trawl	gear, year (and half year), area, quarter	trips	Extrapolation from observer ratio to landings; mean discard rate to landings	$(D_{RH} + Kept_{RH})/L_{AH}$; mean RH /trip * L_{AH}
Lessard and Bryan 2011	K + D	2000-2008		All fisheries with RH and shad catch	NEFOP, VTR	purse seine, midwater trawl (paired and single), bottom-trawl, longline, gillnet, scallop dredge	region, gear, year, species	hauls	Strata specific NEFOP CPUE extrapolated to strata specific VTR hauls	CPUE * hauls
Hendrickson and Curti 2011	K + D	1989-2010	MAFMC SMB FMP A14	All fisheries with RH and shad catch	NEFOP, VTR, NEFSC commercial landings database	Multiple	quarter, region, gear type, mesh	trips	combined ratio method	$(D_{RH} + K_{RH})/K_{all\ species}$
Cieri 2011	K + D	2010	NEFMC AH FMP A5	Declared into AH fishery	NEFOP, VTR, VMS, NEFSC commerical landings database	midwater trawl (single and paired), purse seine, bottom-trawl				

Table 5 At-Sea River Herring Catch Estimated in Research Studies (see Table 4)

Authors	Year	Gear(s)	Catch Type	Species	Catch	Unit	Catch (lbs)	CV	Reference Table
Harrington et al. 2005	2000	midwater trawl	D	ALE	0.004	mt	8.82	-	Table 45, pp.88
Harrington et al. 2005	2003	midwater trawl	D	ALE	0.003	mt	6.61	-	Table 45, pp.88
Harrington et al. 2005	2000	midwater trawl	K	ALE	529.508	mt	1,167,353.34	-	Table 45, pp.88
Harrington et al. 2005	2003	midwater trawl	K	ALE	361.124	mt	796,133.97	-	Table 45, pp.88
Harrington et al. 2005	2000	midwater trawl	K	BBH	28.822	mt	63,540.98	-	Table 45, pp.88
Harrington et al. 2005	2003	midwater trawl	K	BBH	19.657	mt	43,335.82	-	Table 45, pp.88
Harrington et al. 2005	2003	paired midwater trawl	D	ALE	0.86	mt	1,895.96	-	Table 47, pp.89
Harrington et al. 2005	2003	paired midwater trawl	K	ALE	157.59	mt	347,422.91	-	Table 47, pp.89
Cieri et al. 2008	2005	midwater trawl (single and paired), purse seine, bottom-trawl	K + D	RH	285,833	lbs	285,833.00	0.60	Table 2, pp. 10
Cieri et al. 2008	2006	midwater trawl (single and paired), purse seine, bottom-trawl	K + D	RH	171,973	lbs	171,973.00	0.60	Table 2, pp. 10
Cieri et al. 2008	2007	midwater trawl (single and paired), purse seine, bottom-trawl	K + D	RH	1,686,617	lbs	1,686,617.00	0.50	Table 2, pp. 10
Wigley et al. 2009	July 2008-June 2009	shrimp trawl, otter trawl, midwater trawl (single and paired)	D	RH	106,455	lbs	106,455.00	1.49	Table 4, pp. 11
Cournane et al. 2010	2005	midwater trawl (single and paired), purse seine, bottom-trawl	K + D	RH	358,600	lbs	358,600.00	given by sub-area	Table 4, pp. 9
Cournane et al. 2010	2006	midwater trawl (single and paired), purse seine, bottom-trawl	K + D	RH	369,000	lbs	369,000.00	given by sub-area	Table 4, pp. 9
Cournane et al. 2010	2007	midwater trawl (single and paired), purse seine, bottom-trawl	K + D	RH	1,908,800	lbs	1,908,800.00	given by sub-area	Table 4, pp. 9
Cournane et al. 2010	2008	midwater trawl (single and paired), purse seine, bottom-trawl	K + D	RH	972,400	lbs	972,400.00	given by sub-area	Table 4, pp. 9
Cournane et al. 2010	2009	midwater trawl (single and paired), purse seine, bottom-trawl	K + D	RH	766,900	lbs	766,900.00	given by sub-area	Table 4, pp. 9

Table 5 continued. At-Sea River Herring Catch Estimated in Research Studies (see Table 4)

Authors	Year	Gear(s)	Catch Type	Species	Catch	Unit	Catch (lbs)	CV	Reference Table
Lessard and Bryan 2011	2000	Multiple gears	K + D	ALE	2,414,561	lbs	2,414,561.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2001	Multiple gears	K + D	ALE	1,877,641	lbs	1,877,641.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2002	Multiple gears	K + D	ALE	940,268	lbs	940,268.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2003	Multiple gears	K + D	ALE	1,868,052	lbs	1,868,052.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2004	Multiple gears	K + D	ALE	1,044,672	lbs	1,044,672.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2005	Multiple gears	K + D	ALE	871,127	lbs	871,127.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2006	Multiple gears	K + D	ALE	582,714	lbs	582,714.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2007	Multiple gears	K + D	ALE	3,500,890	lbs	3,500,890.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2008	Multiple gears	K + D	ALE	533,356	lbs	533,356.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2000	Multiple gears	K + D	BBH	2,602,342	lbs	2,602,342.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2001	Multiple gears	K + D	BBH	4,657,281	lbs	4,657,281.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2002	Multiple gears	K + D	BBH	7,126,364	lbs	7,126,364.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2003	Multiple gears	K + D	BBH	1,669,084	lbs	1,669,084.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2004	Multiple gears	K + D	BBH	994,206	lbs	994,206.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2005	Multiple gears	K + D	BBH	548,213	lbs	548,213.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2006	Multiple gears	K + D	BBH	527,426	lbs	527,426.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2007	Multiple gears	K + D	BBH	991,492	lbs	991,492.00	-	Table 5, pp. 36
Lessard and Bryan 2011	2008	Multiple gears	K + D	BBH	2,551,356	lbs	2,551,356.00	-	Table 5, pp. 36

Table 5 continued. At-Sea River Herring Catch Estimated in Research Studies (see Table 4)

Authors	Year	Gear(s)	Catch Type	Species	Catch	Unit	Catch (lbs)	CV	Reference Table
Hendrickson and Curti 2011	1989	Multiple gears	K + D	RH	108	mt	238,096.80	0.30	Table 3, pp. 10
Hendrickson and Curti 2011	1990	Multiple gears	K + D	RH	310	mt	683,426.00	0.46	Table 3, pp. 10
Hendrickson and Curti 2011	1991	Multiple gears	K + D	RH	674	mt	1,485,900.40	0.39	Table 3, pp. 10
Hendrickson and Curti 2011	1992	Multiple gears	K + D	RH	1268	mt	2,795,432.80	0.39	Table 3, pp. 10
Hendrickson and Curti 2011	1993	Multiple gears	K + D	RH	1867	mt	4,115,988.20	1.39	Table 3, pp. 10
Hendrickson and Curti 2011	1994	Multiple gears	K + D	RH	134	mt	295,416.40	0.32	Table 3, pp.10
Hendrickson and Curti 2011	1995	Multiple gears	K + D	RH	301	mt	663,584.60	0.4	Table 3, pp. 10
Hendrickson and Curti 2011	1996	Multiple gears	K + D	RH	1613	mt	3,556,019.80	2.59	Table 3, pp. 10
Hendrickson and Curti 2011	1997	Multiple gears	K + D	RH	1633	mt	3,600,111.80	0.71	Table 3, pp. 10
Hendrickson and Curti 2011	1998	Multiple gears	K + D	RH	220	mt	485,012.00	0.93	Table 3, pp. 10
Hendrickson and Curti 2011	1999	Multiple gears	K + D	RH	320	mt	705,472.00	0.68	Table 3, pp. 10
Hendrickson and Curti 2011	2000	Multiple gears	K + D	RH	170	mt	374,782.00	0.47	Table 3, pp. 10
Hendrickson and Curti 2011	2001	Multiple gears	K + D	RH	694	mt	1,529,992.40	0.45	Table 3, pp. 10
Hendrickson and Curti 2011	2002	Multiple gears	K + D	RH	314	mt	692,244.40	0.29	Table 3, pp. 10
Hendrickson and Curti 2011	2003	Multiple gears	K + D	RH	305	mt	672,403.00	0.40	Table 3, pp. 10
Hendrickson and Curti 2011	2004	Multiple gears	K + D	RH	193	mt	425,487.80	0.50	Table 3, pp. 10
Hendrickson and Curti 2011	2005	Multiple gears	K + D	RH	600	mt	1,322,760.00	0.32	Table 3, pp. 10
Hendrickson and Curti 2011	2006	Multiple gears	K + D	RH	456	mt	1,005,297.60	0.59	Table 3, pp. 10
Hendrickson and Curti 2011	2007	Multiple gears	K + D	RH	607	mt	1,338,192.20	0.91	Table 3, pp. 10
Hendrickson and Curti 2011	2008	Multiple gears	K + D	RH	504	mt	1,111,118.40	0.41	Table 3, pp. 10
Hendrickson and Curti 2011	2009	Multiple gears	K + D	RH	364	mt	802,474.40	0.21	Table 3, pp. 10
Hendrickson and Curti 2011	2010	Multiple gears	K + D	RH	241	mt	531,308.60	0.14	Table 3, pp. 10
Cieri 2011	2010	Midwater trawls (single and paired), purse seine	K + D	RH	165,915	lbs	165,915.00	given by sub-area	Table 142, DEIS

Table 6 River Herring Catch Comparison for 2010 Data

Fishery	2010 River Herring Catch Catch (lbs.)		Source
Maine Directed Alewife Landings	1,342,293		Maine DMR
All Fleets (estimated)	531,314	*	NEFSC
Directed Herring Fleet (estimated)	165,915	**	Herring PDT

* High of 3.6 mil lbs. in 1997 (1989-2010)

** High of 1.9 mil lbs. in 2007 (2005-2010)

3.0 SUMMARY OF RIVER HERRING AT-SEA MIGRATORY PATTERNS

In general, river herring at-sea seasonal migratory patterns are reflected using the Herring PDT's hotspot analysis of survey data. Table 7 summarizes the results of the river herring hotspot analysis to identify survey-based areas. River herring travel from southern to northern latitudes from winter through fall, presumably due to temperature fluctuations and timing of in-river spawning, then returning to southern latitudes to overwinter. River herring were relatively more likely to be encountered in the winter in Southern New England waters and the Northern Mid-Atlantic Bight and in the spring in the Gulf of Maine, Southern New England waters, and the Northern Mid-Atlantic Bight. In addition, the winter survey did not operate in the more northern latitudes and the summer survey provided a limited number of observation years. Additional information/analyses provided by the Herring PDT can be found in Volume II, *Appendix III* (Herring PDT Analysis: Development of Measures to Address River Herring Bycatch).

Table 7 Summary of Seasonal River Herring Hotspot Analysis Using NMFS Bottom Trawl Surveys

For each identified season and region combination, the relative likelihood of encountering river herring is summarized by shading in the table (see footnotes).

	Season			
Region	Winter	Spring	Summer	Fall
Scotian Shelf	*		*	
Bay of Fundy	*		*	
Gulf of Maine	*			
Georges Bank				
Southern New England				
Northern Mid-Atlantic Bight				

"*" indicates limited data

Relative likelihood of encountering river herring in hotspots scaled using ranked percent occurrence:

> or = 67% (dark gray), < 67% (light gray), and mixed results (medium gray)

4.0 MAPPING FISHING EFFORT AND REVENUES FROM THE 2010 HERRING FISHING YEAR

Analysis of some of the management alternatives under consideration in Amendment 5 to the Herring Fishery Management Plan requires fine scale spatial data. Permanent and triggered spatial closures of small areas (Quarter Degree squares and the groundfish closed areas) are being considered in this Amendment. These areas do not correspond directly to the statistical areas over which catch is reported. This section describes the general procedure by which 2010 fishing effort, catch, and revenues are mapped using the VMS, VTR, dealer, and observer data. The used are similar to those used by Palmer and Wigley (2007).

The revenues derived from the protection and monitoring areas **should not** be interpreted as changes or losses in revenues or profits associated with implementing monitoring or protection areas for river herring. These are provided to give insight into how much of the herring fleet's activity would be impacted by the proposed alternatives.

Rationale

This procedure is used because the management units (quarter degree squares, QDSQ) are small relative to the statistical areas. VTR data is collected at too coarse of a spatial scale to analyze the impacts of these spatial management measures because only a single location is reported per statistical area. While these single data points may be very accurate for vessels using purse seine gear, it is likely to be fairly inaccurate for vessels using trawl gear. This does not imply any misreporting by participants using trawl gear; however, they cover large amounts of area and a single point does not accurately reflect the location of fishing effort.

Observer data is only available for a subsample of fishing effort. VMS data lacks activities, including catch. The goal of this methods is to locate, more precisely, the fishing effort in the directed herring fishery in order to understand the impacts of the management measures under consideration in Amendment 5.

Methods

The observer data were used to build “profiles” of fishing activity. Haul start and end locations were used to construct “distance traveled.” Haul start and end times were used to construct “time elapsed.” From these two pieces of information, a speed profile was constructed for fishing activities for trawl gear. For trawl gear, fishing occurs at speeds below 5 knots (over ground) and typically well below those speeds. These are similar, but not identical to the findings of Palmer and Wigley (2007). It is not possible to build speed profiles for the purse seine fishery – the locations of start and end are typically the same. The same five-knot cutoff is used to classify purse seine fishing activity; however, this is likely to lead to an over-classification of VMS points as “fishing.” For reference, histograms of VMS speeds for trawl vessels and purse seines are shown in Figure 5 and Figure 6.

The VTR data were used to identify “herring trips” by fishing vessels using the criteria that over 2,000 lbs. of herring were landed on a trip. Some of these “herring trips” may be actually be targeted mackerel trips on which herring were caught and landed incidentally. The data were split into three “fleets”: purse seine (all permit categories), trawl (Categories A, B, and C) , and Category D trawl vessels. Herring catch, herring revenues, and total revenues (herring plus other species) for each trip were extracted from VTR and dealer data.

VMS polls corresponding to those trips were extracted. Points were classified as “fishing” or “traveling” based on the speed criteria (5 knots). Points in obvious non-fishing locations, such as the Cape Cod

Canal and Sakonnet River were classified as “traveling” as well. For VMS polls classified as “fishing,” effort (in hours) was defined as the time elapsed since the previous point. Total effort for a trip was constructed as the sum of effort on that trip. Trip-level catch and revenues of herring and revenues from all other species were allocated to each VMS point which as identified as a fishing point based on the relative of total effort. The catch, effort, and revenue data were spatially joined to the QDSQ map and then aggregated to create catch, effort, and revenue data for each QDSQ, for each “fleet” at the bi-monthly level (Table 8 – Table 11).

Caveats

Use of a 2,000 lb. weight limit may misclassify 'non-herring' trips as herring trips, particularly directed mackerel trips as herring trips. This criteria will include “mackerel” trips which landed herring incidentally, but will not include “mackerel” trips which landed less than 2,000 lbs. of herring. This screen also eliminates unsuccessful trips – trips in which vessels searched for, but did not catch and retain more than 2,000 lbs. of herring.

The classification algorithm is likely to over-classify VMS points as fishing for all gear types, but particularly in the purse seine fleet. In particular, “searching” activities, in which vessels travel at moderate speeds while looking for fish, are likely to be classified “fishing.” There are two reasons for choosing to “over-classify” instead of “under-classify” VMS points as fishing activity.

First, vessels should only search in areas which are promising for catching fish. Therefore, the over-classification of points as fishing effort will identify not just actual catch locations, but potential and likely catch locations as well. Second, any points “misclassified” as fishing are likely to be near actual fishing locations. Aggregation to the level of the QDSQ and then allocation of catch over these areas should minimize the effect of these errors.

The 2010 fishing year had less “offshore fishing effort” than previous years. It is difficult to tell if this effort shifted to nearshore areas or left the fishery. Management Area sub-ACLs for the 2010 fishing year are similar to the sub-ACLs which will be in effect in the near future (2011 and 2012).

Perhaps most importantly, this description of the herring fishery does not include any behavioral changes by the fishing fleet in response to changes in incentives. For some of the options under consideration, a behavioral response is possible. For example, if additional observer coverage is funded by NMFS, vessels may call for an observer more frequently in order to preserve the option of fishing in the monitoring areas. However, if additional coverage is funded by industry, vessels may choose to fish outside of the monitoring areas.

General Results

In general, the monitoring areas overlap with the location of the winter/spring trawl fishery (November-April) and portions of the summer inshore purse seine fishery. The protection areas overlap a portion of the winter trawl fishery (Nov-Feb) and will have minimal impacts on the purse seine fishery. There is minimal overlap between the Category D vessels and the monitoring or protection areas (Figure 7 – Figure 27).

Table 8 Fishing Time (Hrs.) by Bimonthly Period for Purse Seines (PUR) and All Trawl Gears (TR) Separated by Permit Category (ABC or D)

		Fishing Time by Bimonthly Period						
Gear	Category	Jan - Feb	Mar - Apr	May - Jun	Jul - Aug	Sep - Oct	Nov - Dec	Grand Total
PUR				490	1,213	1,115	129	2,947
TR	ABC	3,440	999	712	2,177	2,414	2,364	12,105
	D		10		200	88		298
Grand Total		3,440	1,009	1,202	3,590	3,617	2,493	15,351

Table 9 Percent Fishing Time by Bimonthly Period for Purse Seines (PUR) and All Trawl Gears (TR) Separated by Permit Category (ABC or D)

		Fishing Time by Bimonthly Period (%)						
Gear	Category	Jan - Feb	Mar - Apr	May - Jun	Jul - Aug	Sep - Oct	Nov - Dec	Grand Total
PUR				16.6%	41.1%	37.8%	4.4%	100.0%
TR	ABC	28.4%	8.3%	5.9%	18.0%	19.9%	19.5%	100.0%
	D	0.0%	3.3%		67.1%	29.5%		100.0%
Grand Total		22.4%	6.6%	7.8%	23.4%	23.6%	16.2%	100.0%

Table 10 Herring Catch (Lbs.) by Bimonthly Period for Purse Seines (PUR) and All Trawl Gears (TR) Separated by Permit Category (ABC or D)

		Herring Catch by Bimonthly Period						
Gear	Category	Jan - Feb	Mar - Apr	May - Jun	Jul - Aug	Sep - Oct	Nov - Dec	Grand Total
PUR				1,037,950	5,612,589	10,657,575	1,154,427	18,462,541
TR	ABC	23,150,171	8,390,350	10,954,085	19,839,144	27,783,172	33,986,926	124,103,849
	D		6,500		94,100	48,244		148,844
Grand Total		23,150,171	8,396,850	11,992,035	25,545,833	38,488,992	35,141,353	142,715,233

Table 11 Percent Herring Catch by Bimonthly Period For Purse Seines (PUR) and All Trawl Gears (TR) Separated by Permit Category (ABC or D)

		Herring Catch by Bimonthly Period (%)						
Gear	Category	Jan - Feb	Mar - Apr	May - Jun	Jul - Aug	Sep - Oct	Nov - Dec	Grand Total
PUR				5.6%	30.4%	57.7%	6.3%	100.0%
TR	ABC	18.7%	6.8%	8.8%	16.0%	22.4%	27.4%	100.0%
	D		4.4%		63.2%	32.4%		100.0%
Grand Total		16.2%	5.9%	8.4%	17.9%	27.0%	24.6%	100.0%

Figure 5 Histogram of VMS Speed (Knots) for Trawl Gears

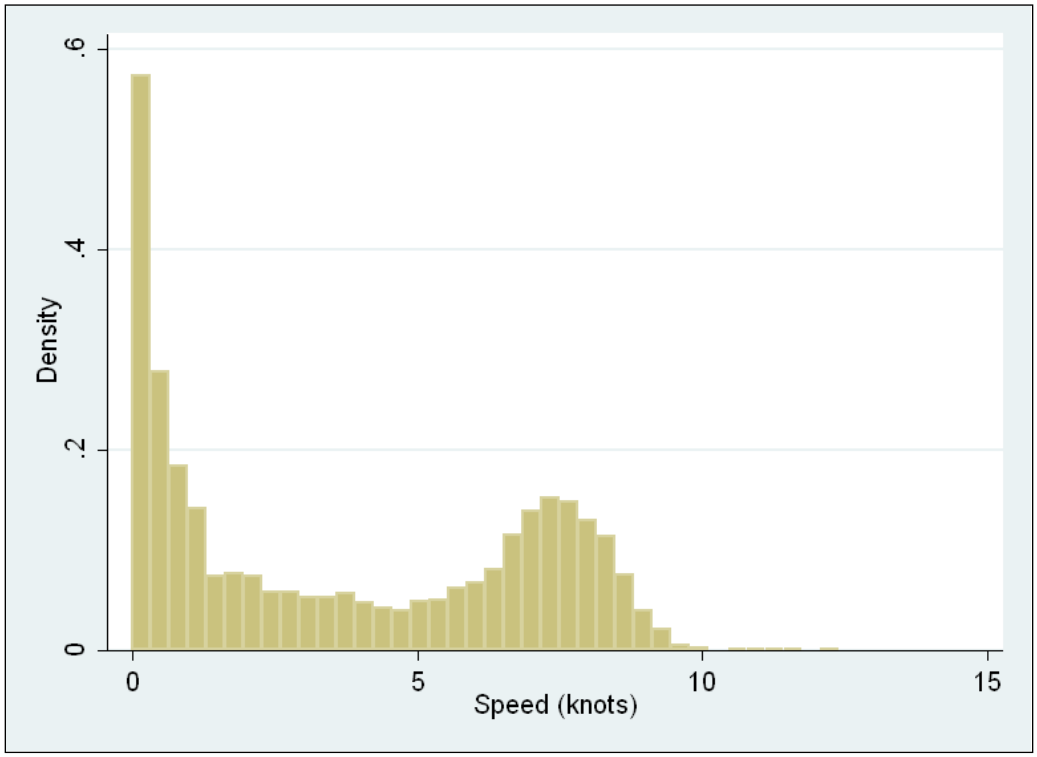


Figure 6 Histogram of VMS Speed (Knots) for Purse Seines

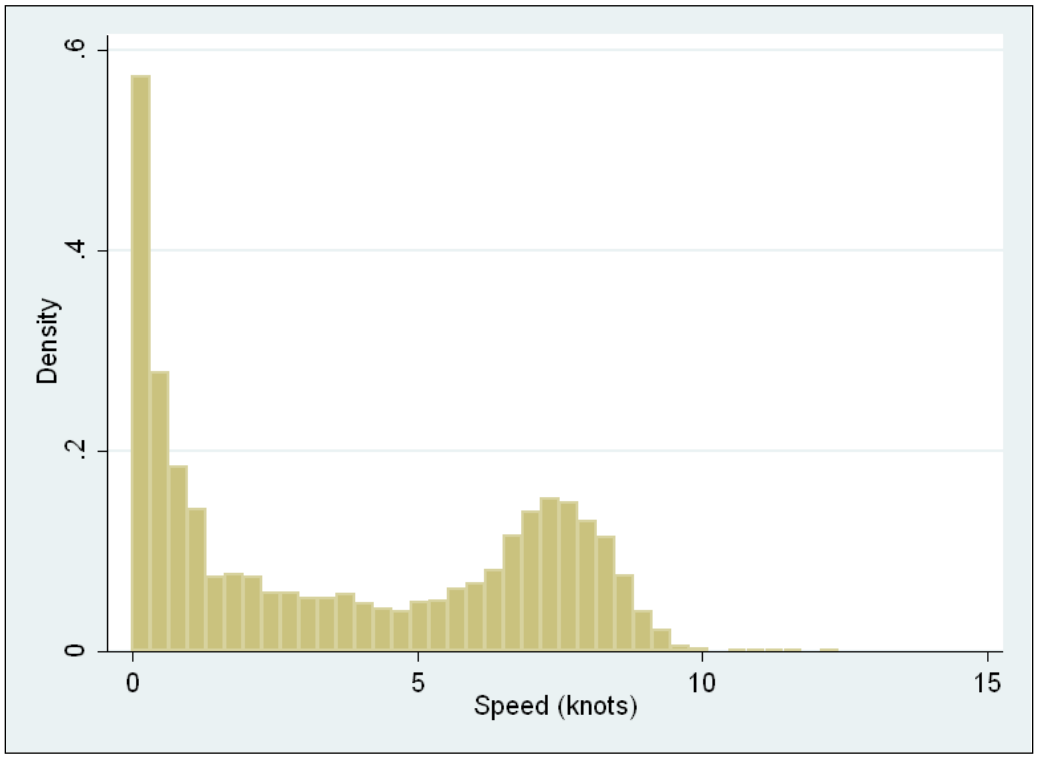


Figure 7 Trawl Effort (ABC only) and Monitoring Areas, January – February

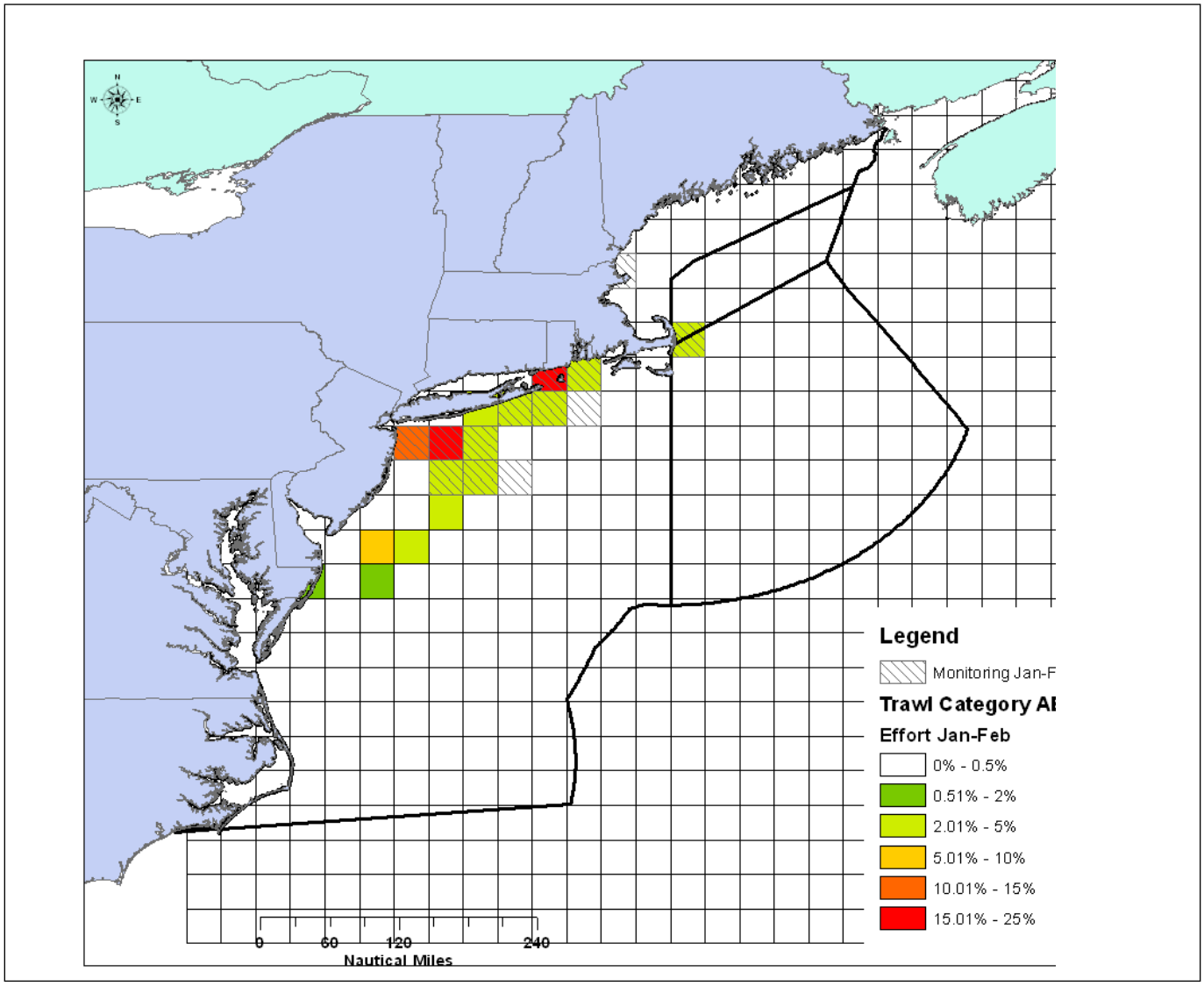


Figure 8 Trawl Effort (ABC only) and Monitoring Areas, March-April

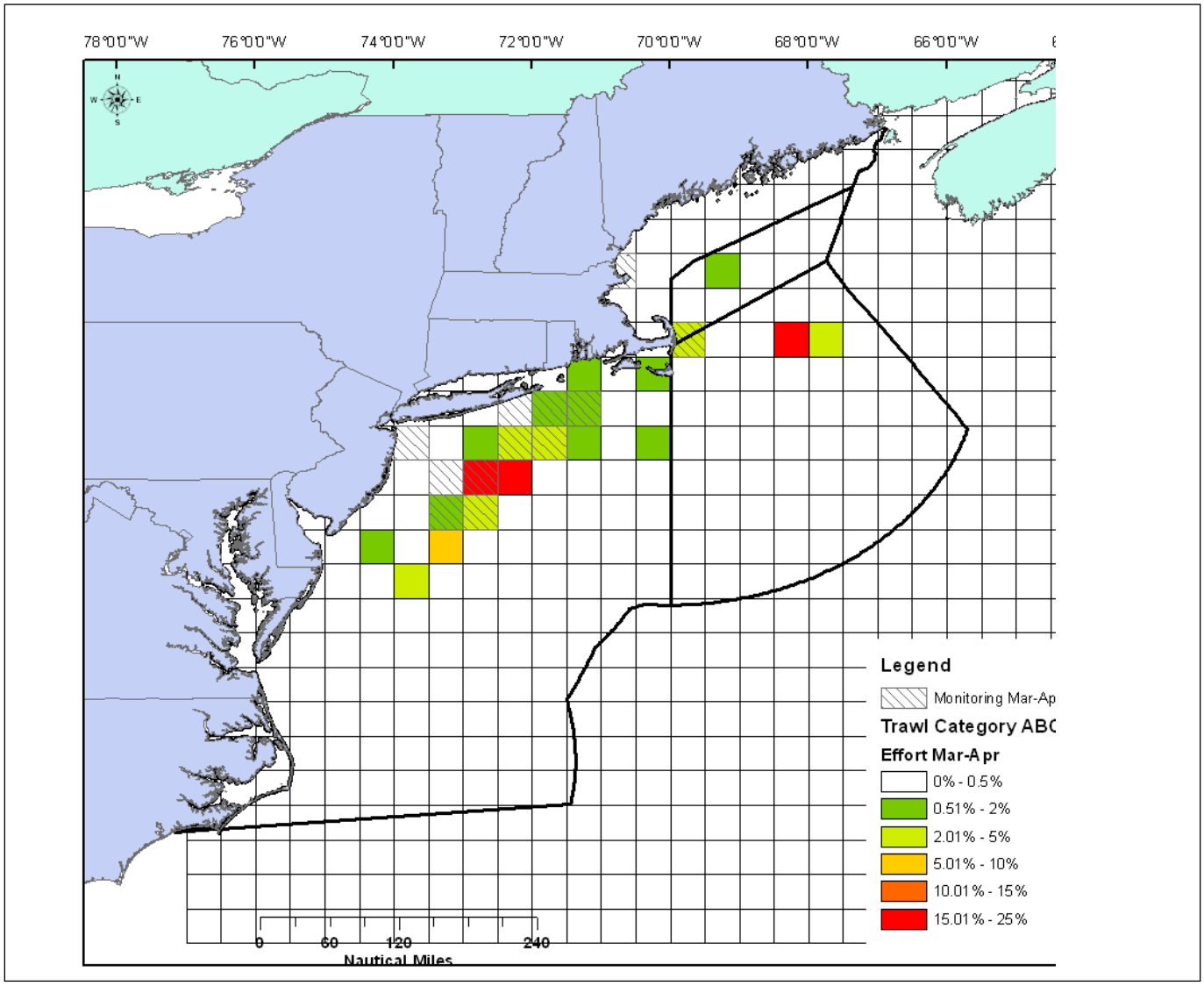


Figure 9 Trawl Effort (ABC only) and Monitoring Areas, May-June

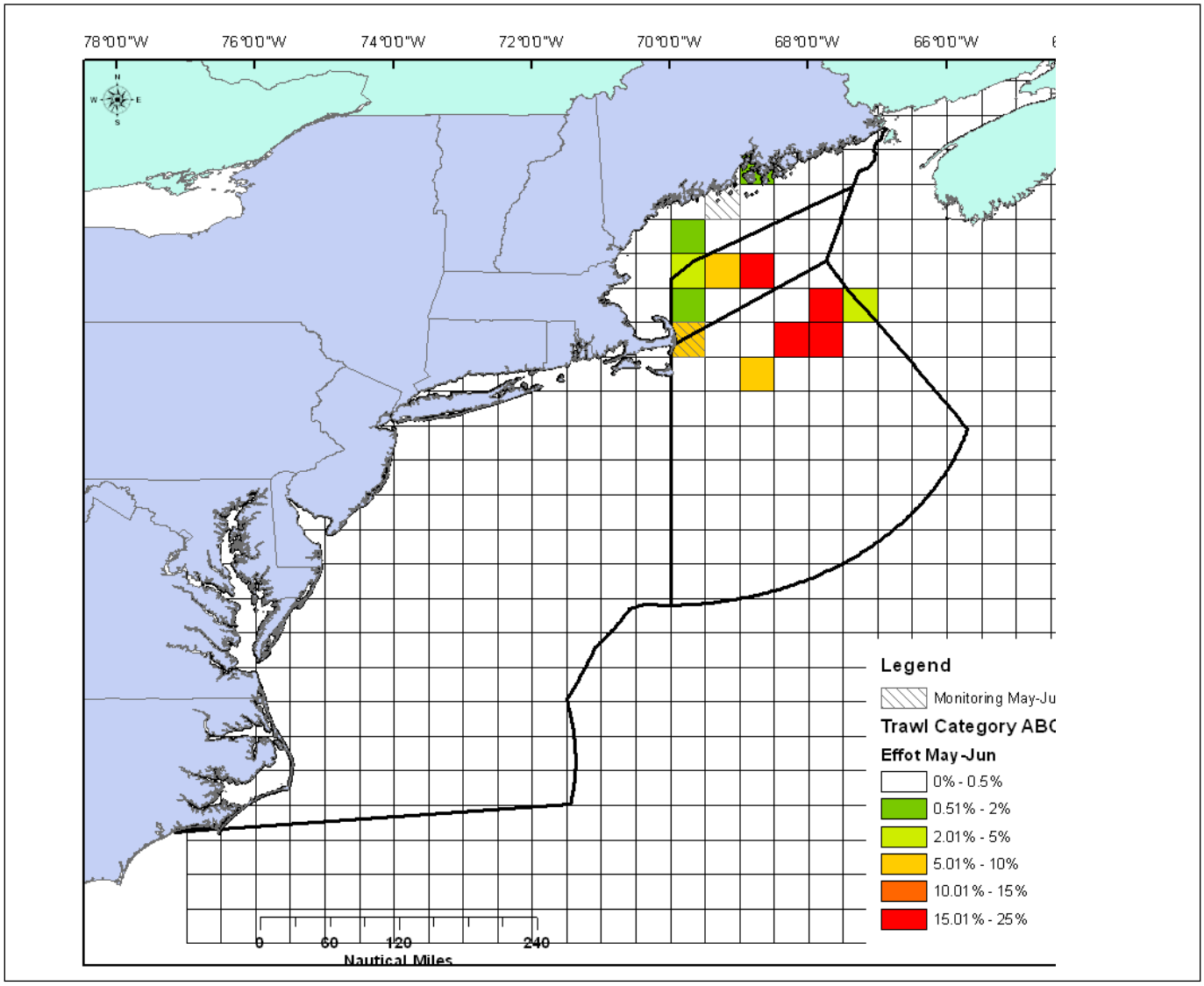


Figure 10 Trawl Effort (ABC only) and Monitoring Areas, July- August

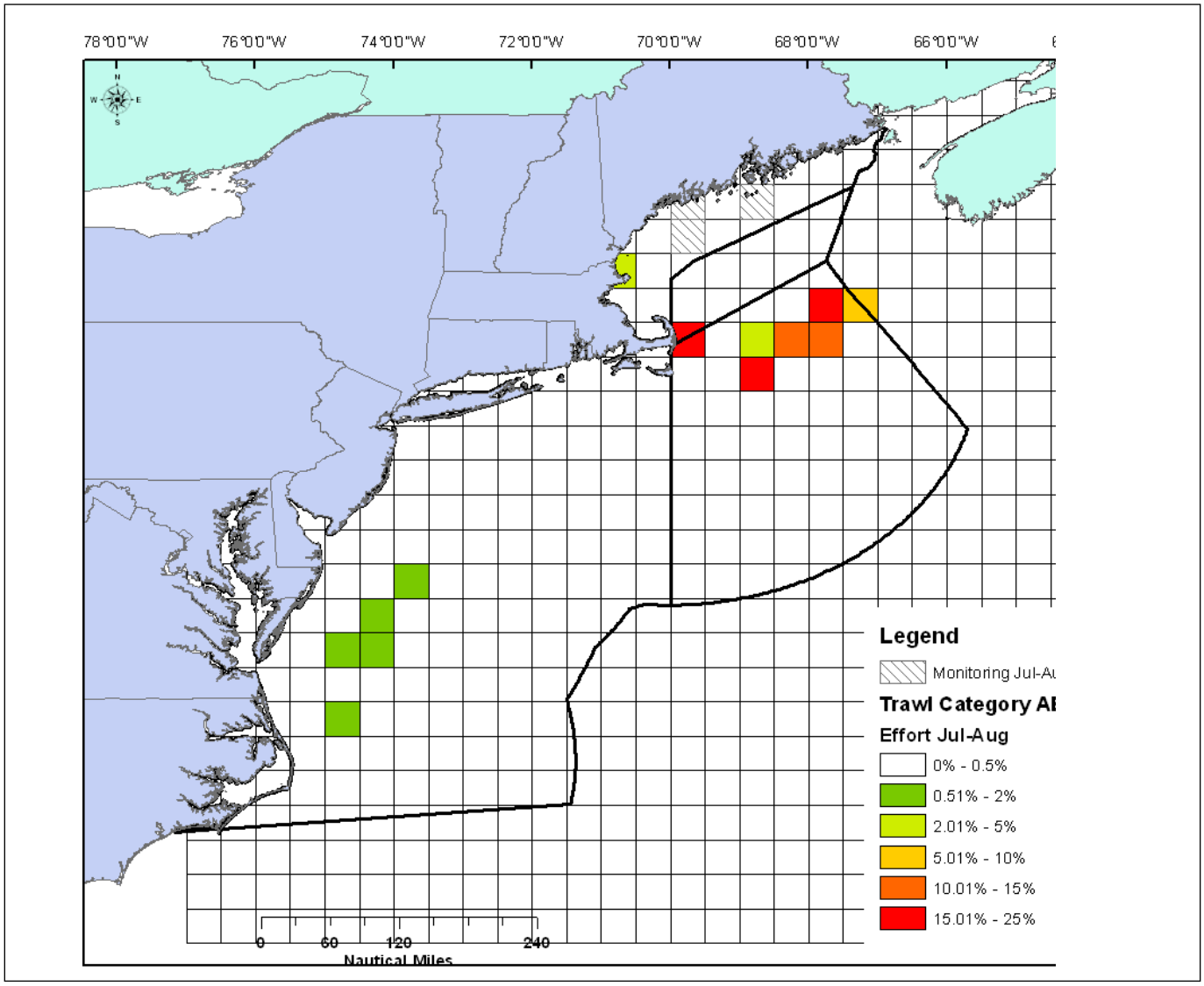


Figure 11 Trawl Effort (ABC only) and Monitoring Areas, September – October

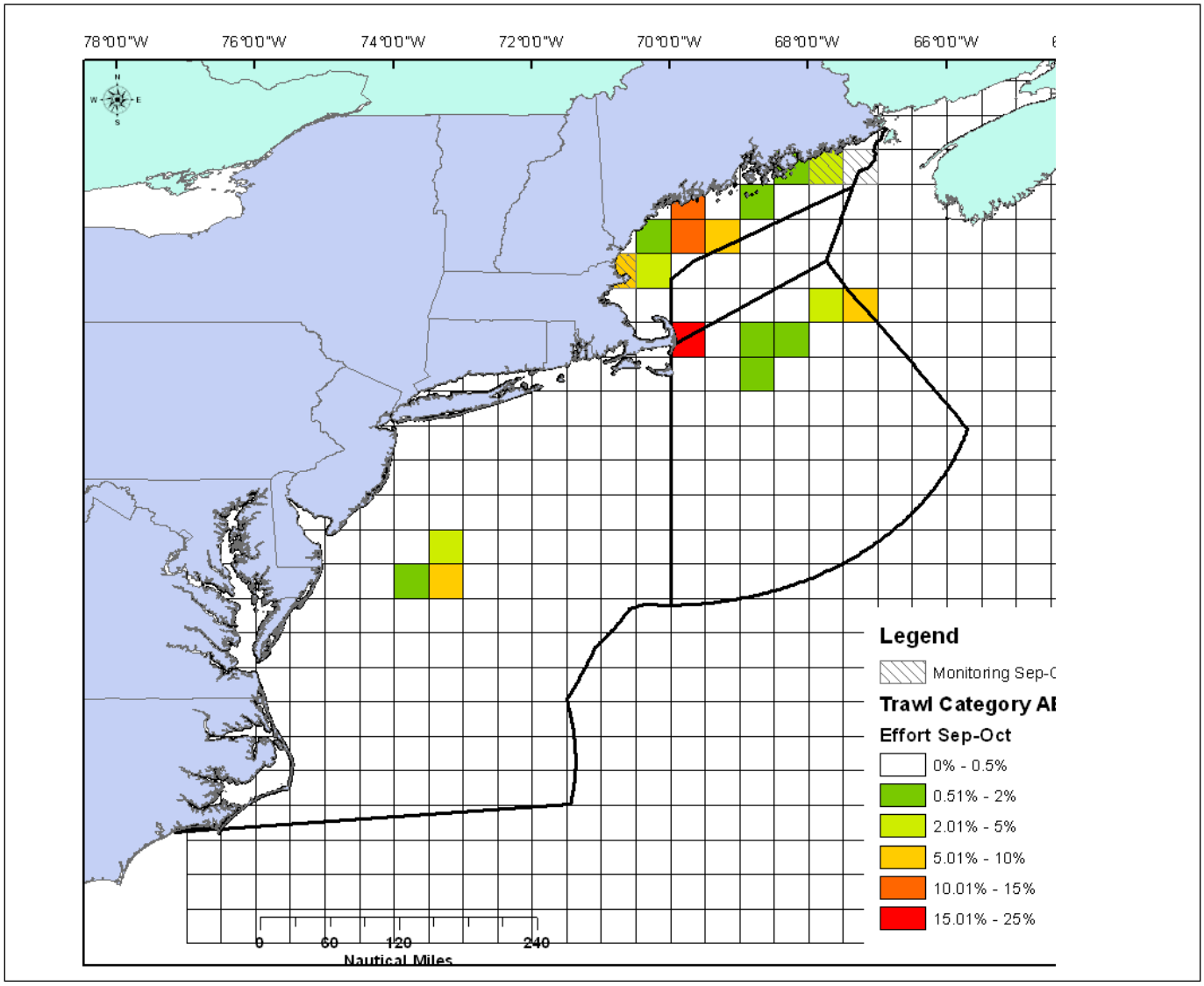


Figure 12 Trawl Effort (ABC only) and Monitoring Areas, November – December

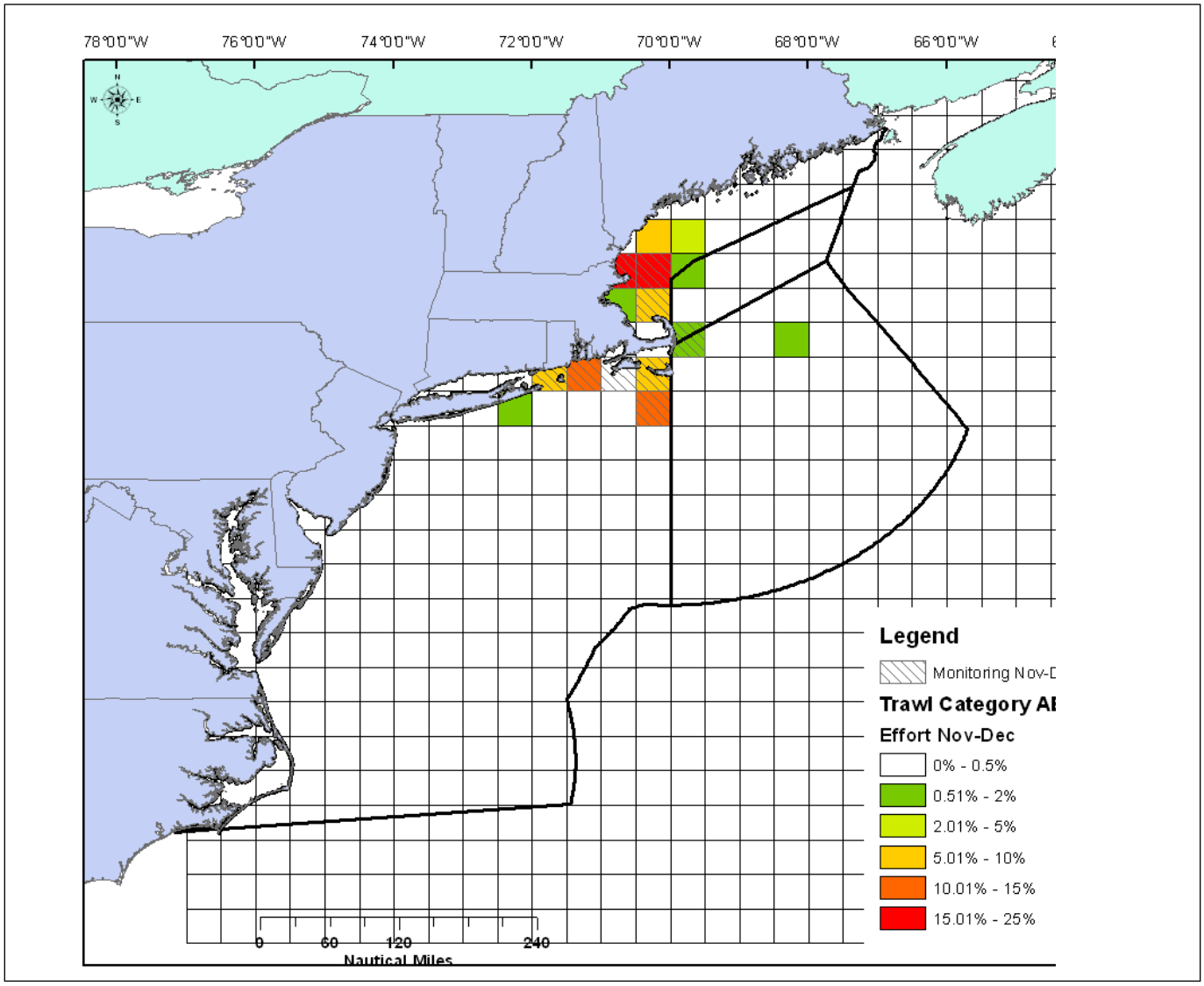


Figure 13 Purse Seine Effort and Monitoring Areas, May-June

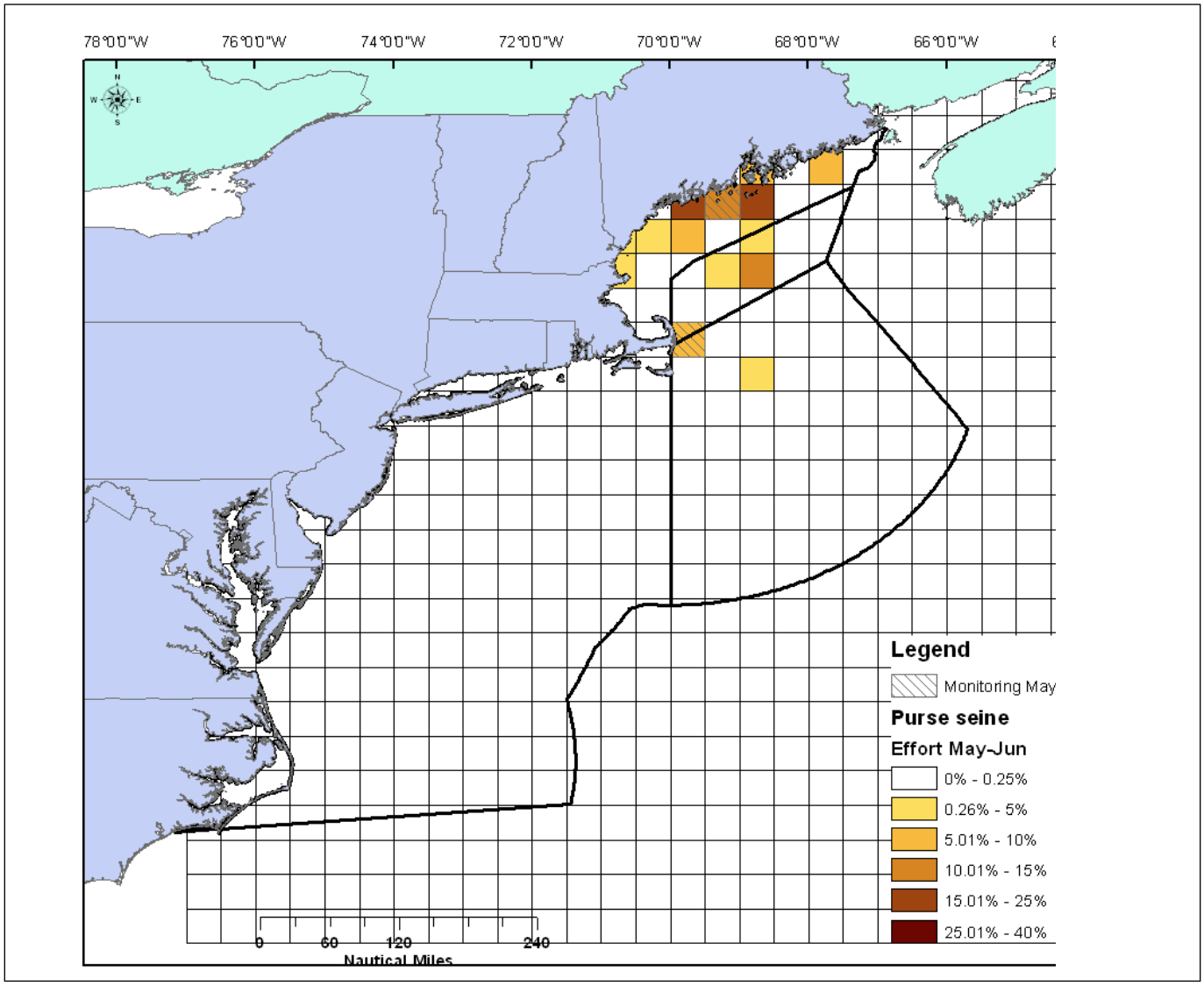


Figure 14 Purse Seine and Monitoring Areas, July – August

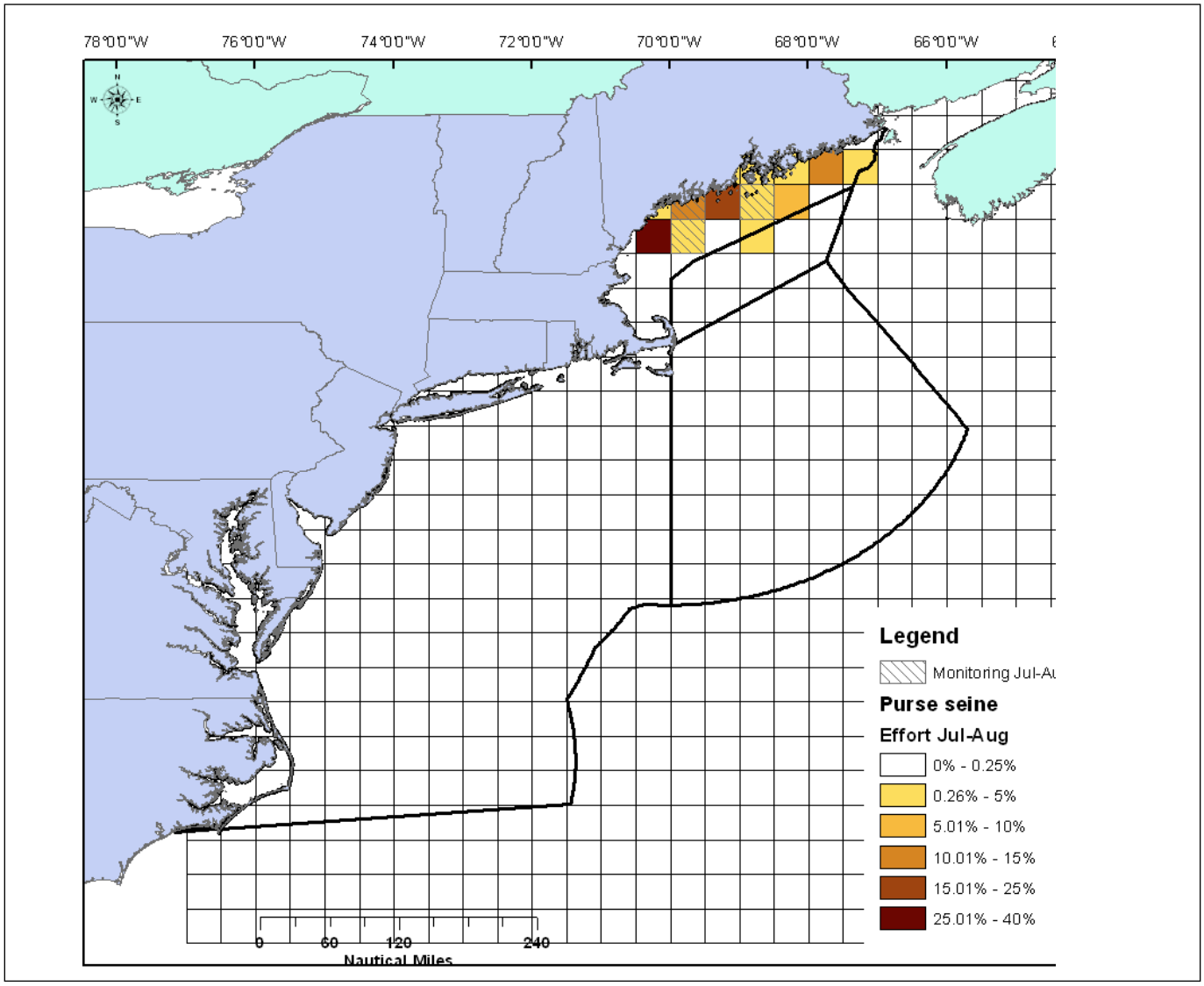


Figure 15 Purse Seine and Monitoring Areas, September – October

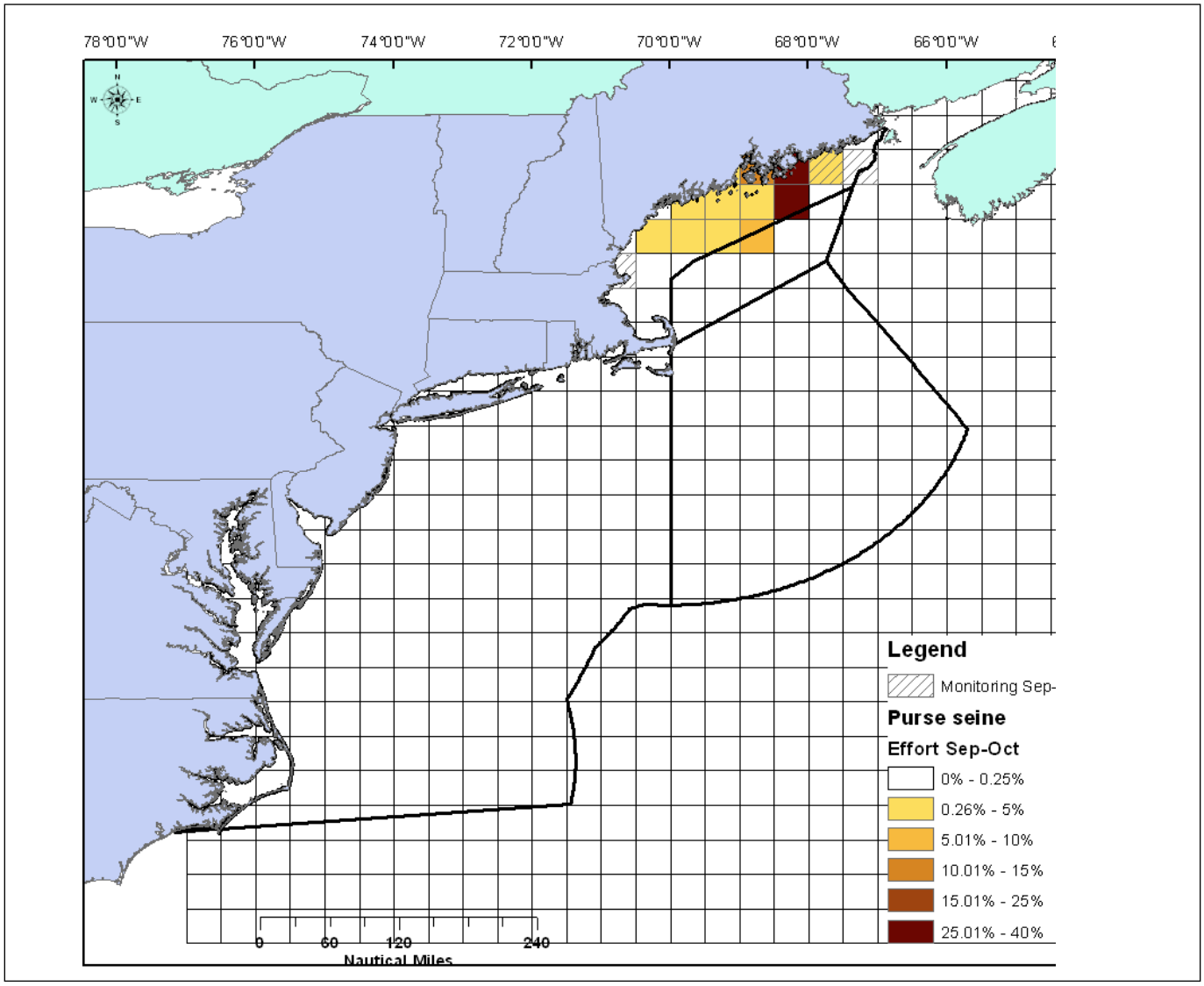


Figure 16 Purse Seine and Monitoring Areas, November – December

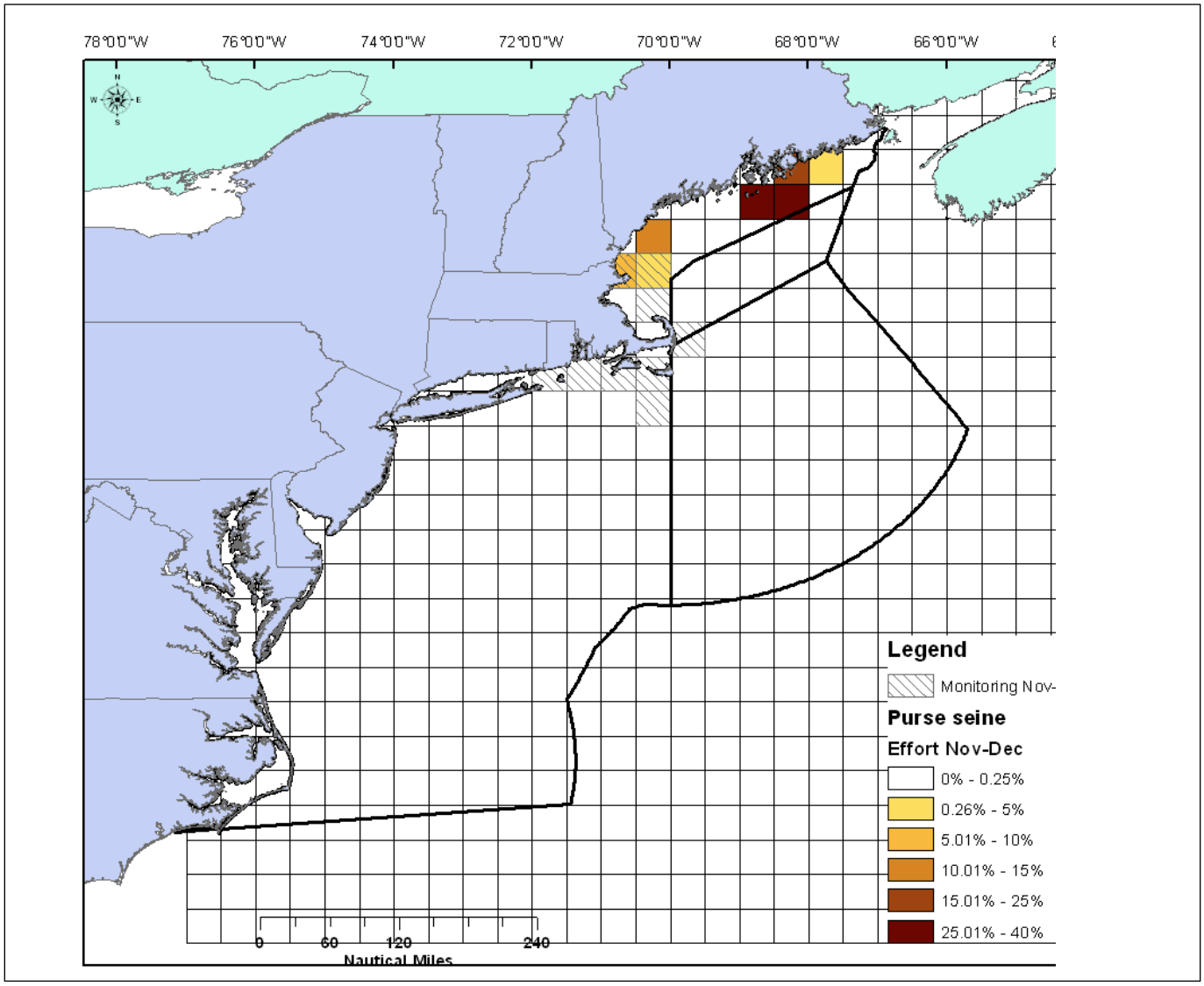


Figure 17 Trawl Effort (Category D Only) and Monitoring Areas, March-April

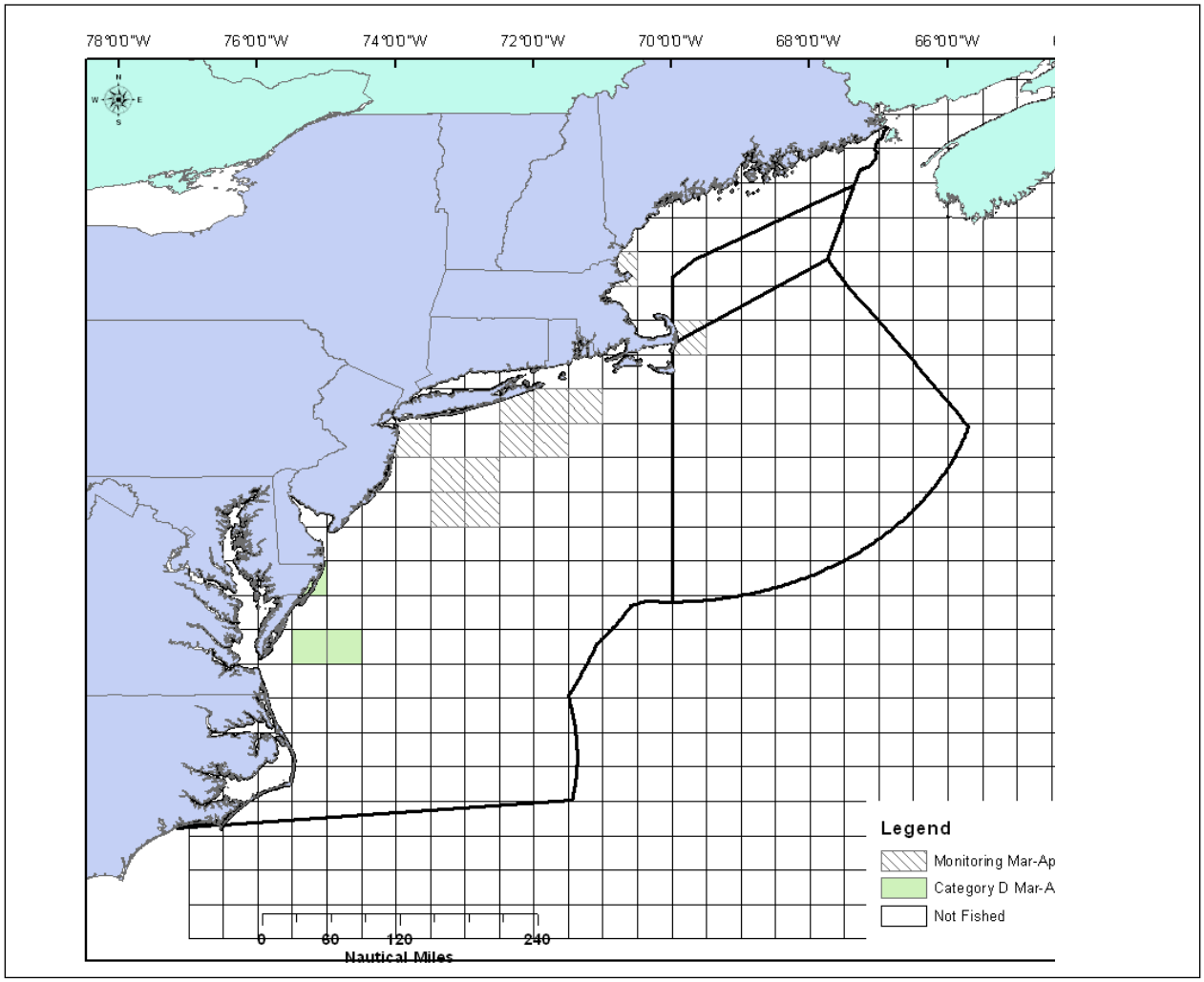


Figure 18 Trawl Effort (Category D Only) and Monitoring Areas, July – August

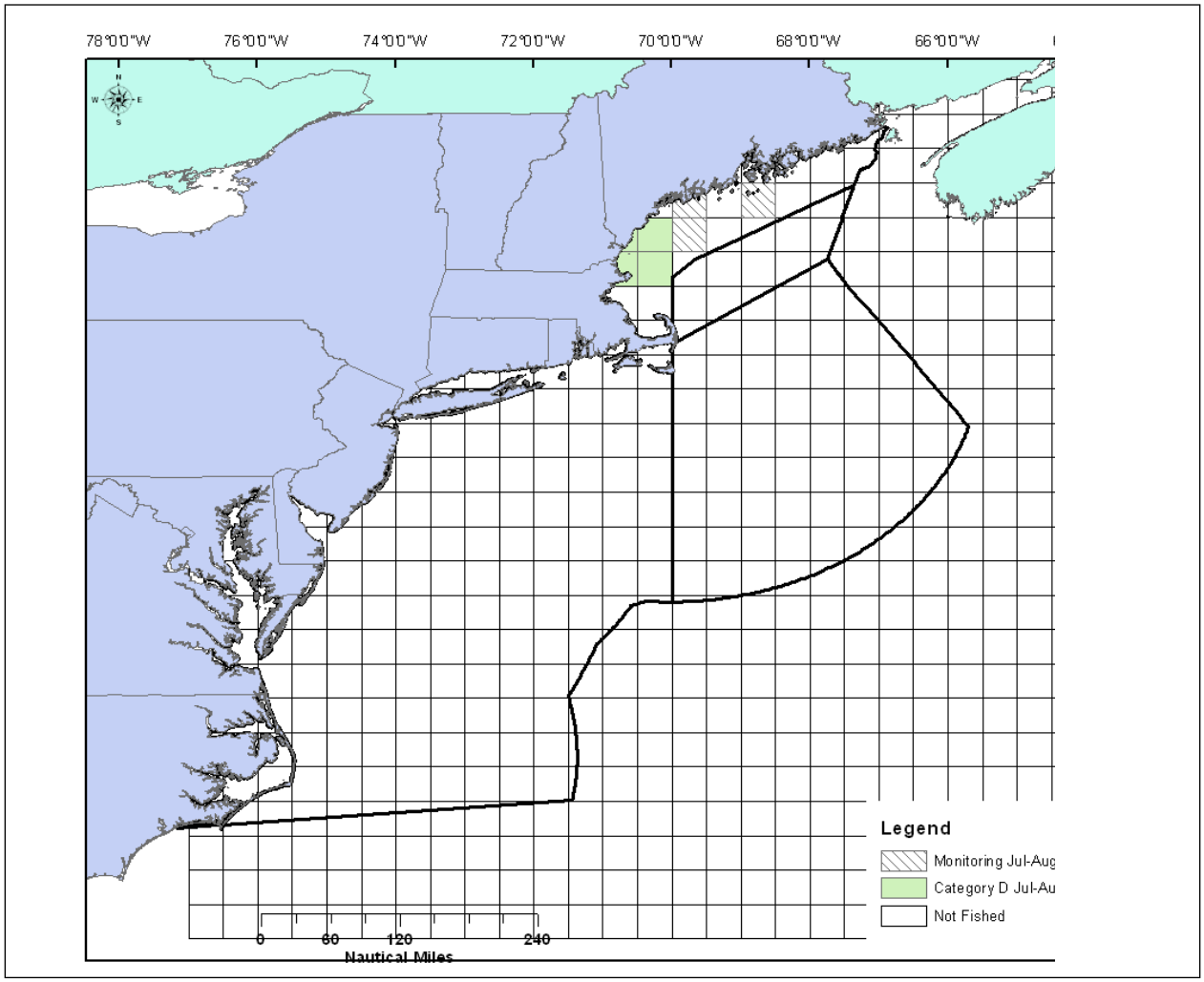


Figure 19 Trawl Effort (Category D Only) and Monitoring Areas, September – October

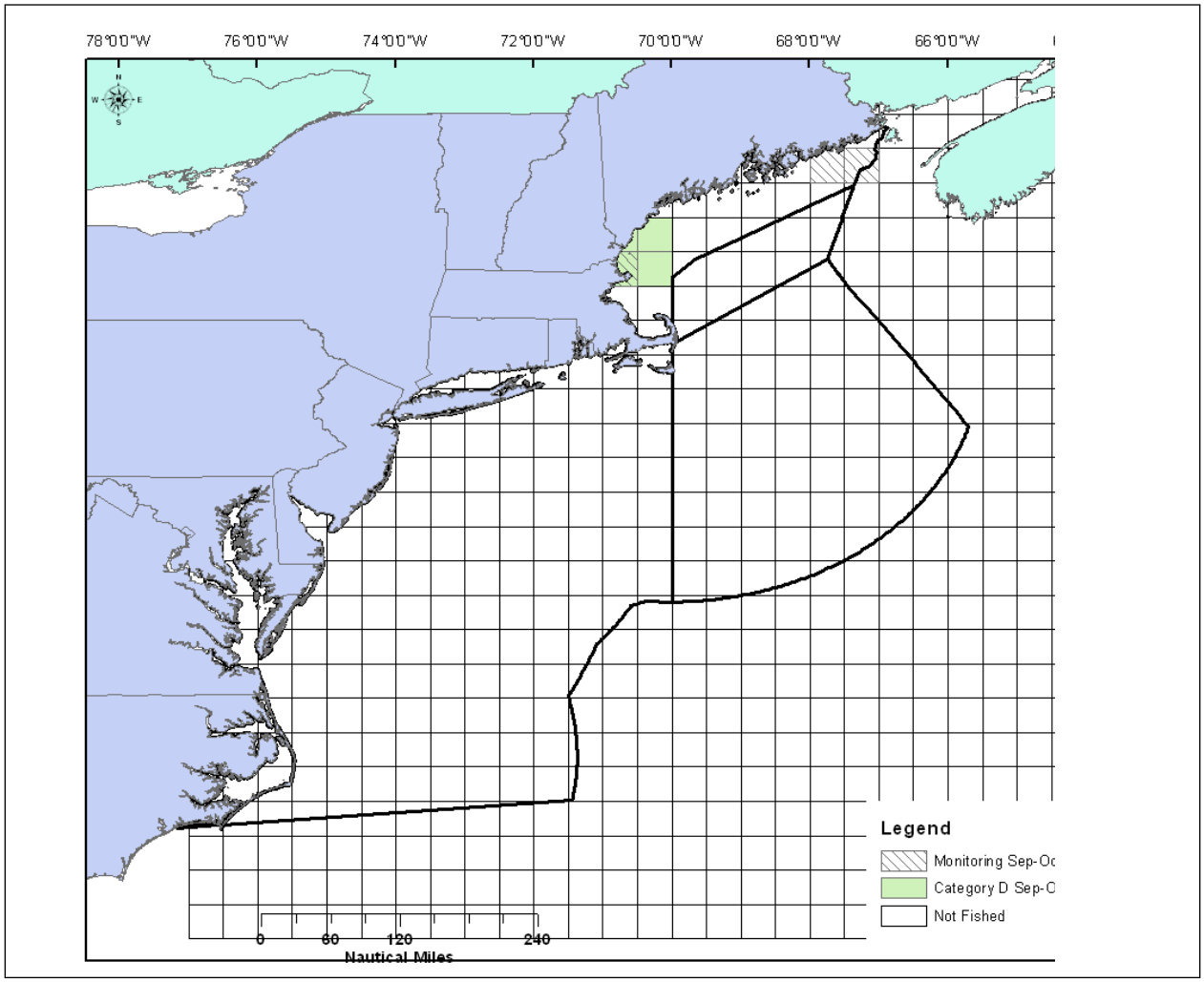


Figure 20 Trawl Effort (ABC only) and Protection Areas, January – February

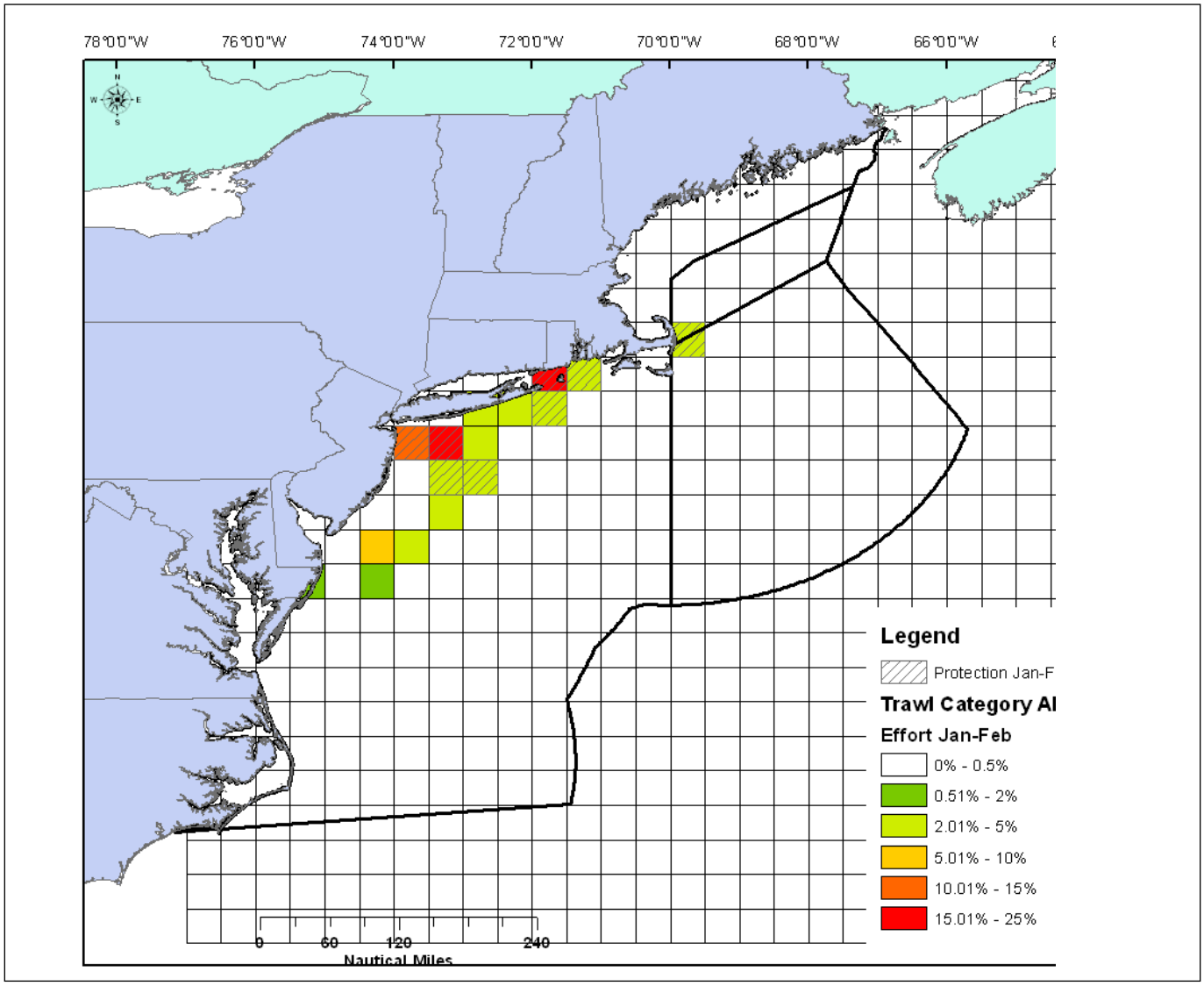


Figure 21 Trawl Effort (ABC only) and Protection Areas, March – April

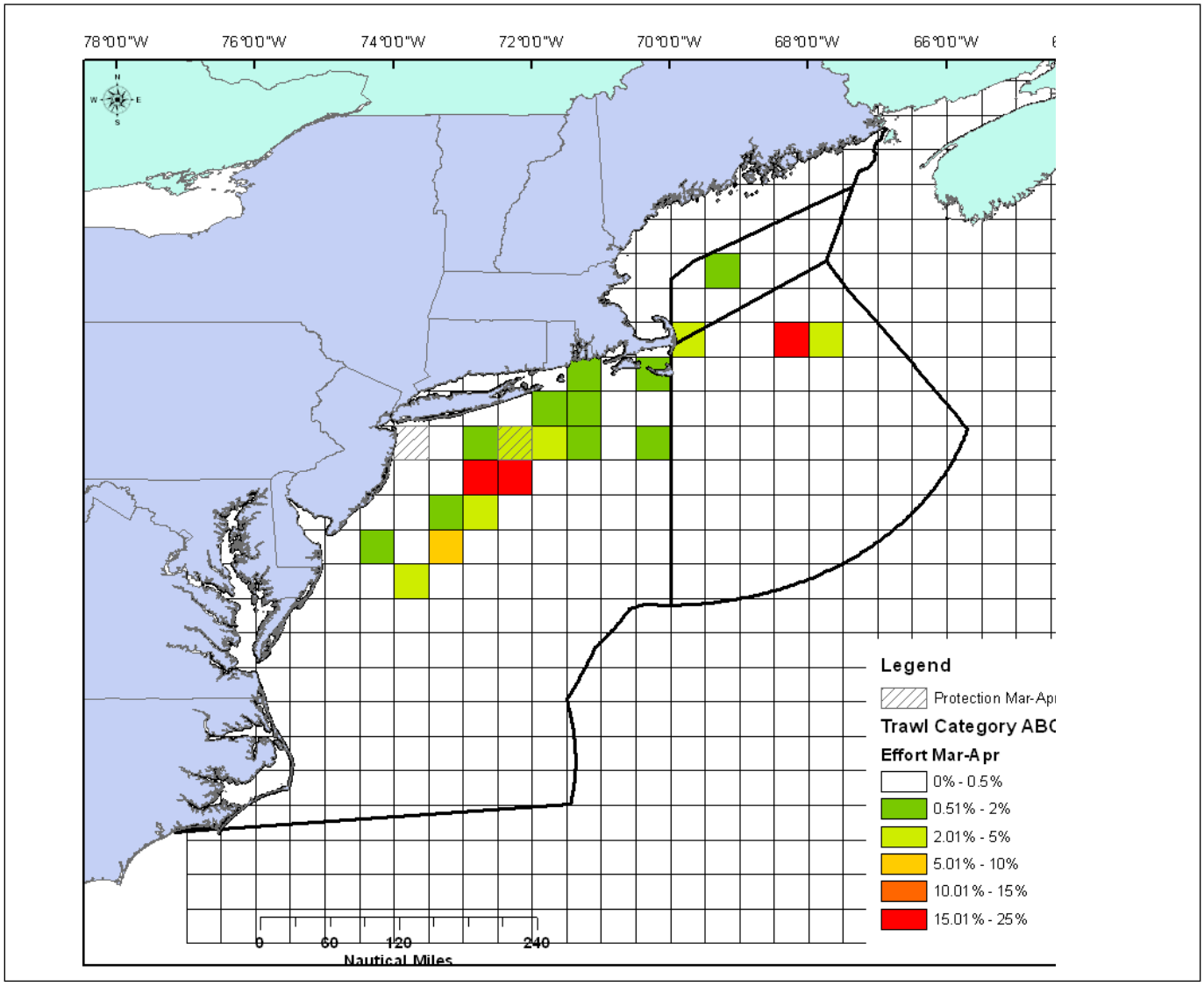


Figure 22 Trawl Effort (ABC Only) and Protection Areas, September – October

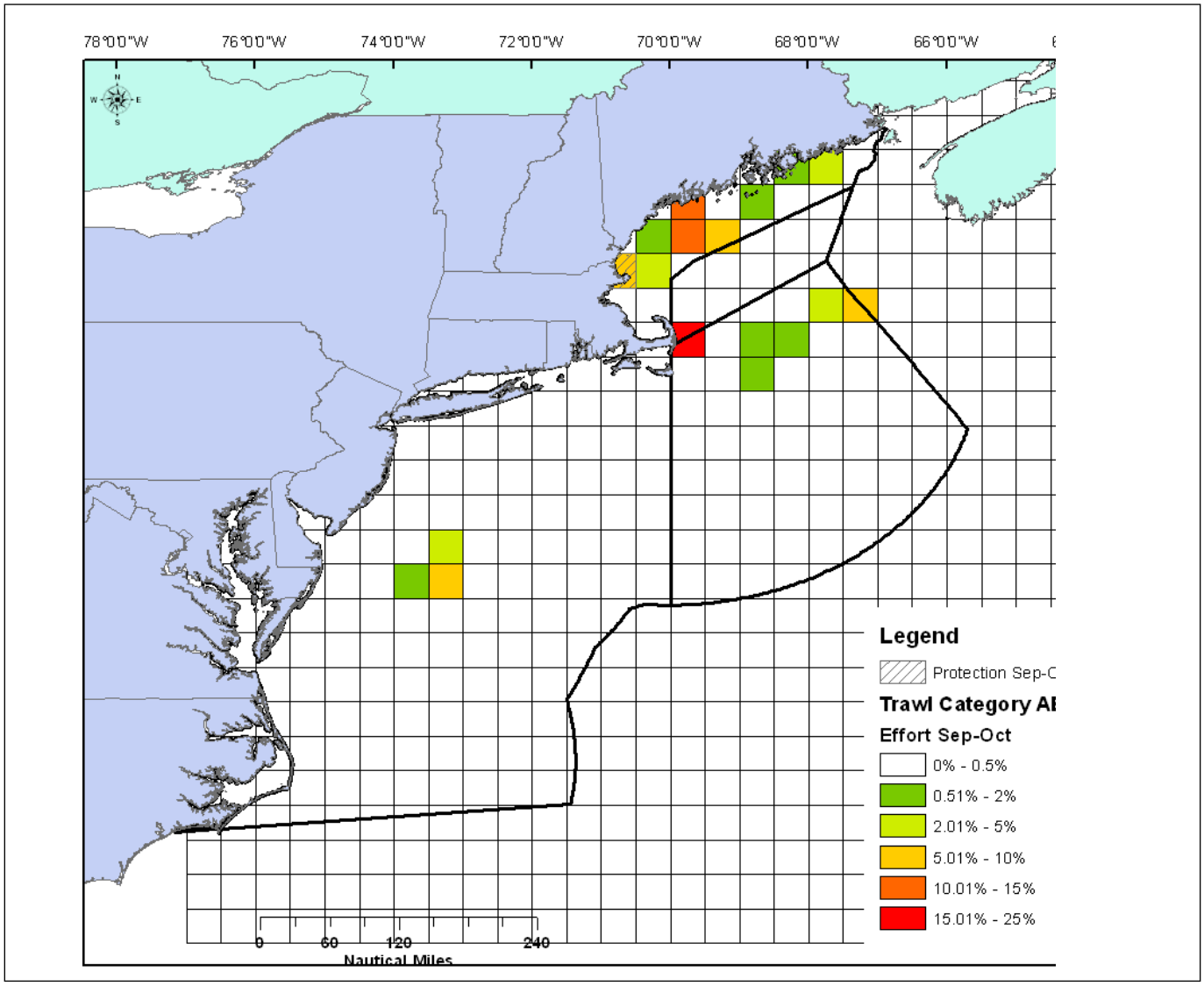


Figure 23 Trawl Effort (ABC Only) and Protection Areas, November – December

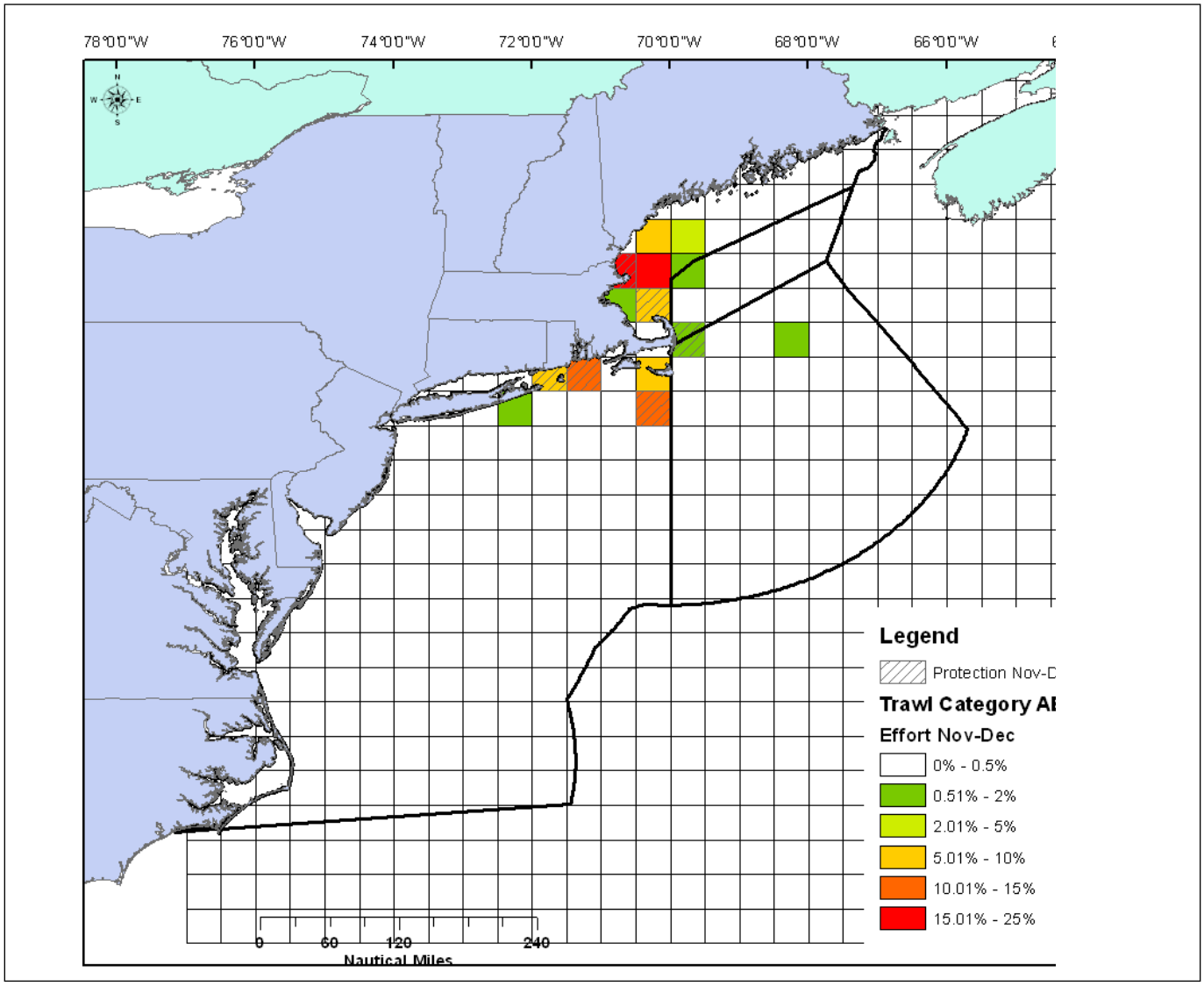


Figure 24 Purse Seine Effort and Protection Areas, September – October

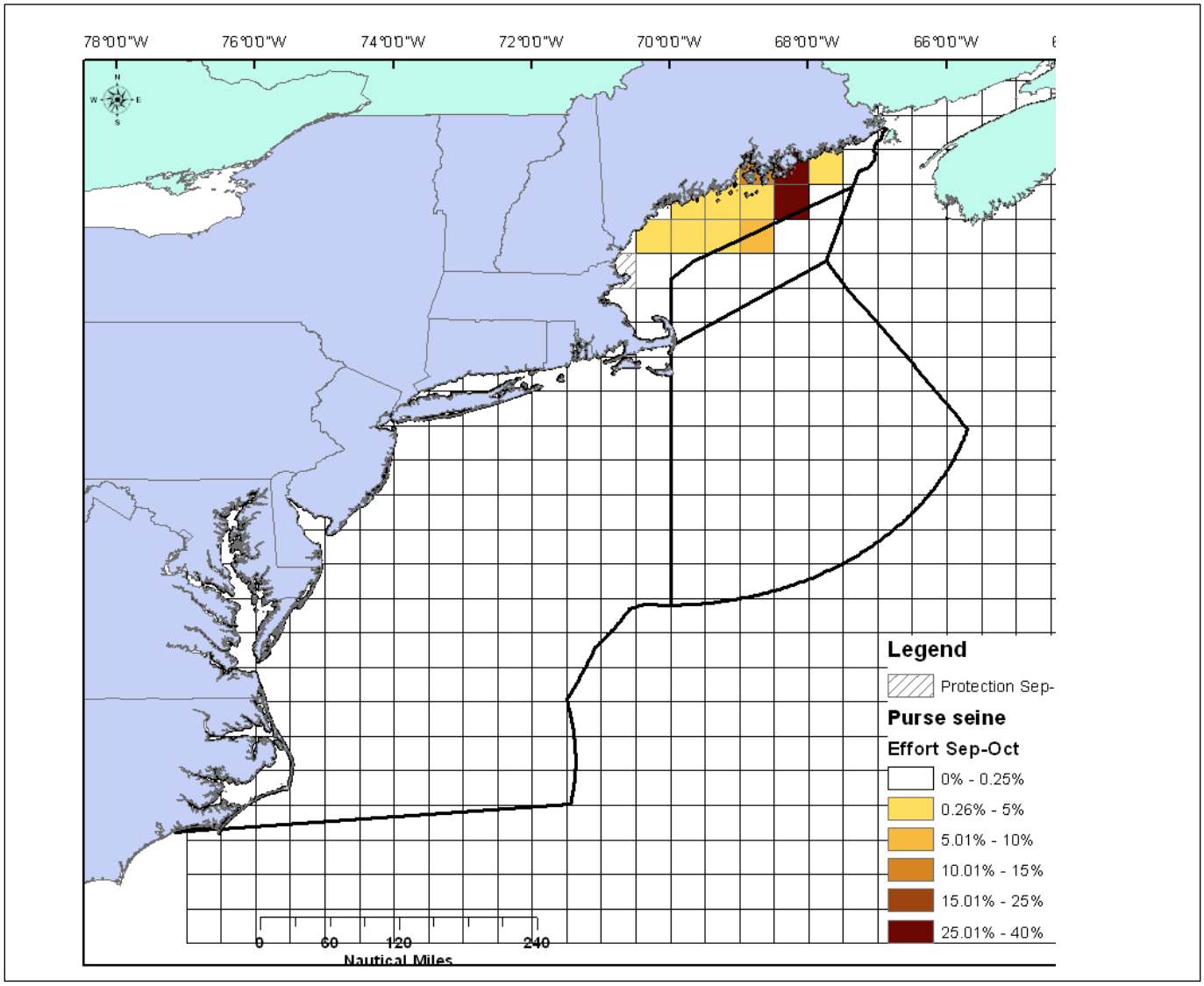


Figure 25 Purse Seine Effort and Protection Areas, November – December

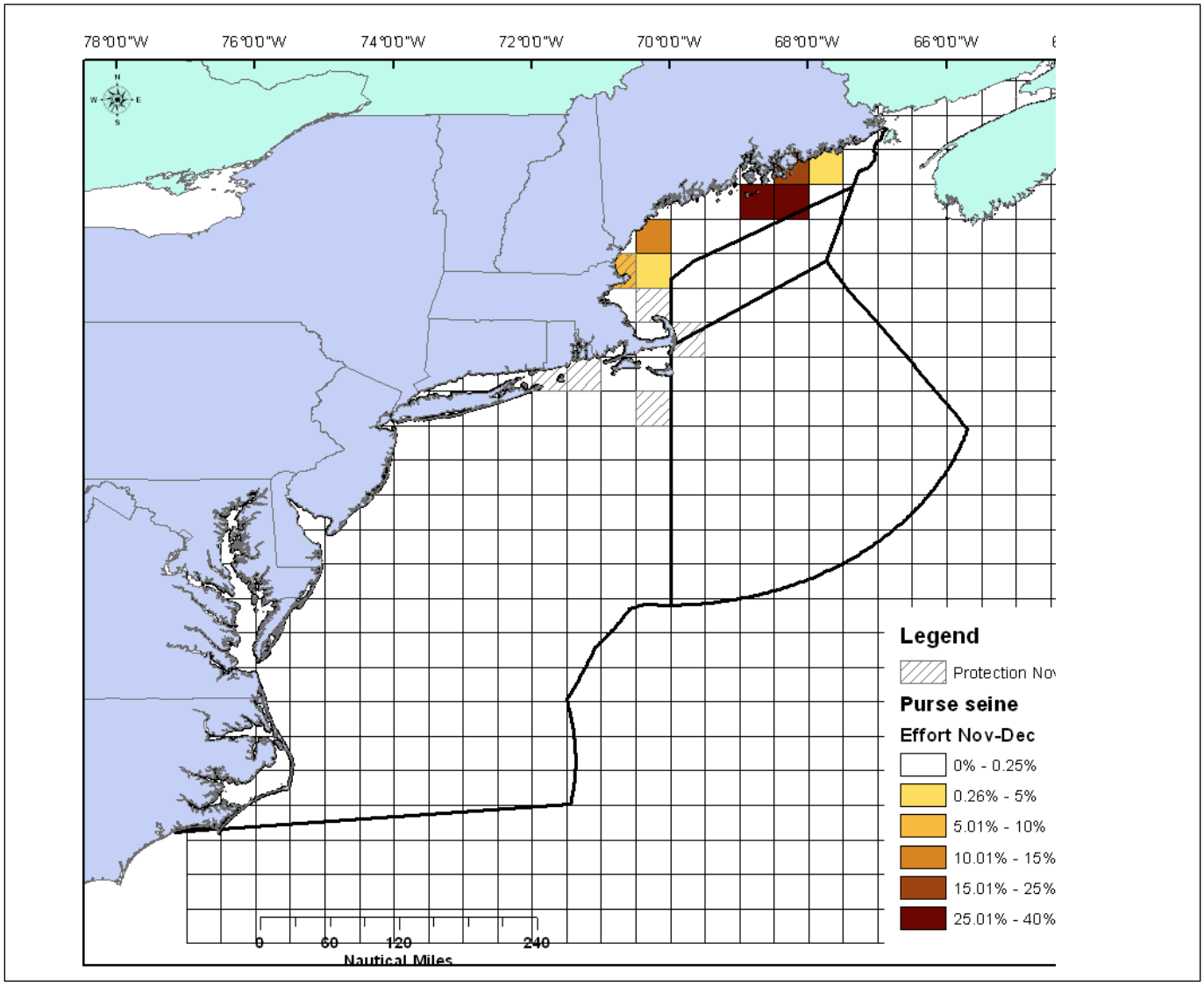


Figure 26 Trawl Effort (Category D Only) and Protection Areas, March – April

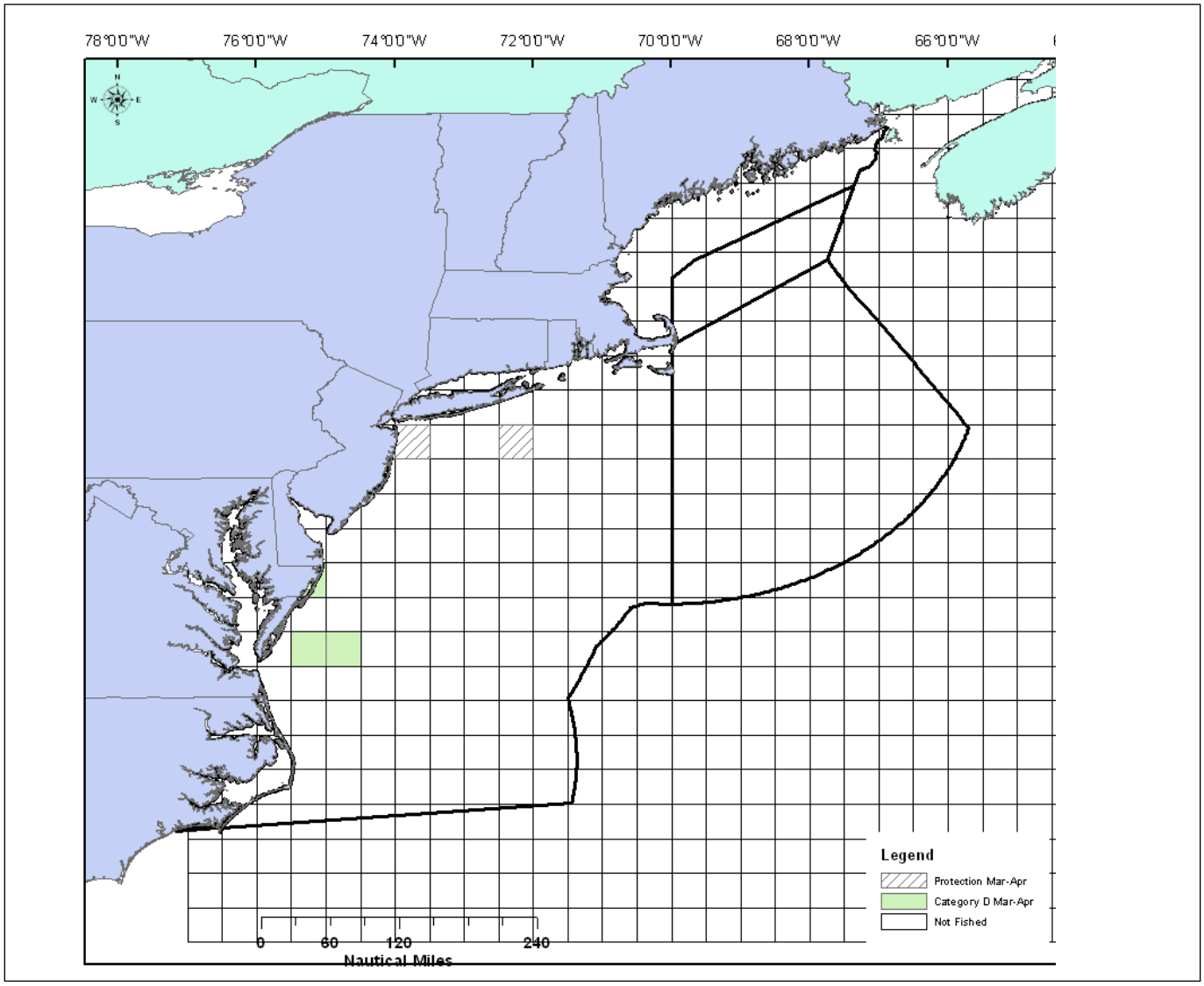
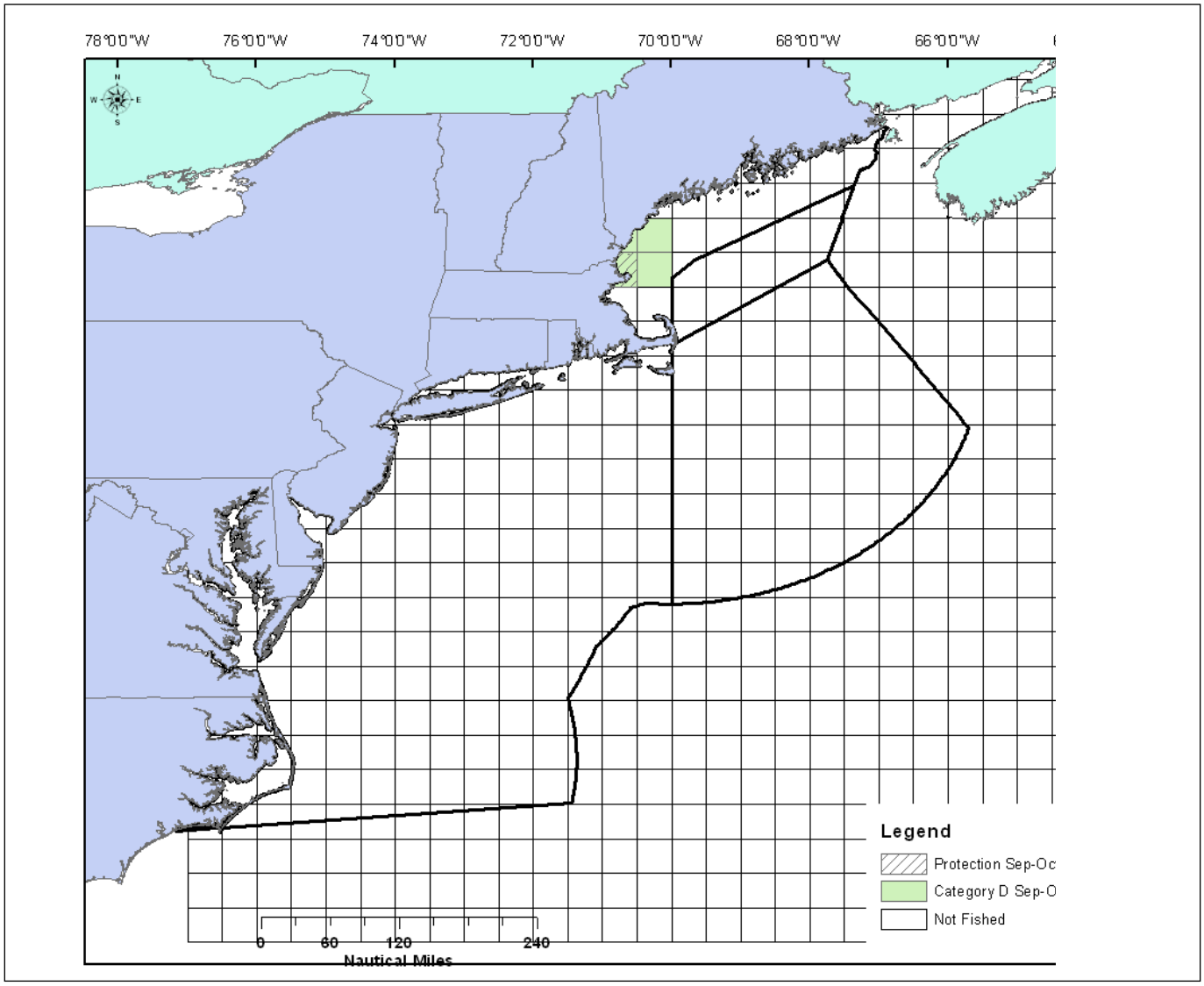


Figure 27 Trawl Effort (Category D Only) and Protection Areas, September - October



5.0 ANALYSIS OF THE PROPOSED RIVER HERRING MONITORING/AVOIDANCE AREAS (ALTERNATIVE 2)

5.1 QUALITATIVE ASSESSMENT

The river herring monitoring/avoidance areas options were compared to other areas identified using research surveys. The survey-based areas provide information on the times and areas were river herring are likely to be encountered absent information from the fishery. Additional information/analyses provided by the Herring PDT can be found in Volume II, Appendix III (Herring PDT Analysis: Development of Measures to Address River Herring Bycatch).

Table 12 – Table 17 and associated Figure 29 – Figure 35 provide a comparison of the bimonthly river herring monitoring/avoidance areas to associated survey-based areas. Each area is referenced as A- BB, with a map of all of these areas combined (Figure 28). The number of NEFOP observations used to identify each monitoring/avoidance area (fishery-based areas) are provided in Table 12 – Table 17. Further, the number of NMFS bottom-trawl surveys used to identify survey-based areas are found within hatched areas in Figure 29 – Figure 35. Several questions were asked to qualitatively compare fishery-based and survey-based areas:

1) Are there any adjacent fishery-based areas?
2) Are there any adjacent survey-based areas?
3) Does the fishery-based area overlap a survey-based area?

Adjacency was defined as areas sharing a side and/or corner. The results of this analysis for each bimonthly period are summarized in Table 12 – Table 17. One important caveat, noted above, is that the winter survey does not cover the Gulf of Maine.

Assessment

Alternative 2: Option 1, Option 2, and Option 3

In general, protection areas would improve understanding of river herring encounters in the Atlantic herring fishery through focused monitoring and could lead to possible reductions in river herring mortality if the fleet avoided those areas. As shown in this analysis, survey-based areas may also be important river herring areas and could be areas of future encounters by the fleet.

This option would have no reduction on river herring mortality in the monitoring/avoidance areas, if the fleet chooses to fish in these areas. Additionally, specific areas monitored instead of across the full range of the species misses important river herring encounters and influences river herring removals estimates.

Alternative 2: Option 4

With this option, areas with relatively high river herring encounters would be avoided (by time or distance) when river herring are encountered at some threshold level. The details of this option are currently under development and await results from the SFC/SMAST/MADMF pilot project. If the pilot is successful at developing at-sea river herring avoidance protocols for the Atlantic herring fleet, there could be reductions in river herring mortality in the bimonthly avoidance areas. Additionally, there would need to be adequate incentives in place for the fleet to avoid the areas.

However, an avoidance strategy linked to specific bimonthly avoidance areas (i.e. not implemented throughout the spatial and temporal extent of the Atlantic herring fishery), would miss river herring encounters in adjacent areas, as demonstrated by the survey-based areas (additional areas of likely river herring encounter). Such an approach would not reduce river herring mortality outside of avoidance areas. Furthermore, areas outside avoidance areas could have increased rates of river herring encounters by the fishery, if areas selected do not reflect year-to-year river herring variability.

Table 12 Comparison of River Herring Monitoring/Avoidance for January-February (Fishery-Based Areas) with Winter Survey-Based Areas

	Monitoring/Avoidance Areas January - February												
Map reference	**G**	**J**	**K**	**L**	**O**	**P**	**Q**	**S**	**T**	**U**	**X**	**Y**	**Z**
Quarter-degree square	**42704**	**41694**	**41712**	**41711**	**40723**	**40714**	**40713**	**40732**	**40731**	**40722**	**39733**	**39724**	**39723**
How many observer tows were greater than 40 lbs of river herring?	**1**	**5**	**31**	**43**	**1**	**5**	**3**	**3**	**8**	**3**	**12**	**4**	**2**
Are there any adjacent fishery-based areas?	**NO**	**NO**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**
Are there any adjacent winter survey-based areas?	**NO**	**NO**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**
Does the fishey-based area overlap a survey-based area?	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**NO**	**NO**	**YES**	**YES**	**NO**	**NO**

Table 13 Comparison of River Herring Monitoring/Avoidance for March-April (Fishery-Based Areas) with Spring Survey-Based Areas

	Monitoring/Avoidance Areas March - April											
Map reference	G	J	O	P	Q	S	V	W	X	Y	AA	BB
Quarter-degree square	42704	41694	40723	40714	40713	40732	40721	40712	39733	39724	39731	39722
How many observer tows were greater than 40 lbs of river herring?	1	3	1	1	2	4	2	1	2	3	1	1
Are there any adjacent fishery-based areas?	NO	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Are there any adjacent spring survey-based areas?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Does the fishey-based area overlap a survey-based area?	YES	NO	YES	YES	YES	NO	YES	YES	YES	NO	NO	NO

Table 14 Comparison of River Herring Monitoring/Avoidance for May-June (Fishery-Based Areas) with Spring Survey-Based Areas

	Monitoring/Avoidance Areas May - June	
Map reference	D	J
Quarter-degree square	43693	41694
How many observer tows were greater than 40 lbs of river herring?	1	2
Are there any adjacent fishery-based areas?	NO	NO
Are there any adjacent spring survey-based areas?	YES	YES
Does the fishey-based area overlap a survey-based area?	NO	NO

Table 15 Comparison of River Herring Monitoring/Avoidance for July-August (Fishery-Based Areas) with Summer Survey-Based Areas

	Monitoring/Avoidance Areas July - August		
Map reference	C	E	F
Quarter-degree square	43694	43684	43692
How many observer tows were greater than 40 lbs of river herring?	2	1	2
Are there any adjacent fishery-based areas?	YES	NO	YES
Are there any adjacent summer survey-based areas?	YES	YES	YES
Does the fishey-based area overlap a survey-based area?	NO	YES	NO

Table 16 Comparison of River Herring Monitoring/Avoidance for September-October (Fishery-Based Areas) with Fall Survey-Based Areas

	Monitoring/Avoidance Areas September - October		
Map reference	A	B	G
Quarter-degree square	44672	44671	42704
How many observer tows were greater than 40 lbs of river herring?	1	1	15
Are there any adjacent fishery-based areas?	YES	YES	NO
Are there any adjacent fall survey-based areas?	YES	YES	YES
Does the fishey-based area overlap a survey-based area?	YES	YES	YES

Table 17 Comparison of River Herring Monitoring/Avoidance for November-December (Fishery-Based Areas) with Fall And Winter Survey-Based Areas

	Monitoring/Avoidance Areas November - December								
Map reference	G	H	I	J	K	L	M	N	R
Quarter-degree square	42704	42703	42701	41694	41712	41711	41702	41701	40703
How many observer tows were greater than 40 lbs of river herring?	29	7	1	23	3	4	2	4	1
Are there any adjacent fishery-based areas?	YES	YES	YES	YES	YES	YES	YES	YES	YES
Are there any adjacent fall survey-based areas?	YES	YES	YES	YES	YES	YES	YES	YES	YES
Are there any adjacent winter survey-based areas?	NO	NO	NO	NO	YES	YES	YES	YES	YES
Does the fishey-based area overlap a fall survey-based area?	YES	YES	YES	NO	NO	YES	NO	NO	NO
Does the fishey-based area overlap a winter survey-based area?	NO	NO	NO	NO	NO	NO	NO	NO	NO

Figure 28 Map of River Herring Monitoring/Avoidance Areas for All Months Combined

Individual areas (grey blocks) are identified A-BB.

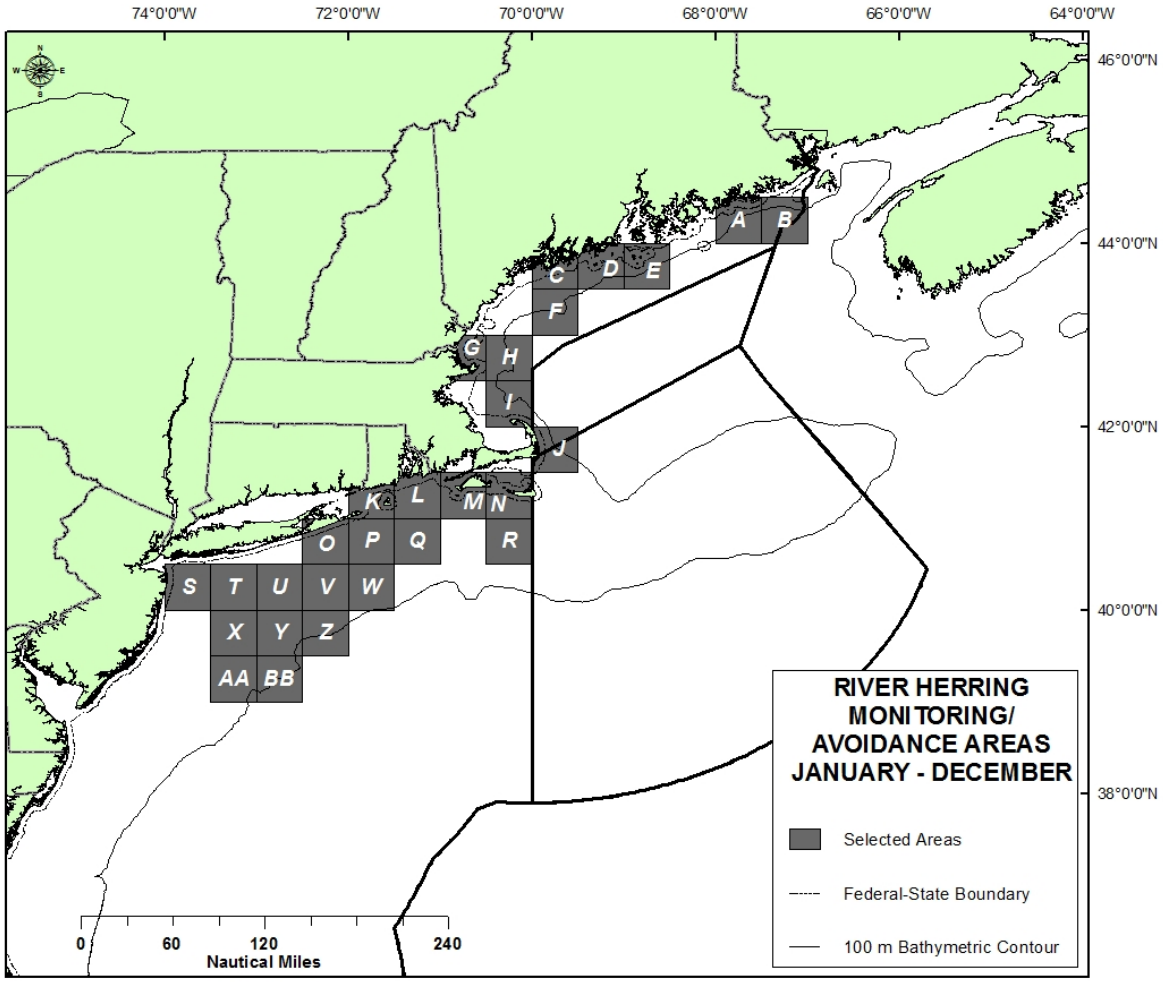


Figure 29 Map of River Herring Monitoring/Avoidance Areas for January - February (Gray Blocks) Overlaid with Survey Hotspot Areas (Hatched Blocks)

Numbers within blocks indicate the number of survey tows used in the hotspot analysis.

Figure 30 Map of River Herring Monitoring/Avoidance Areas for March - April (Gray Blocks) Overlaid with Survey Hotspot Areas (Hatched Blocks)

Numbers within blocks indicate the number of survey tows used in the hotspot analysis.

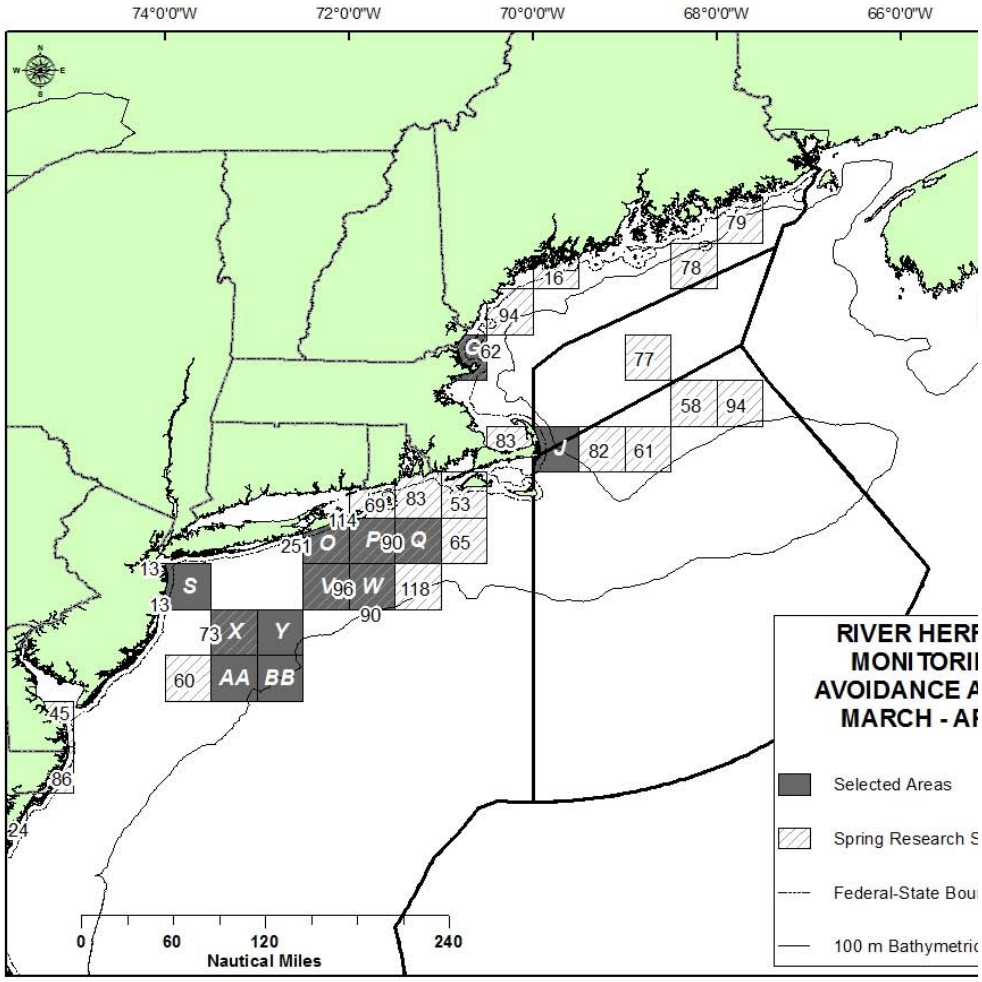


Figure 31 Map of River Herring Monitoring/Avoidance Areas for May - June (Gray Blocks) Overlaid with Survey Hotspot Areas (Hatched Blocks)

Numbers within blocks indicate the number of survey tows used in the hotspot analysis.

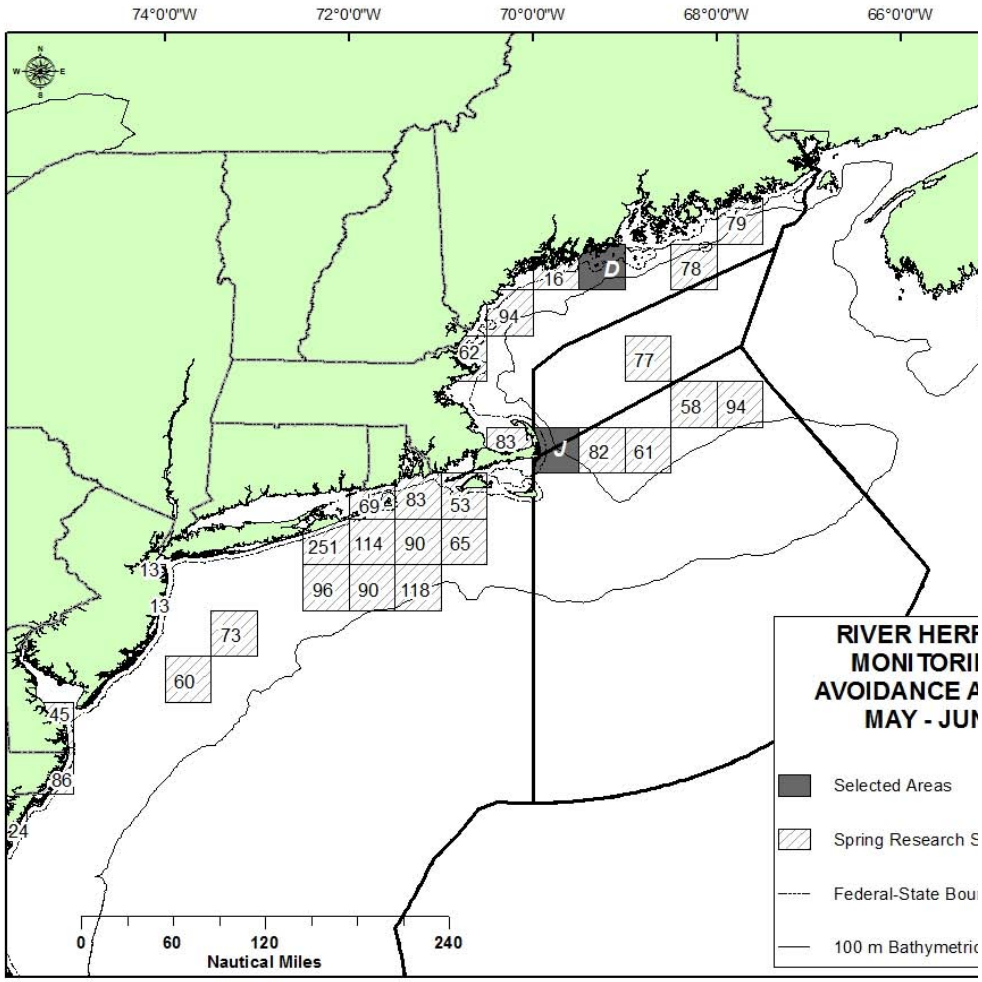


Figure 32 Map of River Herring Monitoring/Avoidance Areas for July - August (Gray Blocks) Overlaid with Survey Hotspot Areas (Hatched Blocks)

Numbers within blocks indicate the number of survey tows used in the hotspot analysis.

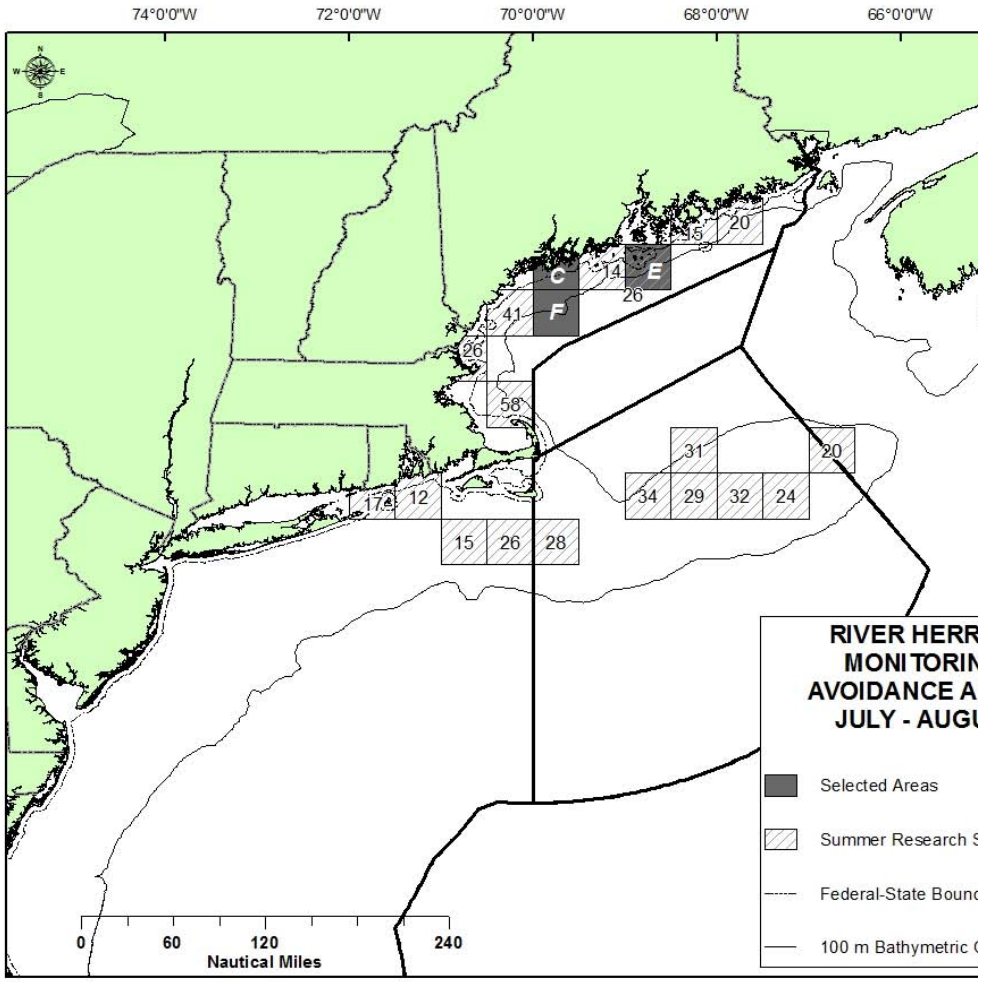


Figure 33 Map of River Herring Monitoring/Avoidance Areas for September – October (Gray Blocks) Overlaid with Survey Hotspot Areas (Hatched Blocks)

Numbers within blocks indicate the number of survey tows used in the hotspot analysis.

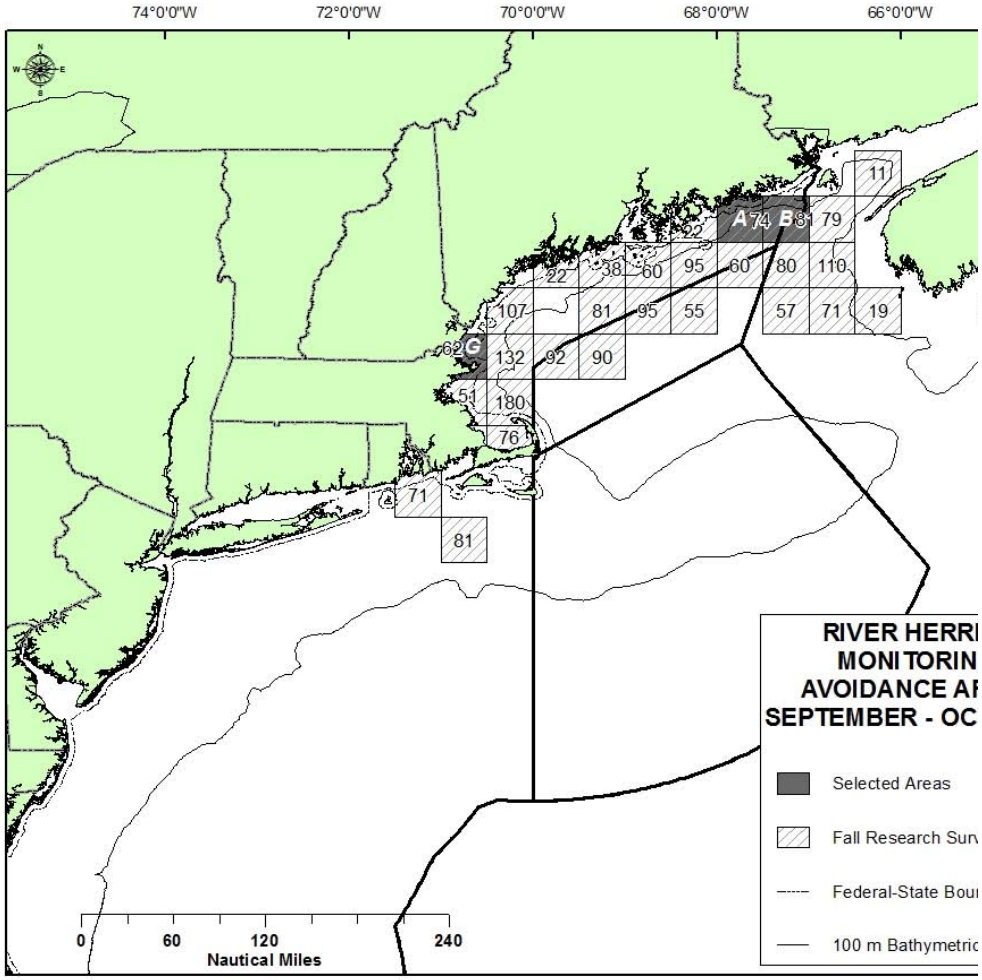


Figure 34 Map of River Herring Monitoring/Avoidance Areas for November - December (Gray Blocks) Overlaid with Survey Hotspot Areas (Hatched Blocks)

Numbers within blocks indicate the number of survey tows used in the hotspot analysis.

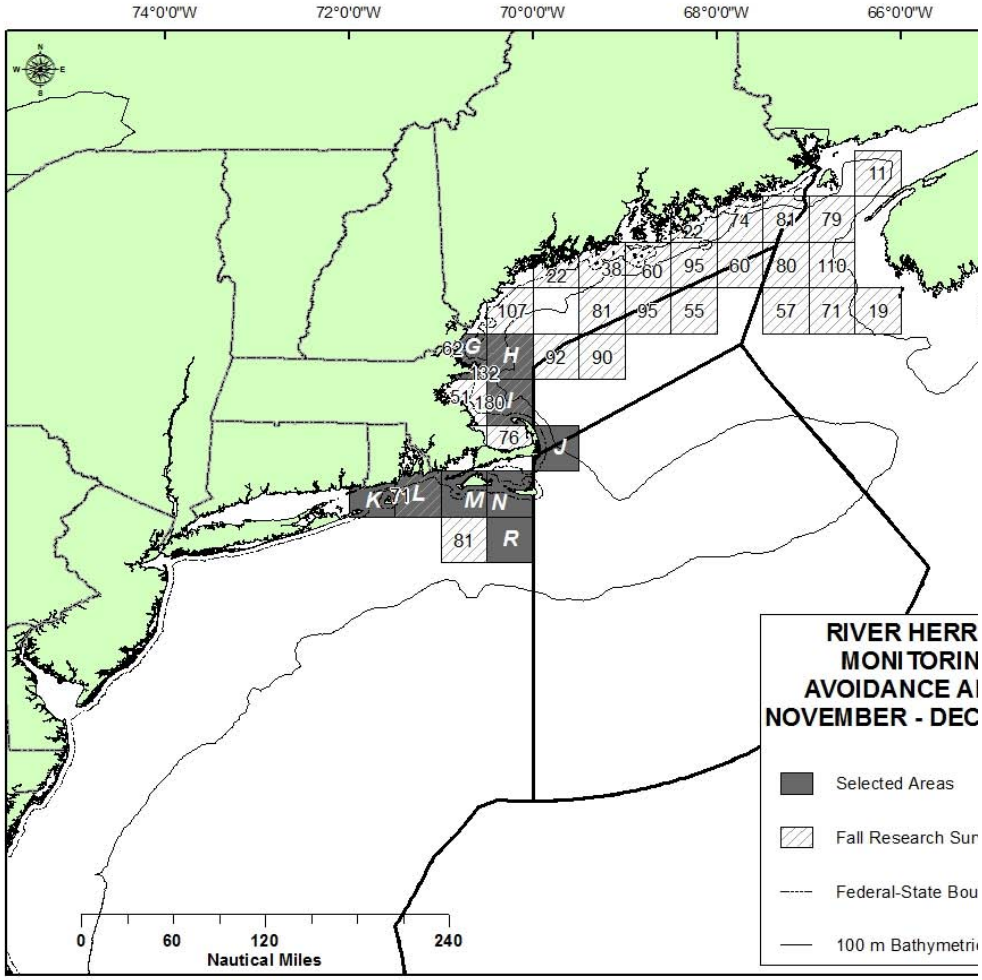
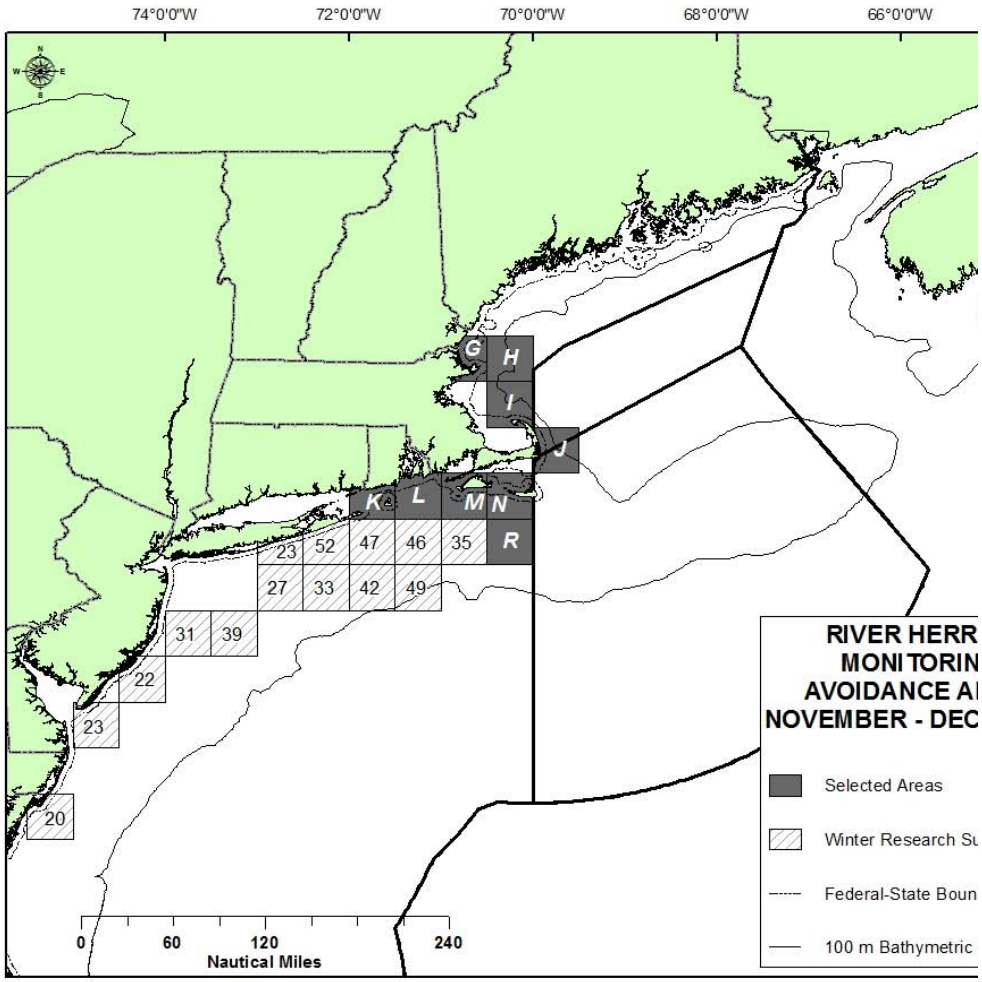


Figure 35 Map of River Herring Monitoring/Avoidance Areas for November - December (Gray Blocks) Overlaid with Survey Hotspot Areas (Hatched Blocks)

Numbers within blocks indicate the number of survey tows used in the hotspot analysis.



5.2 IMPACTS OF MONITORING OPTIONS

Option 1

Option 1A requires 100% observer coverage for A/B/C vessels when on a declared herring trip. Table 22 – Table 29 summarize the fishing effort, herring revenues, herring landings, and total revenues which were located in the monitoring options. Approximately 6% of the purse seine effort, catch, and revenues are derived from the monitoring areas. While 22-24% of the Category D effort, catch, and revenues are derived from the monitoring areas, the magnitude of effort, catch, and revenues attributable to Category D vessels is minimal. A fairly large portion of the Category A/B/C trawl fishery would be impacted by the monitoring options; 40-45% of the effort, catch, and revenues for this segment of the fishery occurred in the monitoring areas.

Sub-option 1A requires 100% observer coverage for A/B/C vessels in the Monitoring Areas when on a declared herring trip. Table 20 describes the total number of trips and number of observer-days required to meet this coverage if this option had been active in 2010. In 2010, 343 trips (51.7% of total trips) entered the monitoring areas. 974 observer-days would have been required under Option 1A if this option had been in place during 2010.

In order to place the costs of industry-funded observers into context, Table 18 summarizes average revenues per trip, average revenues per day absent, operating costs per trip, and operating costs per day absent, classified by gear type for 2008-2010. Revenues were calculated using the VTR and Dealer data while operating costs were based on data collected through the observer program. Operating costs in this fishery are primarily fuel expenses; the price of fuel has fluctuated (along with the price of crude oil) over the past three years.

Table 18 2008-2010 Average Revenues, Costs Per Day and Average Revenues, Costs Per Trip for Category A/B/C Herring Vessels

	Revenue/Day	Revenue/Trip	Operating Costs/Day	Operating Costs/Trip
Single Midwater Trawl	$12,853	$41,721	$4,271	$12,608
Pair Trawl	$15,683	$43,166	$3,295	$9,372
Purse Seine	$18,557	$25,499	$1,798	$2,746
Bottom Trawl	$5,325	$7,863	$785	$524

Revenue Data is from VTR and Dealer (n=5,329)
Operating Costs data is from Observer (n=352)

Relative to the daily operating costs for the fishery, the cost of an observer is fairly high. For example, a NEFOP observer would increase the per-day costs of bottom trawl, single midwater trawl, pair trawl, and purse seine by 153%, 28%, 36%, and 67% respectively (Table 19). However, relative to daily revenues, the cost of an observer is lower; an observer would cost 22%, 9%, 9%, and 6% of average daily revenues for the bottom, midwater, pair trawl, and purse seine vessels. These numbers are presented for illustration; it is possible that the type of data required in this fishery would result in higher or lower per-day costs than described in Table 18.

Table 19 Cost of a NEFOP Observer as a Percentage of Daily Revenues and Daily Operating Costs

	Revenue	Costs
Single Midwater Trawl	9.3%	28.1%
Pair Trawl	7.7%	36.4%
Purse Seine	6.5%	66.7%
Bottom Trawl	22.5%	152.8%

Option 1B requires 100% observer coverage for A/B/C and Category D (open access) vessels when on a declared herring trip. Table 22 – Table 29 summarize the fishing effort, herring revenues, herring landings, and total revenues which were located in the monitoring options. The impacts of this measure are similar to Option 1A. Table 21 describes the total number of trips and number of observer-days required to meet this coverage if this option had been active in 2010. In 2010, 356 trips (50.3% of total trips) entered the proposed monitoring areas. 987 observer-days would have been required under Option 1B if this option had been effective during 2010.

Category C and D Vessels

The potential costs of monitoring the Category C herring vessels is discussed relative to the observer allocation alternatives under consideration in Volume I of the Amendment 5 DEIS document (100% observer coverage). It is possible that Category D vessels would relinquish their herring permit if required to pay for an observer.

Option 2

In general, the affected trips and required coverage for 100% observer coverage are the same as in Option 1 (see Table 20). Beyond additional coverage, vessels will incur additional regulatory costs related to filing out Released catch Affidavits. Note that the requirement to exit the area is creates a disincentive to safety-at-sea.

Option 2A

The impacts of this option are similar to the previous option and depend largely on who is responsible for covering the costs of additional observer coverage.

Option 2B

The impacts of Option 2B are similar to that of 2A, except vessel have the flexibility to fish in the monitoring areas if an observer is unavailable.

Option 2C

The impacts of Option 2C are similar to the impacts of 1A. However, vessels may choose not to declare that they are on a herring trip, and be able to use the monitoring areas without a monitor.

Option 2D

The impacts of Option 2D are similar to the impacts of 1B. However, vessels may choose not to declare that they are on a herring trip, and be able to fish for other species in the monitoring areas without a monitor.

Table 20 Total Number of Trips and Number of Observer-Days Required to Meet Sub-Option 1A, if This Option had been Effective in 2010

Gear (ABC permits only)	Trips in Monitoring Areas	Percentage of total Trips	Days of Coverage Required
Trawl	298	64.6%	874
Purse Seine	45	22.3%	100
Total	343	51.7%	974

Table 21 Total Number of Trips and Number of Observer-Days Required to Meet Sub-Option 1B, if This Option had been Effective in 2010

Gear (ABCD permits)	Trips in Monitoring Areas	Percentage of total Trips	Days of Coverage Required
Trawl	311	61.5%	887
Purse Seine	45	22.3%	100
Total	356	50.3%	987

Table 22 Fishing Time (Hours) Inside and Outside the Monitoring Areas

		Fishing Time		
Gear	Category	Not Monitored	Monitored	Grand Total
PUR		2,617	330	2,947
TR	ABC	6,699	5,406	12,105
	D	227	71	298
Grand Total		9,544	5,807	15,351

Table 23 Fishing Time (%) Inside and Outside the Monitoring Areas

		Fishing Time (%)		
Gear	Category	Not Monitored	Monitored	Grand Total
PUR		88.8%	11.2%	100.0%
TR	ABC	55.3%	44.7%	100.0%
	D	76.3%	23.7%	100.0%
Grand Total		62.2%	37.8%	100.0%

Table 24 Herring Catch (lbs.) Inside and Outside the Monitoring Areas

		Herring Catch		
Gear	Category	Not Monitored	Monitored	Grand Total
PUR		17,434,005	1,028,536	18,462,541
TR	ABC	67,237,466	56,866,383	124,103,849
	D	112,799	36,045	148,844
Grand Total		84,784,270	57,930,964	142,715,233

Table 25 Herring Catch (%) Inside and Outside the Monitoring Areas

		Herring Catch (%)		
Gear	Category	Not Monitored	Monitored	Grand Total
PUR		94.4%	5.6%	100.0%
TR	ABC	54.2%	45.8%	100.0%
	D	75.8%	24.2%	100.0%
Grand Total		59.4%	40.6%	100.0%

Table 26 Herring Revenue ($) Inside and Outside the Monitoring Areas

		Herring Revenue		
Gear	Category	Not Monitored	Monitored	Grand Total
PUR		$2,783,152	$174,925	$2,958,078
TR	ABC	$9,270,814	$6,349,882	$15,620,696
	D	$18,792	$5,645	$24,437
Grand Total		12,072,759	6,530,452	18,603,211

Table 27 Herring Revenue (%) Inside and Outside the Monitoring Areas

		Herring Revenue (%)		
Gear	Category	Not Monitored	Monitored	Grand Total
PUR		94.1%	5.9%	100.0%
TR	ABC	59.3%	40.7%	100.0%
	D	76.9%	23.1%	100.0%
Grand Total		64.9%	35.1%	100.0%

Table 28 Total Revenue ($) Inside and Outside the Monitoring Areas

		Total Revenue		
Gear	Category	Not Monitored	Monitored	Grand Total
PUR		$2,783,201	$174,928	$2,958,129
TR	ABC	$10,100,712	$7,992,356	$18,093,067
	D	$33,329	$9,683	$43,011
Grand Total		12917241.89	8176965.79	21094207.68

Table 29 Total Revenue (%) Inside and Outside the Monitoring Areas

		Total Revenue (%)		
Gear	Category	Not Monitored	Monitored	Grand Total
PUR		94.1%	5.9%	100.0%
TR	ABC	55.8%	44.2%	100.0%
	D	77.5%	22.5%	100.0%
Grand Total		61.2%	38.8%	100.0%

Category A/B Versus Category C and Category D Vessels

As discussed throughout this document, there are costs associated with incorporating a greater number of vessels into a comprehensive monitoring program, especially if there is an industry-funded element of the monitoring program. The goals and objectives of the monitoring program should be weighed against the costs of monitoring to the vessels and the degree of participation in the fishery.

To further investigate differential impacts by herring permit category, herring catch and revenues from these vessels inside and outside the proposed monitoring areas are summarized by permit category in Table 30. While 22-24% of the Category D effort, catch, and revenues are derived from the monitoring areas, the magnitude of effort, catch, and revenues attributable to Category D vessels is minimal. A fairly large portion of the Category A/B/C trawl fishery would be impacted by the monitoring options; 40-45% of the effort, catch, and revenues for this segment of the fishery occurred in the monitoring areas. Table 30 shows the potential impact of the monitoring areas on Category C vessels and the other fisheries on which they rely. While Category A vessels will be most affected because they catch the majority of herring, Category C vessels derive about 20% of their total revenues from all fisheries from the proposed monitoring areas. Should the monitoring measures become too costly for the Category C vessels to fish in these areas, they will likely lose revenues from other fisheries where herring may be caught incidentally.

Table 30 Herring Catch/Revenues and Total Revenues Inside and Outside the Proposed Monitoring Areas by Limited Access Herring Permit Category

Permit Cat.	No. Vessels	Inside/ Outside	Hours Fished	Herring Catch (millions pounds)	Herring Revenue (millions dollars)	Total Revenue (millions dollars)
A	27	Outside	10,575	100.38	$13.77	$14.76
A	22	Inside	3,553	39.17	$4.36	$5.81
B	2	Outside	Cannot report	Cannot report	Cannot report	Cannot report
B	3	Inside	354	1.56	$0.17	$0.17
C	3	Outside	382	0.96	$0.23	$0.25
C	5	Inside	177	0.44	$0.04	$0.06
D	6	Outside	227	0.11	$0.02	$0.03
D	5	Inside	71	0.04	$0.01	$0.01

5.3 IMPACTS OF TRIGGER-BASED MONITORING APPROACHES

Option 3: Trigger-Based Monitoring

This options establishes triggers, based on catch of river herring in three broad areas (CC, GOM, and SNE). There are three sets of options under consideration to establish river herring catch triggers, based on Maximum, Median, and Mean river herring removals estimated by the Herring PDT.

The first stage in assessing the impact of Trigger-Based Monitoring is to estimate when the triggers are likely to be reached. Use of VTR only is problematic, because river herring catch may not be accurately recorded in VTR. Therefore, a simulation based approach which combines VTR and observer bycatch rates is used.

Methods

The 2008-2010 VTR data is the core of the data used for this simulation exercise. Sail date, herring catch, gear type, and statistical area were extracted from these records. Paired and midwater trawl were aggregated. The 2005-2010 observer data forms the second piece of data used in this simulation exercise. Total herring catch, river herring catch, statistical area, and gear were extracted from these records at the trip level. From this data, a river herring bycatch ratio (river herring/total herring) was calculated for each trip. A trip, instead of a haul, was used as a unit of observation for two reasons. First, VTR records are trip level, not haul level. Second, it is likely that if a large bycatch haul of river herring occurs, a vessel will switch locations and it would be inappropriate to assume that a vessel would continue to catch river herring.

For each experiment, one-third of the VTR records were randomly selected; this corresponds to approximately one "year" of fishing. Each VTR record was randomly matched to a river herring bycatch rate which occurred in the same monitoring area and used the same fishing gear. While time of year was not used as a matching variable, there is high correlation between fishing areas and time of year. For each VTR record, the (experimental) river herring catch was calculated by multiplying the bycatch rate by the VTR herring catch.

A running total of Atlantic herring catch in each management area was created from the selected VTR herring catch and a management area was 'closed' if the Atlantic herring catch exceeded the sub-TACs/ACLs listed in the 2010-2012 herring fishery specifications package. A running total of river herring catch in each of the three monitoring areas was also created from the river herring bycatch. The date at which the trigger was then computed.

These experiments were repeated 1,000 times to create a distribution of trigger dates for each of the sub-options.

Finally, to illustrate how the triggered options might work with less than 100% observer coverage, the set of experiments was repeated using a 50% coverage rate over all of the fishing fleets. Prior to matching VTR to the river herring bycatch rates, a trip is randomly assigned to be observed or not observed. If a trip is not observed, it is assigned an "assumed" bycatch rate based on the year-to-date observed bycatch rate. This assumed bycatch rate is gear and monitoring-area specific. The remainder of the experiment is unchanged.

The results are summarized using the cumulative distribution of the trigger dates. For a given date, the probability that the trigger was reached can be found by reading up to the vertical line in the graph. There

is a vertical line on the final day of the fishing year in all graphs. This does not mean that the triggers are reached on the final day; instead, this is used to provide some perspective about the frequency that a trigger is not reached.

Reporting Option 1:

Reporting Option 1 imposes some administrative and regulatory burden on fishing vessels.

Reporting Option 2:

Reporting Option 2 also imposes some administrative and regulatory burden on fishing vessels.

Trigger Option 3A (Max):

See Figure 36 – Figure 41 for illustrative examples of the potential impacts of using the distribution max for the river herring catch trigger. Under Option 3A, with 100% observer coverage, the Cape Cod and Gulf of Maine triggers are unlikely to be reached; the triggers in those regions were reached in 5% and 4% of experiments (Figure 36 and Figure 37). When reached, the triggers were reached late in the fishing year. However, the triggers were reached in 46% of the experiments in the Southern New England region. The fishery is prosecuted in the winter; therefore, the triggers are likely to be reached either in the beginning of the year or at the end of the year.

Under Option 3A with 50% observer coverage, the same qualitative pattern occurs: low probability of the trigger being reached in the Cape Cod or Gulf of Maine regions and a relatively high probability in the Southern New England area.

Trigger Option 3B (Median):

See Figure 42 – Figure 47 for illustrative examples of the potential impacts of using the distribution median for the river herring catch trigger. Under Option 3B, with 100% observer coverage, all triggers likely to be reached. The triggers in CC, GOM, and SNE were reached in 60%, 86%, and 77% of experiments respectively. (Figure 42 – Figure 47). The triggers in GOM and CC are likely to be reached at various times through the fishing year. The triggers in the Southern New England region again are likely to be reached either in the beginning of the year or at the end of the year.

Under Option 3B, with 50% observer coverage, the same qualitative pattern occurs. The triggers in CC, GOM, and SNE were reached in 52%, 78%, and 62% of experiments respectively.

Trigger Option 3C (Mean):

See Figure 48 – Figure 53 for illustrative examples of the potential impacts of using the distribution median for the river herring catch trigger. Under Option 3C, with 100% observer coverage, all triggers likely to be reached. The triggers in CC, GOM, and SNE were reached in 27%, 67%, and 93% of experiments respectively. (Figure 48 – Figure 53). The triggers in GOM and CC are likely to be reached at various times through the fishing year. The triggers in the Southern New England region again are likely to be reached either in the beginning of the year or at the end of the year.

Under Option 3C, with 50% observer coverage, the same qualitative pattern occurs. The triggers in CC, GOM, and SNE were reached in 25%, 60%, and 80% of experiments respectively.

General Impacts:

The impacts of triggered closures are difficult to predict because it is difficult to know when these triggers would be achieved. The largest potential impacts are likely to be in the Southern New England areas

because there is a large amount of overlap between the Protection areas and the fishery (see Figure 20 – Figure 27). Under these options, it is likely that all participants would undertake additional effort to avoid river herring in general. Therefore, it is reasonable to expect that this analysis somewhat **over-estimates** the probability that any trigger would be reached. However, it is not clear how effective the fishery is at avoiding river herring while continuing to harvest Atlantic herring.

Option 3A is likely to have the smallest negative impacts on the entire fishery. Option 3B is likely to have the largest impact on the fishery which uses the Cape Cod and Gulf of Maine areas and the 2nd smallest impact on the participants which use the Southern New England area. Option 3C is likely to have the next smallest impact on the parts of the fishery which operate in the Cape Cod and Gulf of Maine areas and the largest impact on part of the fishery which use the Southern New England areas.

Figure 36 Probability of Gulf of Maine (Max) Trigger Being Exceeded with 100% Observer Coverage

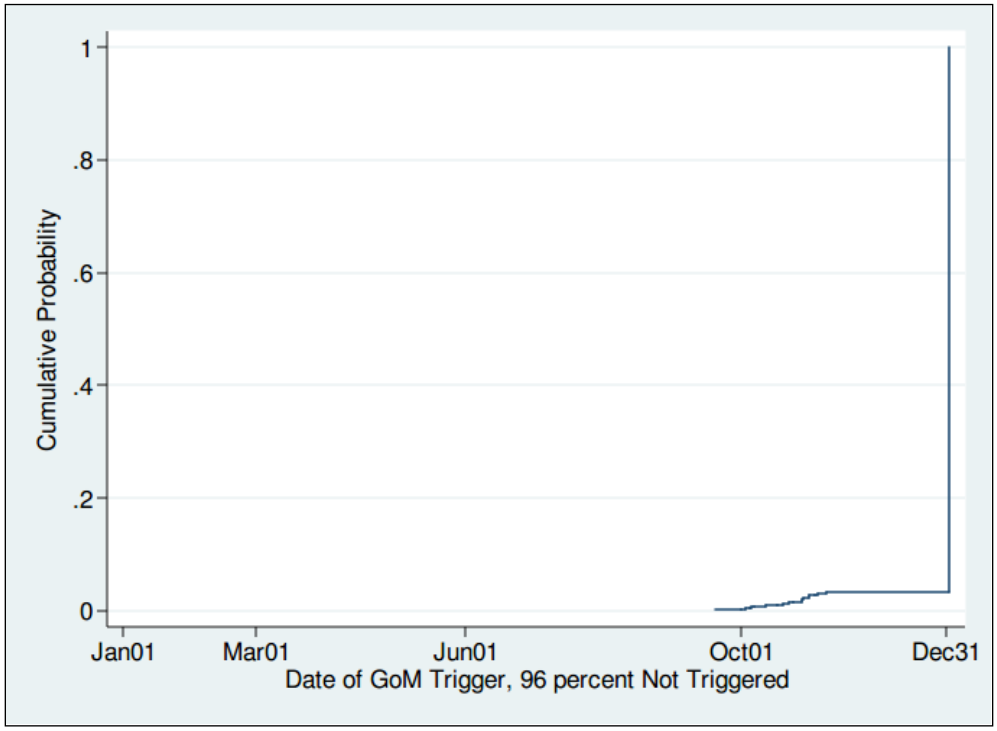


Figure 37 Probability of Cape Cod (Max) Trigger Being Exceeded with 100% Observer Coverage

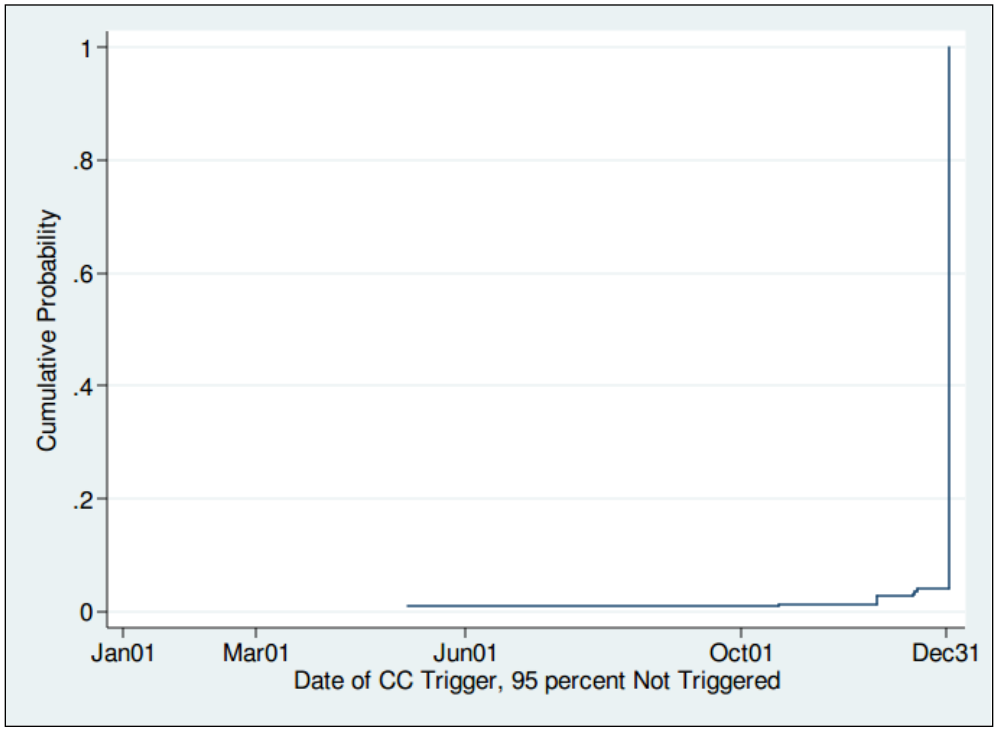


Figure 38 Probability of Southern New England (Max) Trigger Being Exceeded with 100% Observer Coverage

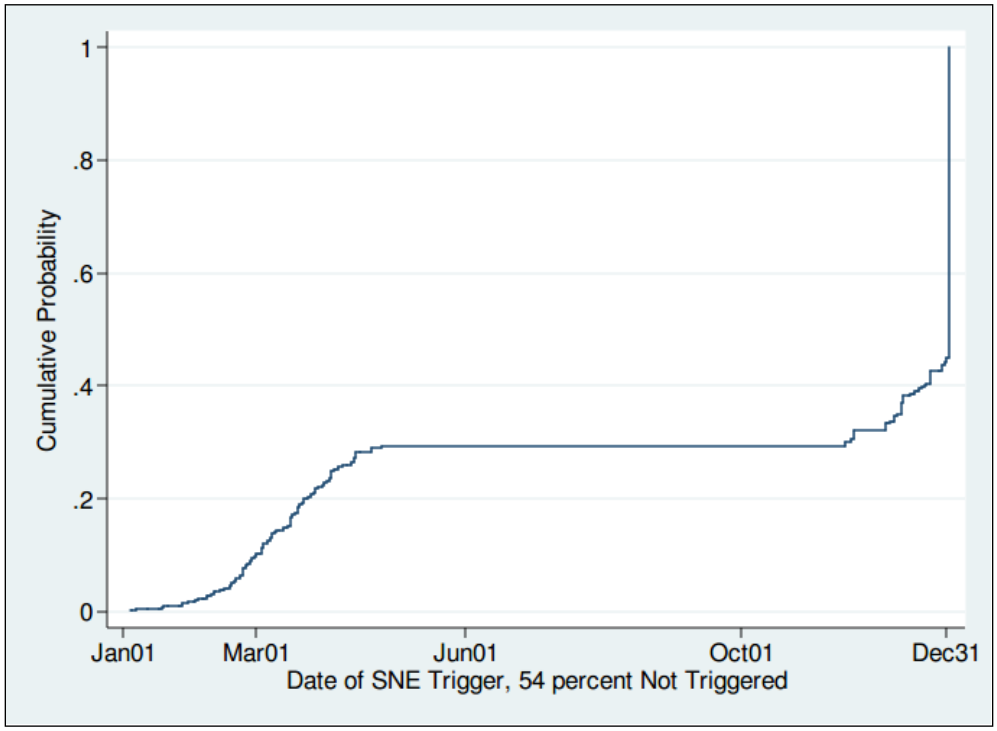


Figure 39 Probability of Gulf of Maine (Max) Trigger Being Exceeded with 50% Observer Coverage

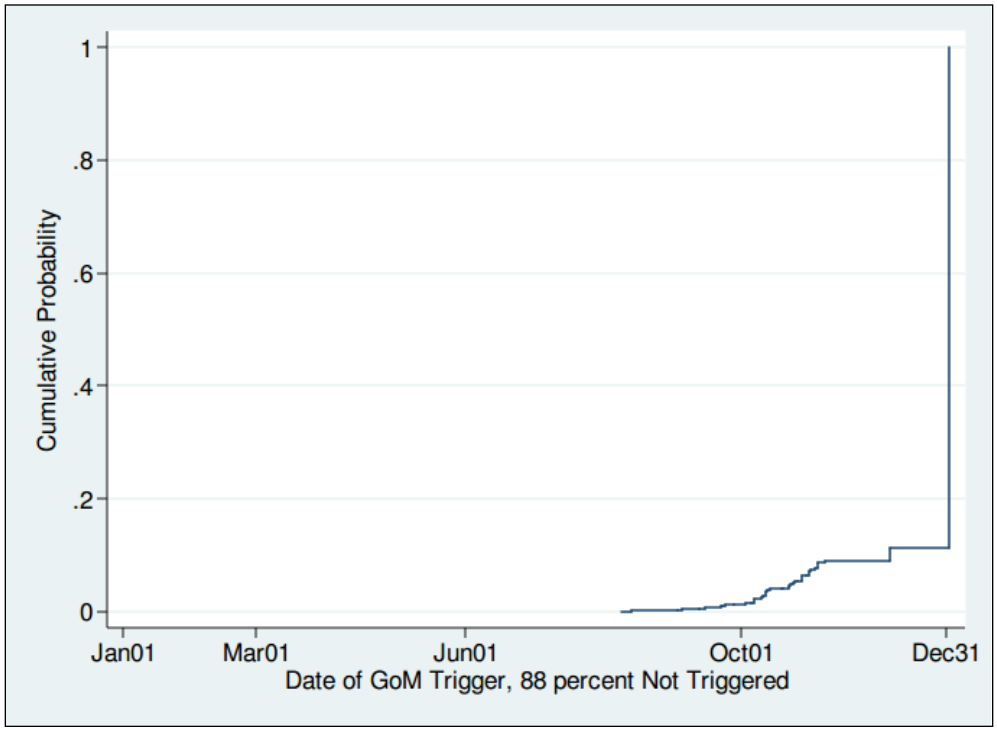


Figure 40 Probability of Cape Cod (Max) Trigger Being Exceeded with 50% Observer Coverage

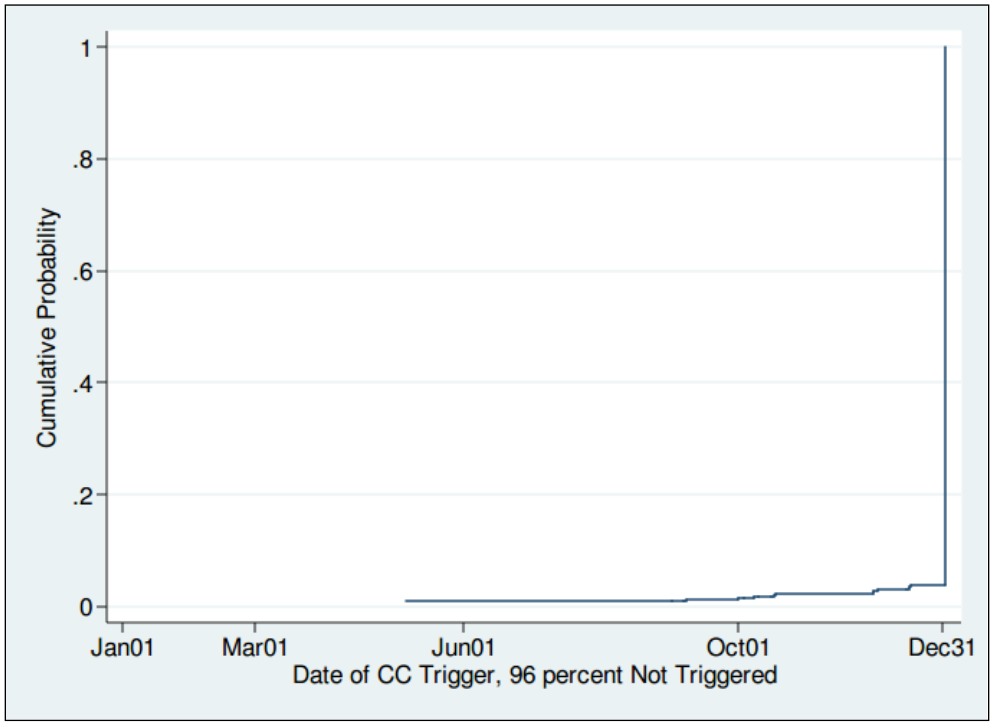


Figure 41 Probability of Southern New England (Max) Trigger Being Exceeded with 50% Observer Coverage

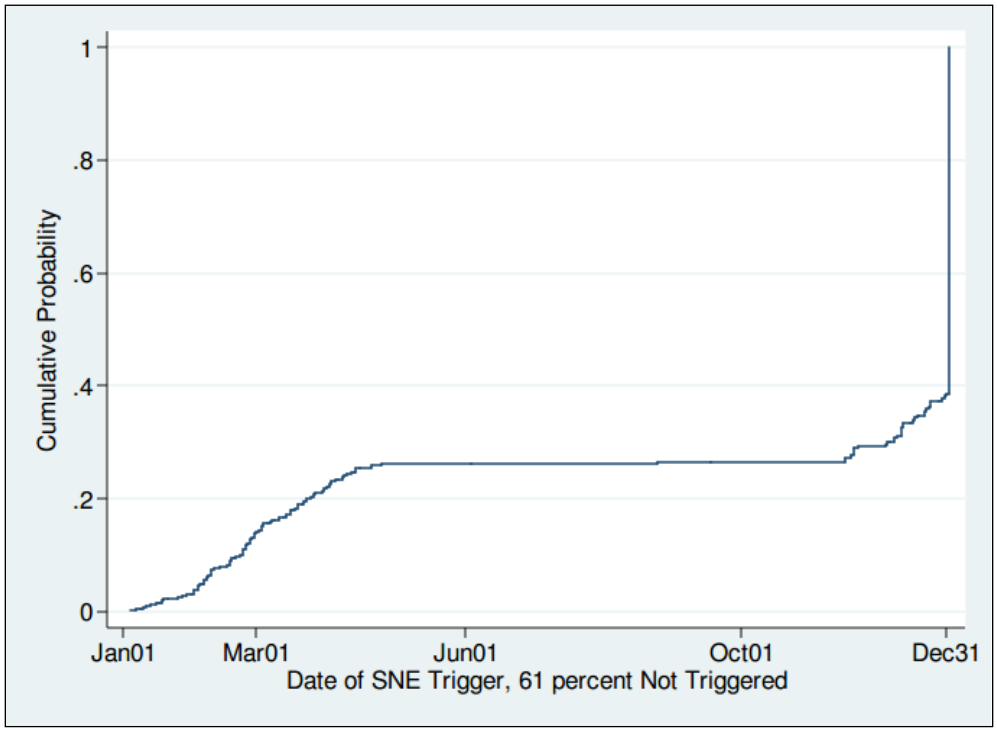


Figure 42 Probability of Gulf of Maine (Median) Trigger Being Exceeded with 100% Observer Coverage

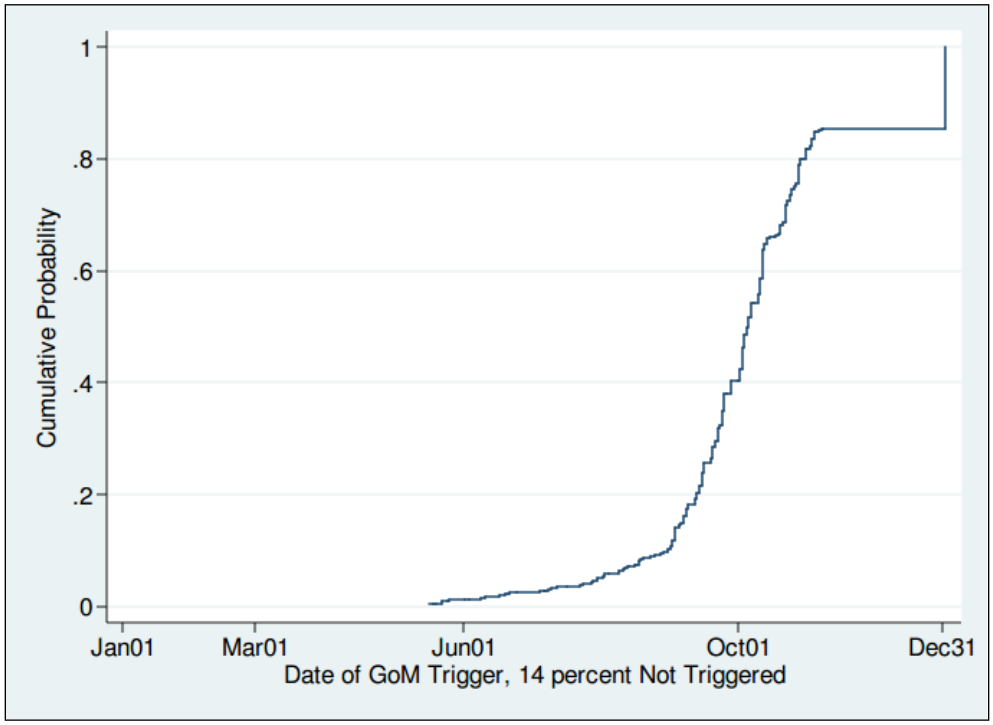


Figure 43 Probability of Cape Cod (Median) Trigger Being Exceeded with 100% Observer Coverage

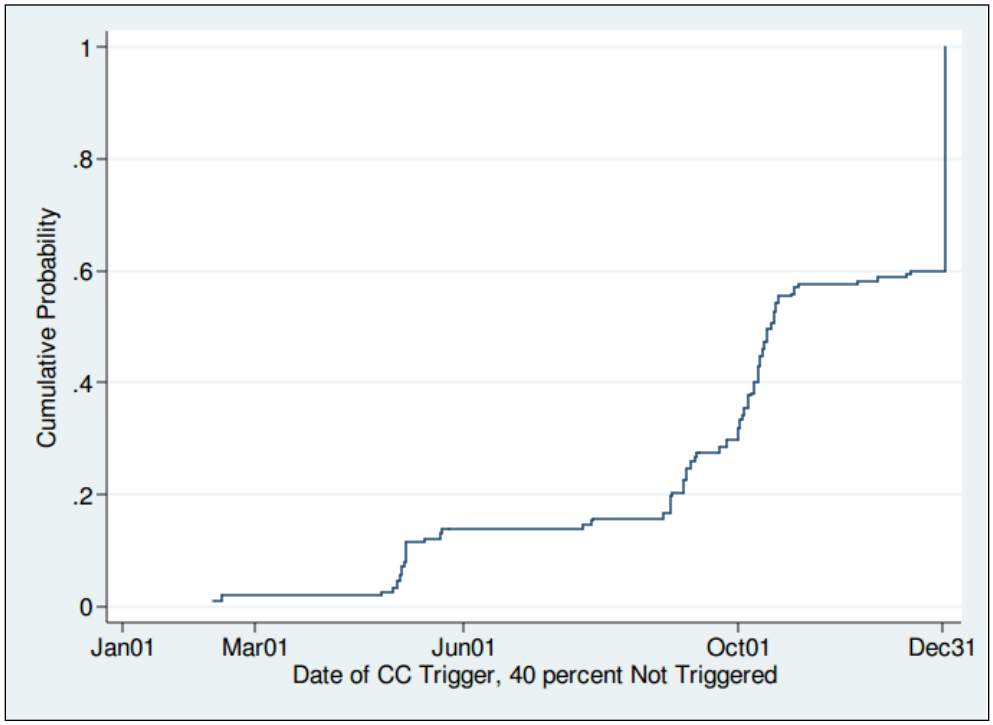


Figure 44 Probability of Southern New England (Median) Trigger Being Exceeded with 100% Observer Coverage

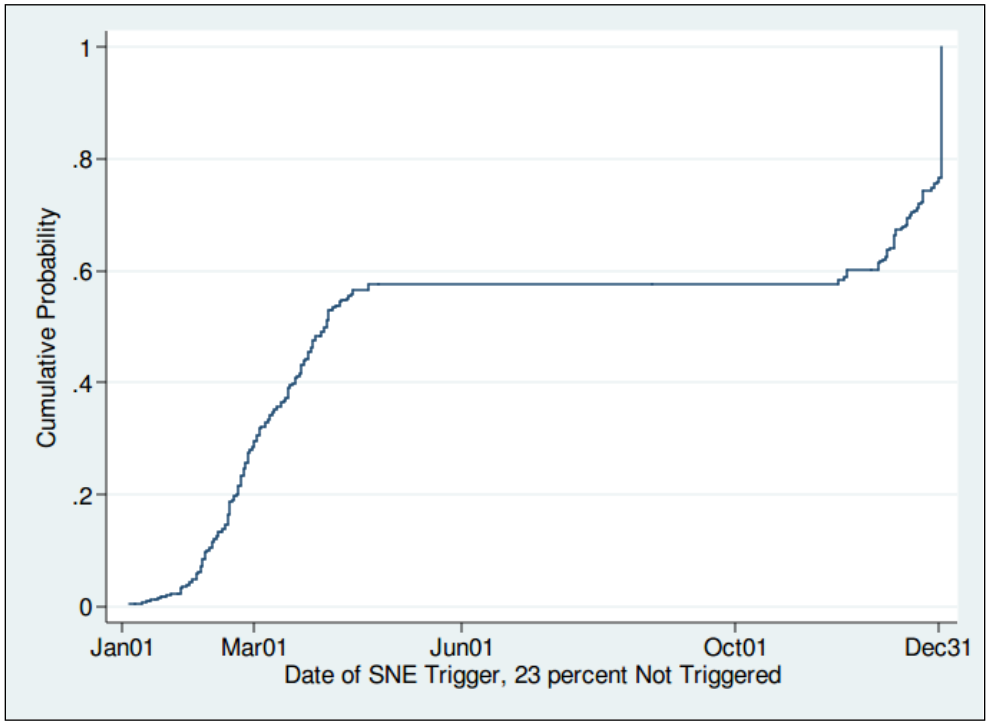


Figure 45 Probability of Gulf of Maine (Median) Trigger Being Exceeded with 50% Observer Coverage

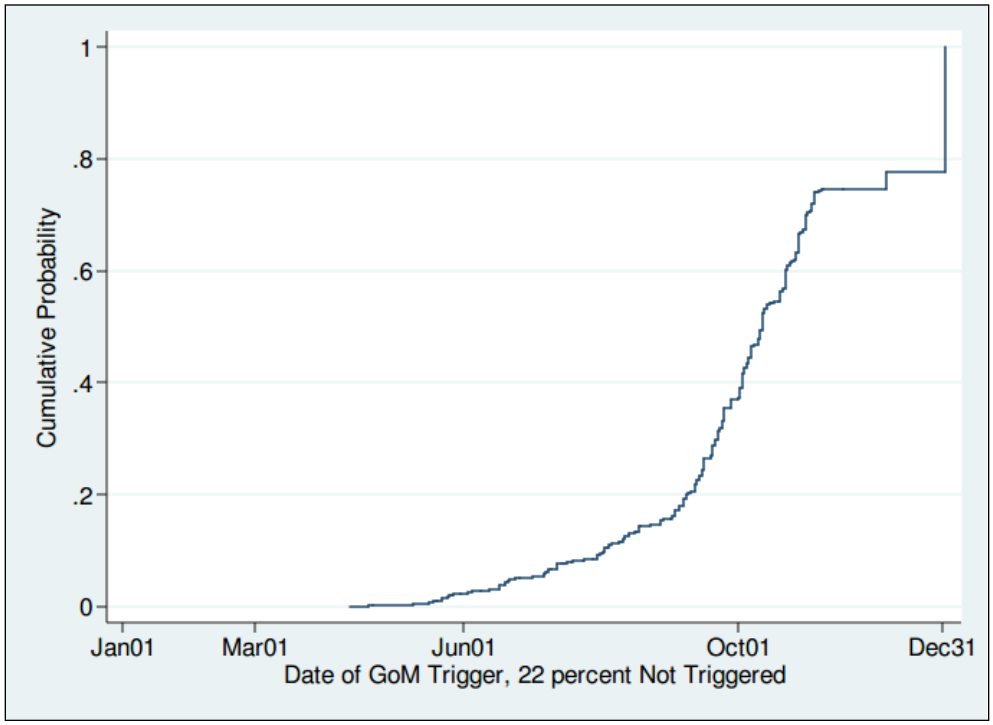


Figure 46 Probability of Cape Cod (Median) Trigger Being Exceeded With 50% Observer Coverage

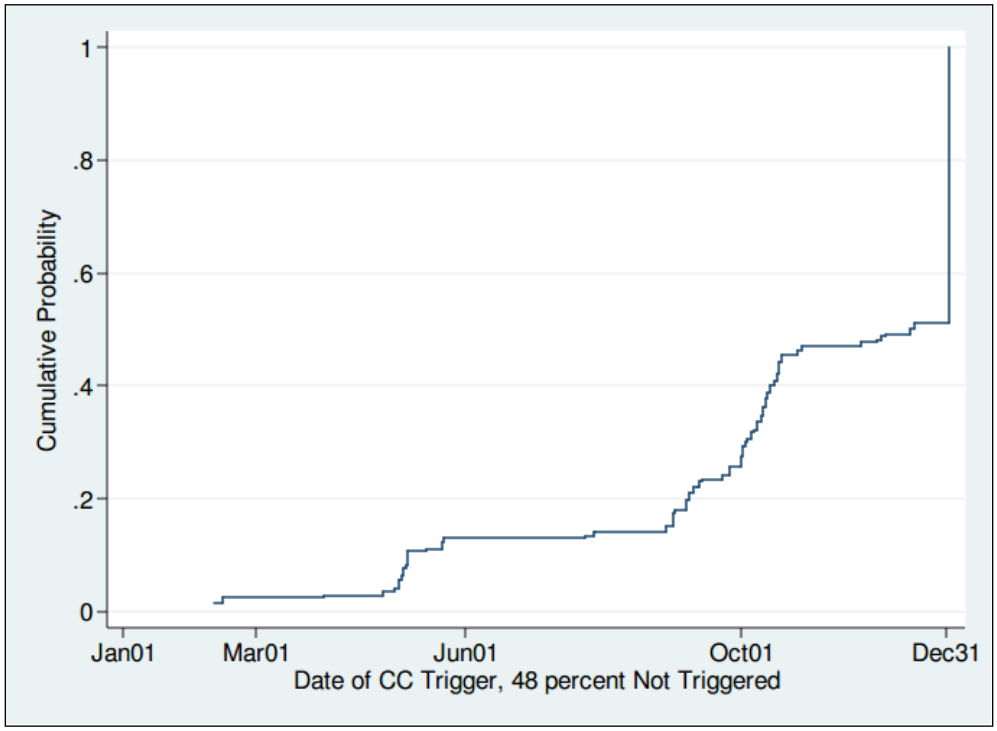


Figure 47 Probability of Southern New England (Median) Trigger Being Exceeded With 50% Observer Coverage

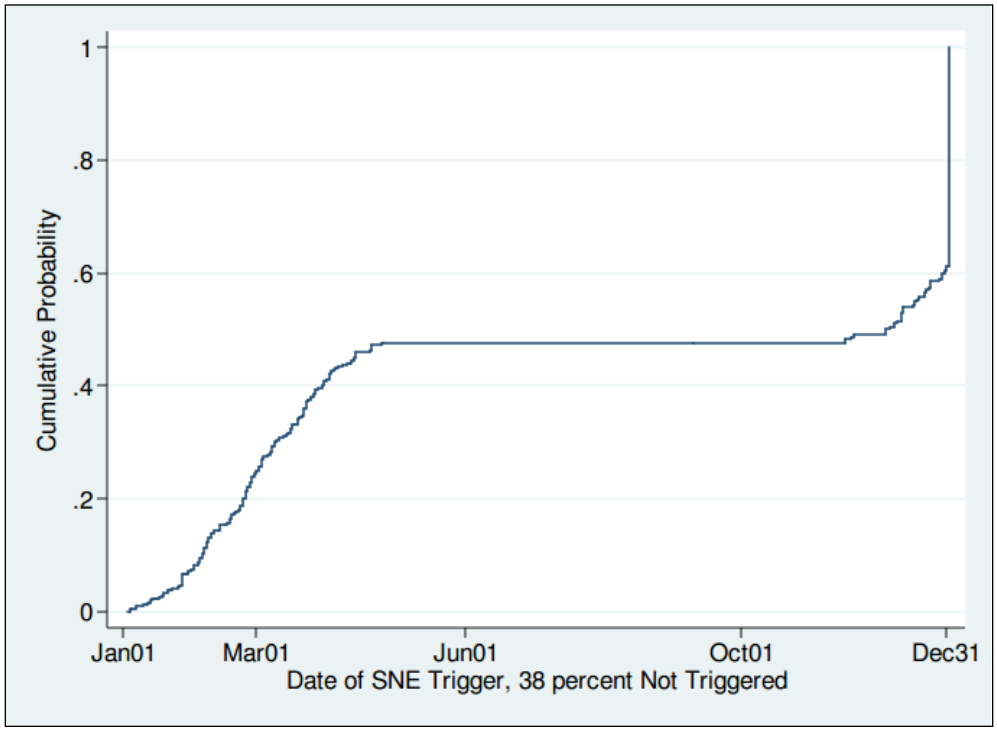


Figure 48 Probability of Gulf of Maine (Mean) Trigger Being Exceeded With 100% Observer Coverage

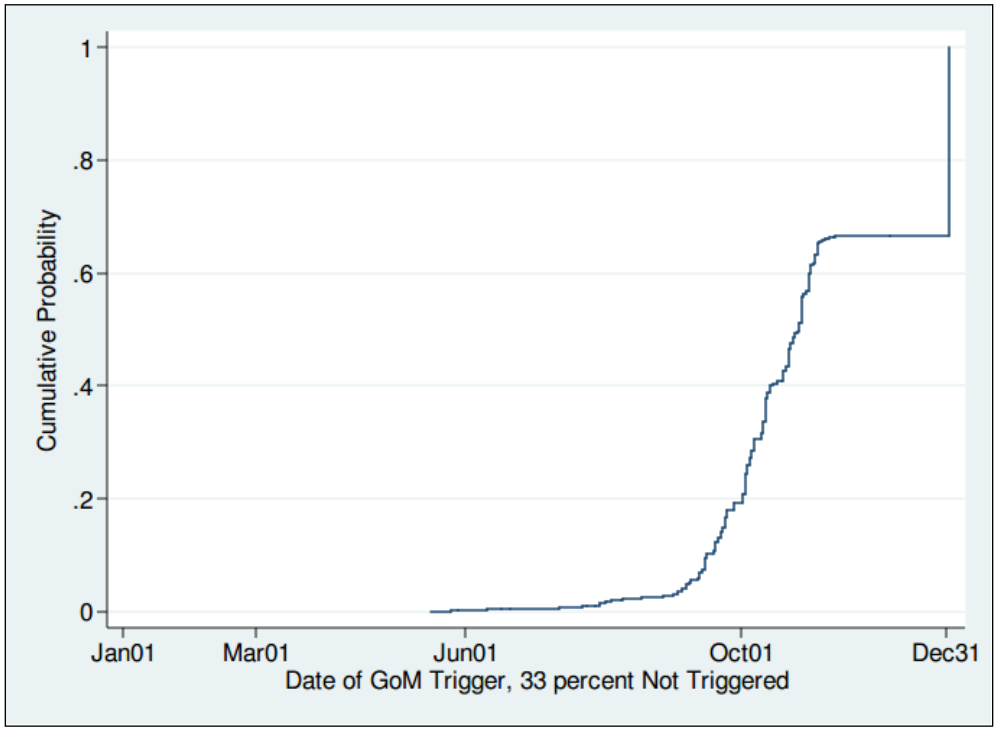


Figure 49 Probability of Cape Cod (Mean) Trigger Being Exceeded With 100% Observer Coverage

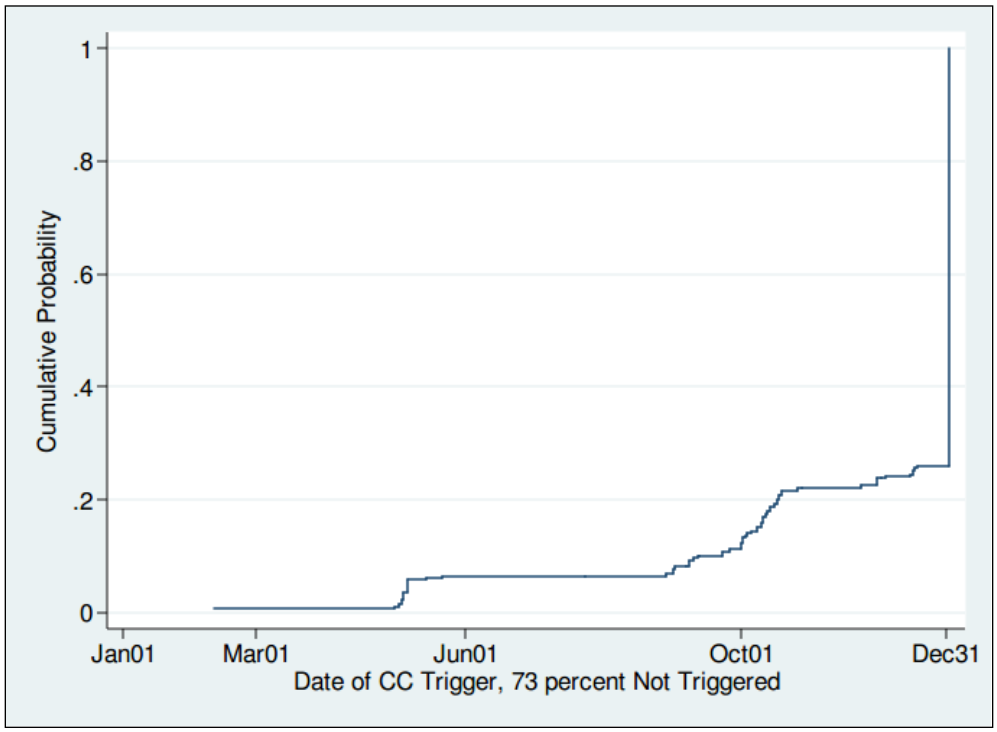


Figure 50 Probability of Southern New England (Mean) Trigger Being Exceeded With 100% Observer Coverage

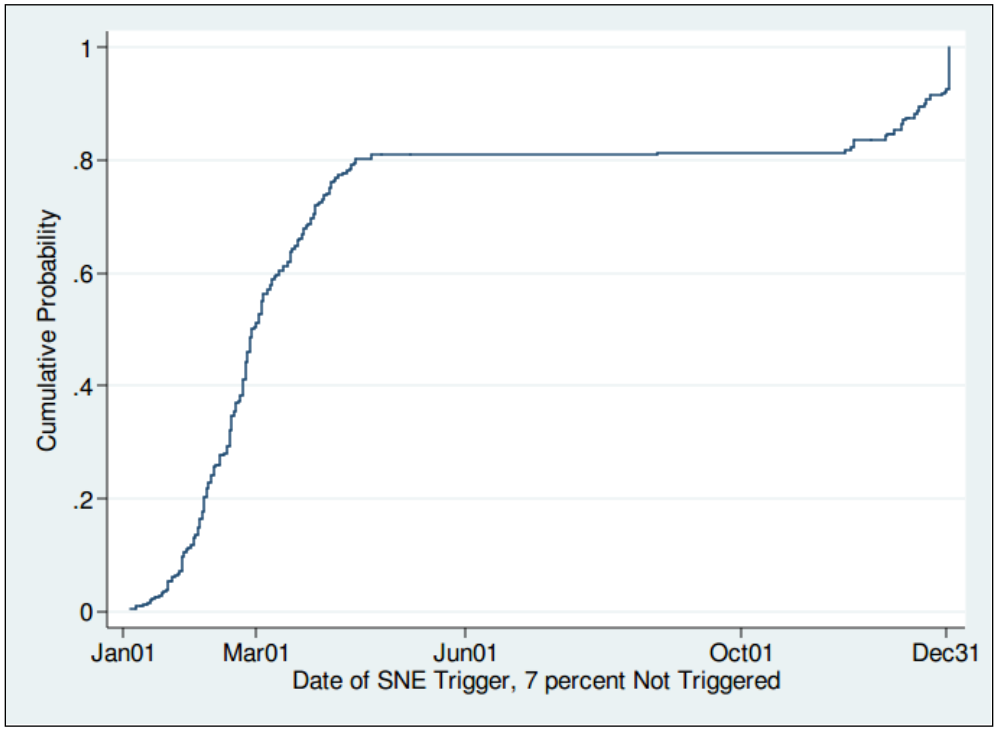


Figure 51 Probability of Gulf of Maine (Mean) Trigger Being Exceeded With 50% Observer Coverage

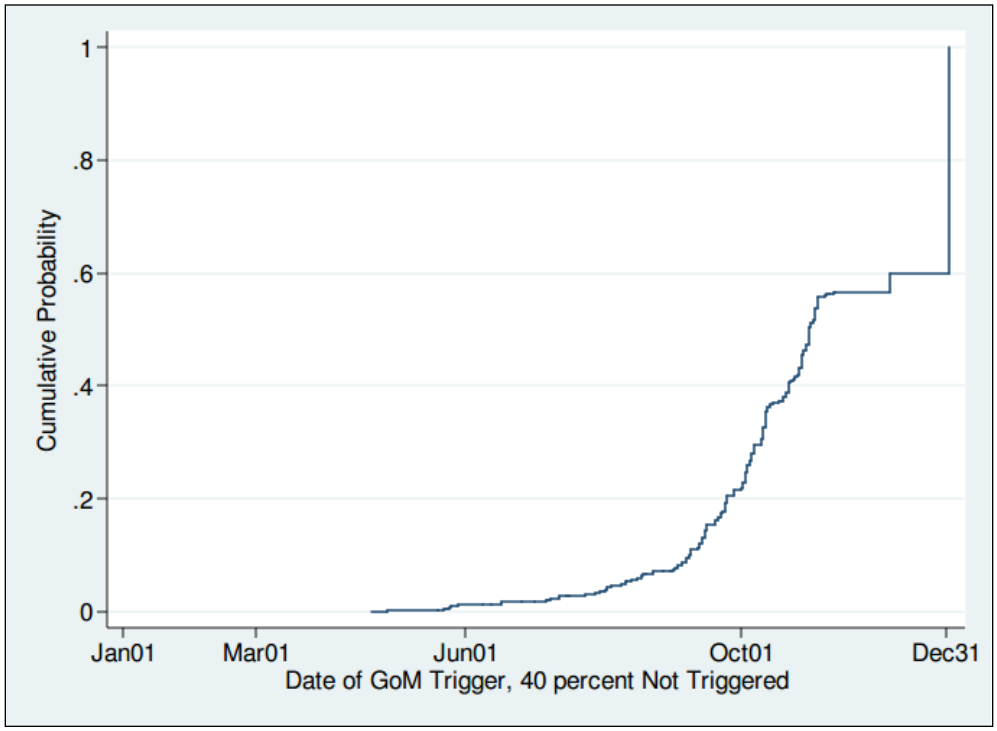


Figure 52 Probability of Cape Cod (Mean) Trigger Being Exceeded With 50% Observer Coverage

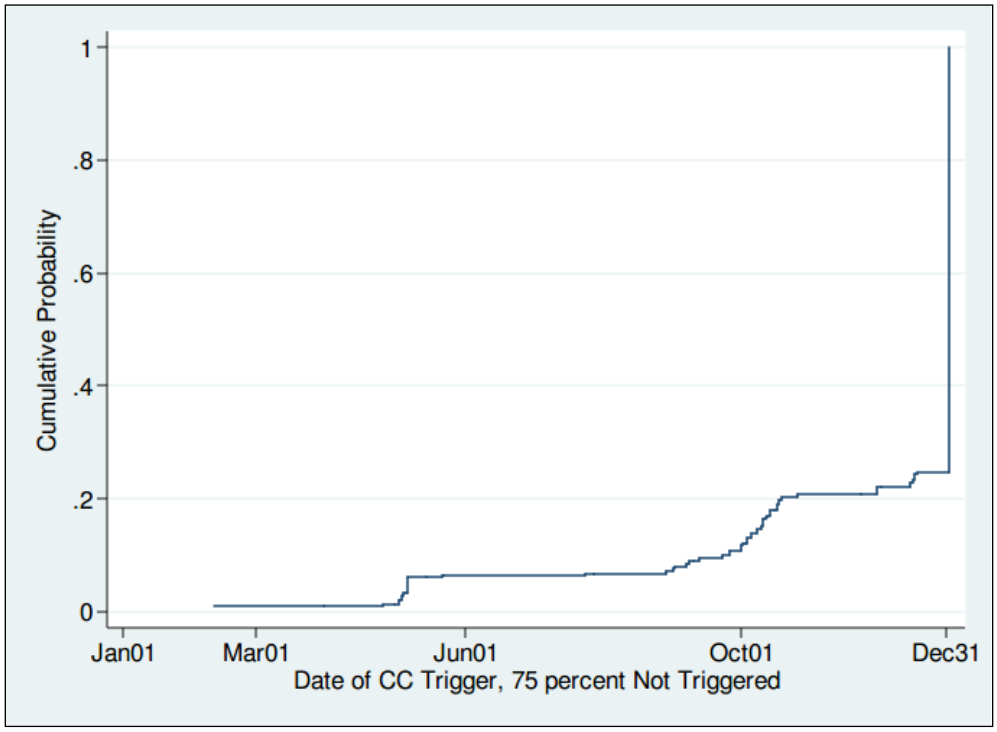
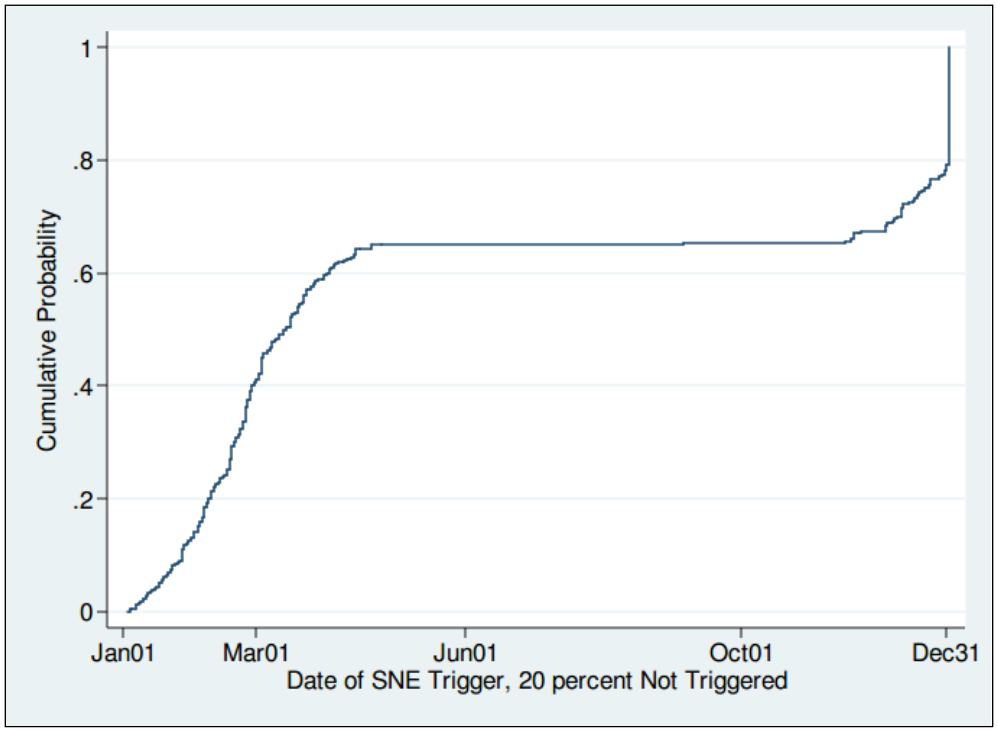


Figure 53 Probability of Southern New England (Mean) Trigger Being Exceeded With 50% Observer Coverage



6.0 ANALYSIS OF THE RIVER HERRING PROTECTION AREAS (ALTERNATIVE 3)

6.1 QUALITATIVE ASSESSMENT

The river herring protection areas options were compared to other areas identified using research surveys. The survey-based areas provide information on the times and areas were river herring are likely to be encountered absent information from the fishery. Additional information/analyses provided by the Herring PDT can be found in Volume II, Appendix III (Herring PDT Analysis: Development of Measures to Address River Herring Bycatch).

Table 31 – Table 34 and associated Figure 55 – Figure 58 provide a comparison of the bimonthly river herring protection areas to associated survey areas. Each area is referenced as A- BB, with a map of all of these areas combined (Figure 54). The number of NEFOP data points used to identify each protection area (fishery-based areas) are provided in Table 31 – Table 34. Further, the number of NMFS bottom-trawl surveys used to identify survey-based areas are found within hatched areas in Figure 55 – Figure 58. Several questions were asked to qualitatively compare fishery-based and survey-based areas:

1) Are there any adjacent fishery-based areas?
2) Are there any adjacent survey-based areas?
3) Does the fishery-based area overlap a survey-based area?

Adjacency was defined as areas sharing a side and/or corner. The results of this analysis for each bimonthly period are summarized in Table 31 – Table 34. One important caveat, noted above, is that the winter survey does not cover the Gulf of Maine.

Alternative 3: Option 1

The potential benefit of the bimonthly protection areas is that they provide river herring mortality protection during at-sea migrations by closing specific river herring fishery-based encounter hotspots. Such an approach could lead to reductions in at-sea river herring mortality. However, with fixed bimonthly protection areas, there would not be river herring mortality protection outside of protection areas. Therefore, areas outside fixed areas could have increased rates of river herring encounters by the fishery, if areas selected do not reflect river herring year-to-year variability.

Alternative 3: Option 2

The potential benefit of the bimonthly triggered protection areas is that they provide river herring mortality protection during at-sea migrations by closing specific river herring encounter hotspots upon reaching a river herring catch trigger. This may lead to possible reductions in river herring mortality. However, there would be no river herring mortality protection outside of the areas. Likewise, triggered protection areas might not be put in place quickly enough to be at the pace with river herring migratory patterns.

Table 31 Comparison of River Herring Protection for January-February (Fishery-Based Areas) with Winter Survey-Based Areas

	Protection Areas January - February							
Map reference	J	K	L	P	S	T	X	Y
Quarter-degree square	41694	41712	41711	40714	40732	40731	39733	39724
How many observer tows were greater than 1233 lbs of river herring?	3	3	12	3	1	4	2	3
Are there any adjacent fishery-based areas?	NO	YES	YES	YES	YES	YES	YES	YES
Are there any adjacent winter survey-based areas?	NO	YES	YES	YES	YES	YES	YES	YES
Does the fishey-based area overlap a survey-based area?	NO	NO	NO	YES	NO	NO	YES	NO

Table 32 Comparison of River Herring Protection for March-April (Fishery-Based Areas) with Spring Survey-Based Areas

	Protection Areas March - April	
Map reference	S	V
Quarter-degree square	40732	40721
How many observer tows were greater than 1233 lbs of river herring?	1	1
Are there any adjacent fishery-based areas?	NO	YES
Are there any adjacent spring survey-based areas?	YES	YES
Does the fishey-based area overlap a survey-based area?	NO	YES

Table 33 Comparison of River Herring Protection for September-October (Fishery-Based Areas) with Fall Survey-Based Areas

	Protection Areas September - October
Map reference	G
Quarter-degree square	42704
How many observer tows were greater than 1233 lbs of river herring?	5
Are there any adjacent fishery-based areas?	NO
Are there any adjacent fall survey-based areas?	YES
Does the fishey-based area overlap a survey-based area?	YES

Table 34 Comparison of River Herring Protection for November-December (Fishery-Based Areas) with Fall and Winter Survey-Based Areas

	Protection Areas November - December					
Map reference	G	I	J	K	L	R
Quarter-degree square	42704	42701	41694	41712	41711	40703
How many observer tows were greater than 1233 lbs of river herring?	10	1	8	1	1	1
Are there any adjacent fishery-based areas?	YES	YES	YES	YES	YES	NO
Are there any adjacent fall survey-based areas?	YES	YES	YES	YES	YES	YES
Are there any adjacent winter survey-based areas?	NO	NO	NO	YES	YES	YES
Does the fishey-based area overlap a fall survey-based area?	YES	YES	NO	NO	YES	NO
Does the fishey-based area overlap a winter survey-based area?	NO	NO	NO	NO	NO	NO

Figure 54 Map of River Herring Protection Areas for All Months Combined

Individual areas (grey blocks) are identified G-Y.

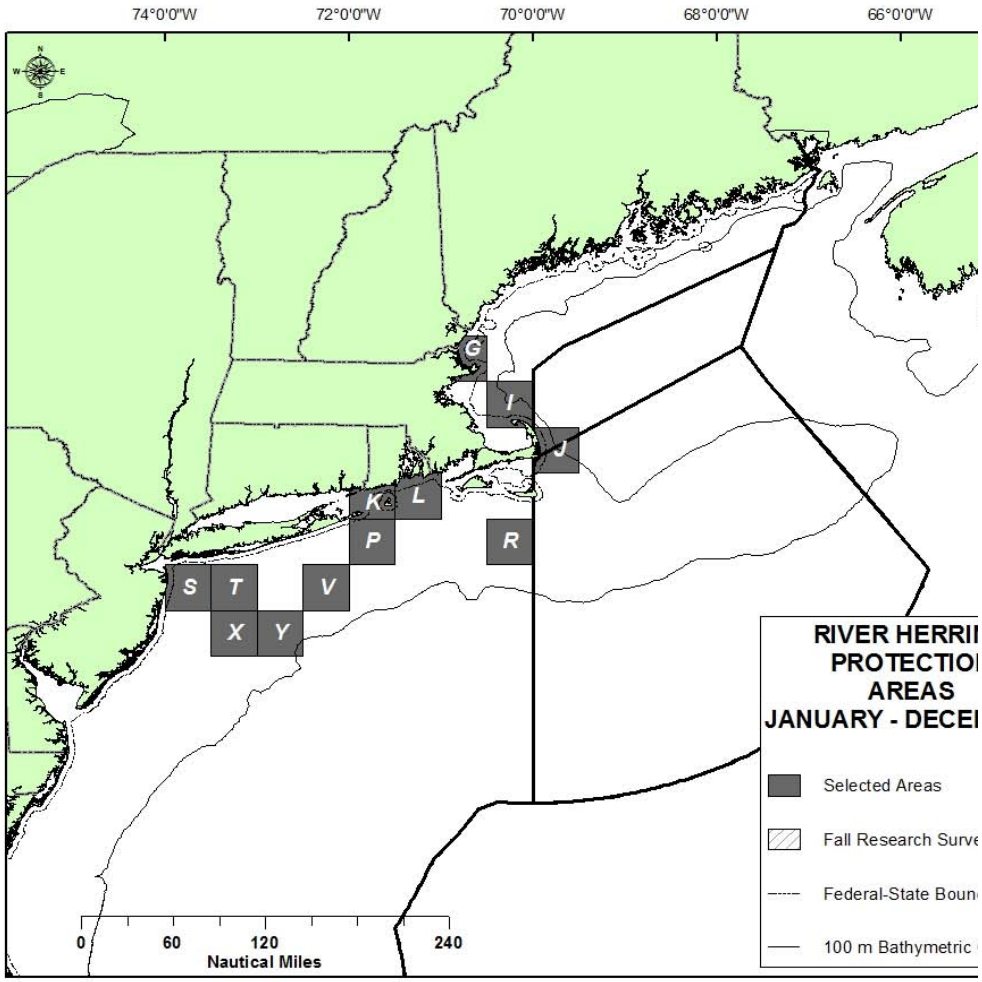


Figure 55 Map of River Herring Protection Areas for January - February (Gray Blocks) Overlaid with Survey Hotspot Areas (Hatched Blocks)

Numbers within blocks indicate the number of survey tows used in the hotspot analysis.

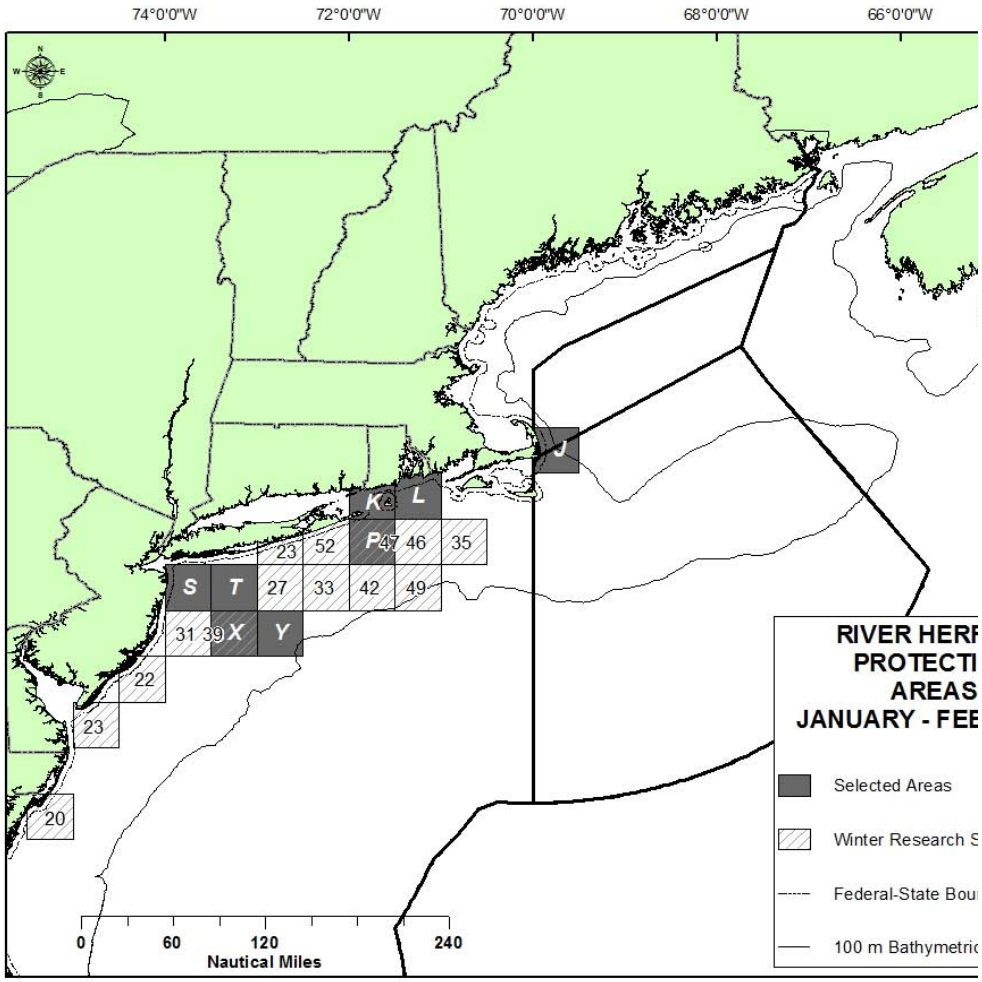


Figure 56 Map of River Herring Protection Areas for March - April (Gray Blocks) Overlaid with Survey Hotspot Areas (Hatched Blocks)

Numbers within blocks indicate the number of survey tows used in the hotspot analysis.

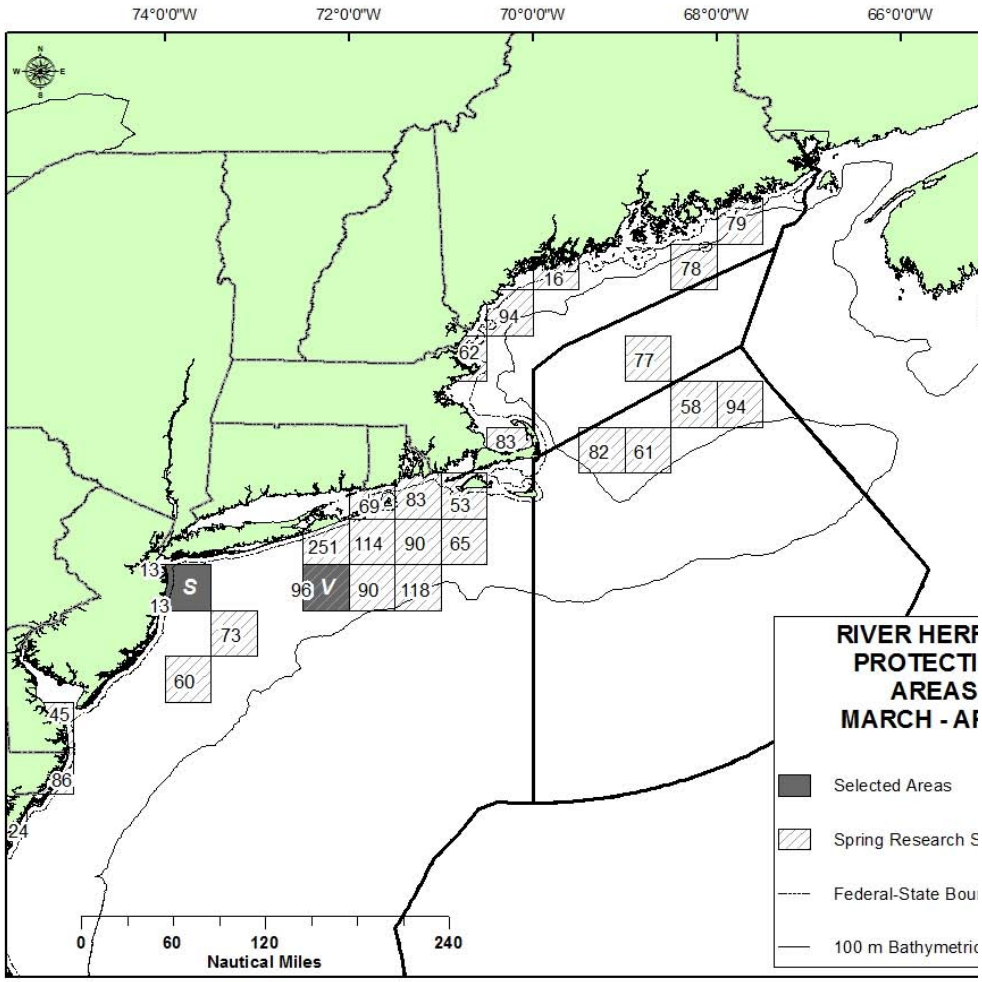


Figure 57 Map of River Herring Protection Areas for September – October (Gray Blocks) Overlaid with Survey Hotspot Areas (Hatched Blocks)

Numbers within blocks indicate the number of survey tows used in the hotspot analysis.

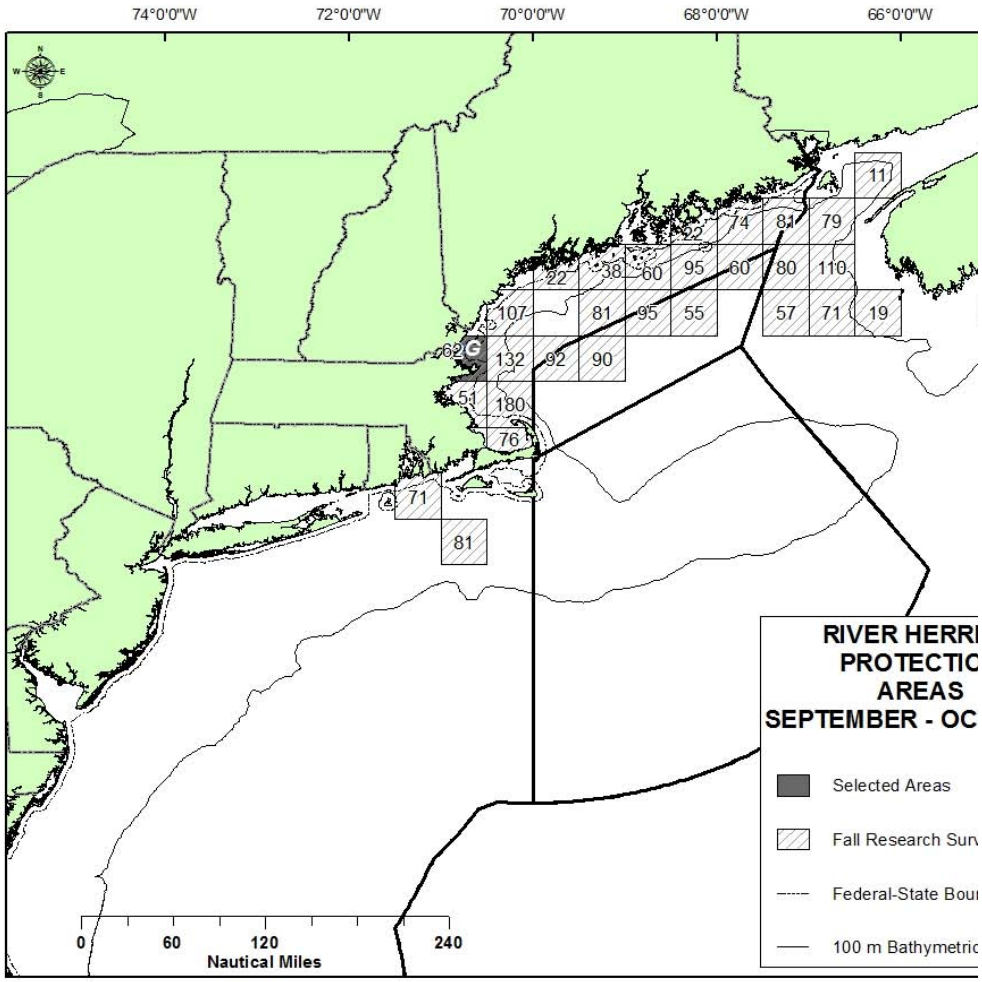
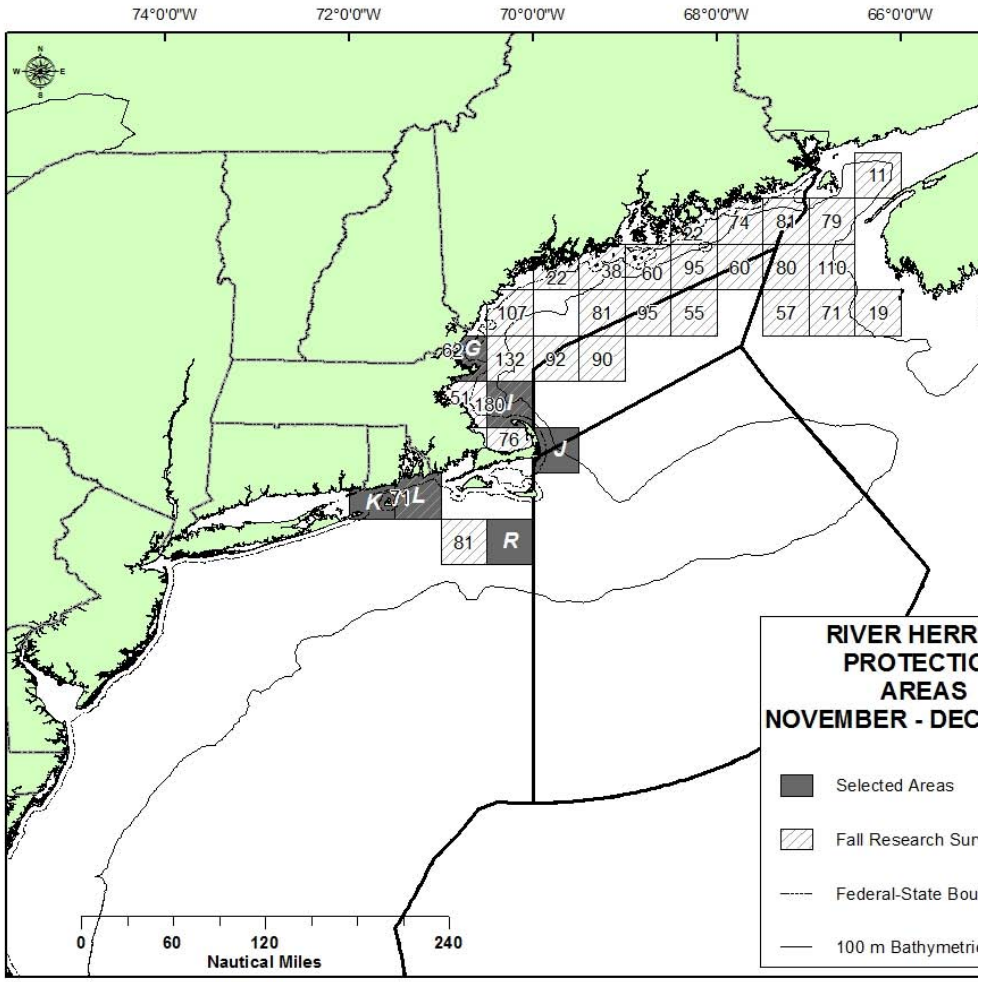


Figure 58 Map of River Herring Protection Areas for November – December (Gray Blocks) Overlaid with Survey Hotspot Areas (Hatched Blocks)

Numbers within blocks indicate the number of survey tows used in the hotspot analysis.



6.2 IMPACTS OF SPATIAL CLOSURES

Alternative 3: River Herring Protection

Section 3.0 describes the general methods used to map the directed Atlantic herring fishery in relation to the proposed River Herring Protection Areas.

Economic Impacts

Under this option, all vessels having a Category A, B, C, or D permit would be prohibited from fishing for, possessing, catching, transferring, or landing herring from the proposed River Herring Protection Areas on all fishing trips using small mesh. The economic impact of this alternative on fishing vessels is the change in profits of these vessels, after accounting for any behavioral changes. Under a spatial closure, the directed herring fleet may undertake different averting behavior to minimize the impact of those spatial closures. Vessels may fish in other areas, likely with lower profits. Vessels may fish in other fisheries, again, likely earning lower profits, or cease fishing operations, in which case they earn zero operating profits.

Maps of fishing effort in the herring fishery are presented in Figure 7 – Figure 27. The fishing time, herring catch, herring revenues, and total revenues which would occur in the River Herring Protection areas are presented in Table 35 – Table 42. It is important to note that the revenue figures presented in Table 39 – Table 42 **do not** represent the economic impacts of the proposed River Herring Protection Areas. These tables should be interpreted as the effort, landings, and revenue which would be at-risk or exposed to change from the protection areas.

There is minimal overlap between the purse seine fishery and the river herring protection areas during September-December. There is also minimal overlap between the Category D permit holders and the river herring protection areas. There is substantial overlap between the trawl fishery and the proposed river herring protection areas, particularly in January-February and November-December, with lesser overlap in other months. Over 50% of the Category A/B/C trips fished for some time within the proposed protection areas.

The effort, catch and revenue tables confirm that the River Herring Protection Areas would have minimal impact on the purse seine fleet and could have substantial impacts on the trawl fleet. In 2010, the trawl fishery spent approximately one-third of its fishing time within the proposed River Herring Protection Areas, catching one-third of the annual herring catch, 29% of its total herring revenues, and 33% of total revenues within those areas.

The impacts of the River Herring Protection Areas are likely to be largest for the trawl fishery during the winter (January-February and November-December). According to those figures, a large portion of total effort during those months occurs inside the proposed River Herring Protection Areas. Captains have built up large amounts of human capital (knowledge and experience) regarding where and how to catch fish. Closing the most productive areas to fishing will lead to higher costs (searching and steaming), lower catch-per-unit-effort, as vessels fish in unfamiliar areas and on lower densities of fish, and lower profits. For these months, captains are not likely to be familiar with alternative fishing locations. If they choose to fish for herring in alternative locations, captains will build their knowledge and experience; however, this process may take time.

This river herring protection option may have impacts on shoreside processors, bait dealers, and other consumptive users of herring. This option may reduce supply of herring, particularly in the winter months in the Southern New England areas.

Table 35 Fishing Time (Hours) Inside and Outside the River Herring Protection Areas

		Fishing Time		
Gear	Category	Not Protected	Protected	Grand Total
PUR		2,940	7	2,947
TR	ABC	8,029	4,077	12,105
	D	227	71	298
Grand Total		11,197	4,155	15,351

Table 36 Fishing Time (%) Inside and Outside the River Herring Protection Areas

		Fishing Time (%)		
Gear	Category	Not Protected	Protected	Grand Total
PUR		99.8%	0.2%	100.0%
TR	ABC	66.3%	33.7%	100.0%
	D	76.3%	23.7%	100.0%
Grand Total		72.9%	27.1%	100.0%

Table 37 Herring Catch (lbs.) Inside and Outside the River Herring Protection Areas

		Herring Catch		
Gear	Category	Not Protected	Protected	Grand Total
PUR		18,423,800	38,741	18,462,541
TR	ABC	82,973,751	41,130,098	124,103,849
	D	112,799	36,045	148,844
Grand Total		101,510,350	41,204,884	142,715,233

Table 38 Herring Catch (%) Inside and Outside the River Herring Protection Areas

		Herring Catch (%)		
Gear	Category	Not Protected	Protected	Grand Total
PUR		99.8%	0.2%	100.0%
TR	ABC	66.9%	33.1%	100.0%
	D	75.8%	24.2%	100.0%
Grand Total		71.1%	28.9%	100.0%

Table 39 Herring Revenue ($) Inside and Outside the River Herring Protection Areas

		Herring Revenue		
Gear	Category	Not Protected	Protected	Grand Total
PUR		$2,952,318	$5,760	$2,958,078
TR	ABC	$11,059,051	$4,561,645	$15,620,696
	D	$18,792	$5,645	$24,437
Grand Total		$14,030,161	$4,573,050	$18,603,211

Table 40 Herring Revenue (%) Inside and Outside the River Herring Protection Areas

		Herring Revenue (%)		
Gear	Category	Not Protected	Protected	Grand Total
PUR		99.8%	0.2%	100.0%
TR	ABC	70.8%	29.2%	100.0%
	D	76.9%	23.1%	100.0%
Grand Total		75.4%	24.6%	100.0%

Table 41 Total Revenue ($) Inside and Outside the River Herring Protection Areas

		Total Revenue		
Gear	Category	Not Protected	Protected	Grand Total
PUR		$2,952,369	$5,760	$2,958,129
TR	ABC	$12,065,312	$6,027,755	$18,093,067
	D	$33,329	$9,683	$43,011
Grand Total		$15,051,010	$6,043,198	$21,094,208

Table 42 Total Revenue (%) Inside and Outside the River Herring Protection Areas

		Total Revenue (%)		
Gear	Category	Not Protected	Protected	Grand Total
PUR		99.8%	0.2%	100.0%
TR	ABC	66.7%	33.3%	100.0%
	D	77.5%	22.5%	100.0%
Grand Total		71.4%	28.6%	100.0%

Category A/B Versus Category C and Category D Vessels

To further investigate differential impacts by herring permit category, herring catch and revenues from these vessels inside and outside the proposed protection areas are summarized by permit category in Table 43. While 22-24% of the Category D effort, catch, and revenues are derived from the monitoring areas, the magnitude of effort, catch, and revenues attributable to Category D vessels is minimal. A fairly large portion of the Category A/B/C trawl fishery would be impacted by the monitoring options; 40-45% of the effort, catch, and revenues for this segment of the fishery occurred in the monitoring areas. Category C vessels often participate in other fisheries and catch herring incidentally. Table 43 shows that Category C vessels derive almost 30% of their revenues from the areas proposed for closure under this alternative.

Table 43 Herring Catch/Revenues and Total Revenues Inside and Outside the Proposed Protection Areas by Limited Access Herring Permit Category

Permit Cat.	No. Vessels	Inside/ Outside	Hours Fished	Herring Revenues (millions dollars)	Herring Catch (millions pounds)	Total Revenue (millions dollars)
A	27	Outside	8,988	$11.84	83.79	$12.66
A	26	Inside	5,140	$6.28	55.75	$7.91
B	1	Outside	Cannot report	Cannot report	Cannot report	Cannot report
B	3	Inside	357	$0.17	1.58	$0.17
C	3	Outside	320	$0.21	0.84	$0.22
C	6	Inside	239	$0.07	0.56	$0.09
D	6	Outside	227	$0.02	0.11	$0.03
D	5	Inside	71	$0.01	0.04	$0.01

7.0 HERRING PDT ANALYSIS – TRADE-OFFS OF SPATIAL MANAGEMENT MEASURES

The following tables summarize the biological, economic, and social trade-offs of the spatial management measures under consideration in Amendment 5 to address river herring bycatch (Table 44 – Table 48).

Table 44 Biological – River Herring-Focused Trade-offs of Spatial Management Approaches

	Biological- River Herring	
Possible Measure	**Positive Impacts**	**Negative Impacts**
No Action (A1)	No additional positive impacts.	No additional negative impacts.
Fixed Bimonthly Monitoring Areas (Alt.2, Opt.1-3)	Areas improve understanding of river herring encounters in the Atlantic herring fishery through focused monitoring. Possible reductions in river herring mortality.	No impact on river herring mortality, unless the fishery chooses to stay out of monitoring areas. Specific areas monitored instead of across the full range of the species misses important river herring encounters and influences river herring removals estimates.
Fixed Bimonthly Avoidance Areas (Alt.2, Opt.4)	Areas with relatively high river herring encounters are avoided (by time or distance) when river herring are encountered at some threshold level. Likely reductions in river herring mortality.	No river herring mortality protection outside of avoidance areas. Areas outside avoidance areas could have increased rates of river herring encounters by the fishery, if areas selected do not reflect year-to-year variability.
Fixed Bimonthly Protection Areas (Alt. 3, Opt.1)	Areas provide river herring mortality protection during at-sea migrations by closing specific river herring encounter hotspots. Likely reductions in river herring mortality.	No river herring mortality protection outside of protection areas. Areas outside fixed areas could have increased rates of river herring encounters by the fishery, if areas selected do not reflect year-to-year variability.
Triggered Bimonthly Protection Areas (Alt.3, Opt.2)	Areas provide river herring mortality protection during at-sea migrations by closing specific river herring encounter hotspots upon reaching a trigger. Possible reductions in river herring mortality.	No river herring mortality protection outside of trigger areas. Trigger areas are not put in place quickly enough to be at the pace with river herring migratory patterns.

Table 45 Biological – Other Small Pelagics-Focused Trade-offs of Spatial Management Approaches

	Other Small Pelagic- American and Hickory Shad, Mackerel, Herring, Squid, Butterfish, Whiting, Menhaden	
Possible Measure	**Positive Impacts**	**Negative Impacts**
No Action (A1)	No additional positive impacts.	No additional negative impacts.
Fixed Bimonthly Monitoring Areas (Alt.2, Opt.1-3)	Increased monitoring can provide additional information on bycatch/discards of other non-target species	Dependent on individual species life history and migratory patterns.
Fixed Bimonthly Avoidance Areas (Alt.2, Opt.4)	Areas with co-occurring small pelagic species (shads, mackerel, herring, squid, butterfish, whiting) and potentially groundfish are avoided (by time or distance) when river herring are encountered at some threshold level. Possible reductions in American and hickory shad mortality, high rate of co-occurrence with river herring in NEFOP data for Atlantic herring fishery.	Dependent on individual species life history and migratory patterns.
Fixed Bimonthly Protection Areas (Alt. 3, Opt.1)	Areas might provide mortality protection for co-occurring small pelagic species (shads, mackerel, herring, squid, butterfish, whiting) and potentially groundfish are protected by closing specific river herring encounter hotspots. Likely reductions in American and hickory shad mortality, due to high rate of co-occurrence with river herring encounters in NEFOP data for Atlantic herring fishery.	Dependent on individual species life history and migratory patterns.
Triggered Bimonthly Protection Areas (Alt.3, Opt.2)	Areas might provide mortality protection for co-occurring small pelagic species (shads, mackerel, herring, squid, butterfish, whiting) and potentially groundfish are protected by closing specific river herring encounter hotspots upon reaching a trigger. Possible reductions in American and hickory shad mortality, due to high rate of co-occurrence with river herring encounters in NEFOP data for AH fishery.	Dependent on individual species life history and migratory patterns.

Table 46 Economic – Atlantic Herring Fishery Participants Focused Trade-offs of Spatial Management Approaches

	Economic- Atlantic herring fishery participants	
Possible Measure	**Positive Impacts**	**Negative Impacts**
No Action (A1)	No additional positive impacts.	No additional negative impacts.
Fixed Bimonthly Monitoring Areas (Alt.2, Opt.1-3)	There are no economic benefits to the directed Atlantic herring fishery, relative to the status quo (no action alternative).	The SBRM-prioritized monitoring of fishing fleets can be considered the optimal pattern of observer coverage. To the extent that Fixed Bimonthly Monitoring Areas results in diversion of scarce observer days away from this optimal pattern of observer coverage, there is an economic loss. This is a loss of information which will result in less data available about bycatch in other fisheries and, presumably, stock assessments with larger errors. If the Fixed Bimonthly Monitoring Areas do not shift observer days away from the optimal pattern, then there is no information loss. If additional observer coverage is paid for by industry, this represents a negative economic impact. This can be calculated by estimating the additional observer coverage days and multiplying by the cost of an observer day. The Closed Area I Sampling Provisions would entail slightly higher regulatory and compliance costs than the other options being considered.
Fixed Bimonthly Avoidance Areas (Alt.2, Opt.4)		
Fixed Bimonthly Protection Areas (Alt. 3, Opt.1)	There are no direct economic benefits to the directed Atlantic herring fishery, relative to the status quo (no action alternative).	Decreases in revenue in the directed Atlantic Herring Fishery and/or increases in costs of fishing for participants in the directed Atlantic Herring Fishery. The largest impacts are likely to be felt by trawl fishery participants during the winter season due to the high overlap between the Protection Areas and the current spatio-temporal distribution of fishing effort.
Triggered Bimonthly Protection Areas (Alt.3, Opt.2)	There are no direct economic benefits to the directed Atlantic herring fishery, relative to the status quo (no action alternative).	Decreases in revenue in the directed Atlantic Herring Fishery and/or increases in costs of fishing for participants in the directed Atlantic Herring Fishery. The largest impacts are likely to be felt by trawl fishery participants during the winter season due to the high overlap between the Protection Areas and the current spatio-temporal distribution of fishing effort. These costs are likely to be lower than Alt 3, Opt 1; however, there is substantial uncertainty associated with projecting when the Triggers might be reached.

Table 47 Social – Focused Trade-offs of Spatial Management Approaches

	Social/Other- management, directed-river herring fishery, etc.	
Possible Measure	**Positive Impacts**	**Negative Impacts**
No Action (A1)	No additional positive impacts.	No additional negative impacts.
Fixed Bimonthly Monitoring Areas (Alt.2, Opt.1-3)	Participants in the directed river herring fishery should see increased availability of river herring catch, if the fixed monitoring areas results in higher stock levels of river herring. Indirect users of the river herring resource, including consumers that use species that prey on river herring, will benefit if the monitoring areas result in higher stock levels of river herring. Would enable Atlantic herring fishery participants to avoid river herring mortality if encounters are communicated quickly and consistently.	Increased economic costs associated with industry payment for observers could trigger additional losses of vessels and processing plants, thereby also affecting bait supplies for other fisheries.
Fixed Bimonthly Avoidance Areas (Alt.2, Opt.4)	Would enable Atlantic herring fishery participants to avoid river herring mortality if encounters are communicated quickly and consistently. This would also demonstrate the fishery's responsiveness to concerns about river herring.	Increased economic costs with industry payment for observers could trigger additional losses of vessels and processing plants, thereby also affecting bait supplies for other fisheries. Keeping the threshold values meaningful could be problematic as the size of the river herring stock changes.
Fixed Bimonthly Protection Areas (Alt. 3, Opt.1)	Most straight-forward option to enforce	Since the hotspots are variable, this might unnecessarily constrain Atlantic herring operations, leading to increased social costs triggered by economic losses.
Triggered Bimonthly Protection Areas (Alt.3, Opt.2)	Triggers are understood so Atlantic herring fishery participants would be likely to limit fishing in the protection area if feasible, but if river herring is not encountered, fishing could continue if the Atlantic herring are present.	Uncertainty associated with trigger mechanisms makes planning more difficult. Keeping the trigger values meaningful could be problematic as the size of the river herring stock changes.

Table 48 Monitoring – Focused Trade-offs of Spatial Management Approaches

	Monitoring- NEFOP	
Possible Measure	**Positive Impacts**	**Negative Impacts**
No Action (A1)	Benefits associated under the no action alternative possible if catch monitoring provisions that would apply across the fishery, (i.e. the 100% observer coverage option) which would allow for observers to document interactions with river herring across the fleet, at different times and in different areas that perhaps have not been sampled before. More coverage allows for more biological sampling, more scale sampling and length frequency collection which will aid in the stock assessment process and will add to further understanding of the species and stock. Catch Monitoring Alternatives 3 and 4 would also increase coverage rates, if selected, and therefore provide the same type of biological benefits associated with increased sampling, and generally increasing the possibility of encountering the species. Increased monitoring will lead to greater understanding of interactions with river herring and the overall fleet during peak fishing times and off peak fishing times of the year.	Increased monitoring beyond federal funds would cost the industry and would have a negative impact with the potential for backlash to observers if/when industry has to pay for them. Or it could be the opposite – perhaps industry will buy into the increase in scientific information to improve stock assessments for the future of their fishery, and therefore work more closely with observers. Cost could be different if an industry funded at-sea monitoring program were developed vs. a full observer program currently in place.
Fixed Bimonthly Monitoring Areas (Alt.2, Opt.1-3)	Increased sampling would be achieved, therefore further quantifying the catch composition. Biological sampling would be increased, potentially if increased interactions occur. Further understanding of the interactions and where and when they take place. Ground-truthing the monitoring areas if catches show river herring composition. May in fact avoid fishing in areas with the coverage requirements, if they are paying for the coverage, which would decrease potential negative impacts on the species.	Possibly difficult determining ahead of time what areas the fleet will fish in, and therefore how they will notify for an area. Are they allowed to fish in multiple monitoring areas on a single trip, if not it would impact their flexibility and therefore possible catch, if there are low catch rates in an area. Can they fish inside and outside of a monitoring area, and if so do they need to have the coverage for that particular situation? How to enforce the notifications (i.e. what if they notify for one area and fish in another?) This could affect the coverage rates if coverage is less than 100%. Increased monitoring beyond federal funds would cost the industry and would have a negative impact. Again, an ASM program may be a cost-effective option. Monitoring areas are set in place until a framework action is taken, which could take some time, if river herring are not present in the areas, as would be documented by the observer data, and the industry is paying for it likely they will want to update the area determination quickly.
Fixed Bimonthly Avoidance Areas (Alt.2, Opt.4)	Same as above	Same as above
Fixed Bimonthly Protection Areas (Alt. 3, Opt.1)		
Triggered Bimonthly Protection Areas (Alt.3, Opt.2)	Similar to Monitoring/Avoidance	Similar to Monitoring/Avoidance Except similar to the haddock cap, if the industry is paying attention to the trigger number, and they are close to hitting

	Monitoring- NEFOP	
Possible Measure	**Positive Impacts**	**Negative Impacts**
		the trigger, which could prove difficult for observers. Pressure is higher on such trips. Potential of releasing catch (slippage) may be higher. Or if the industry knows if they hit the trigger then they have to pay for 100% coverage to fish in an area, again may lead to potential slippage events.

8.0 OPTIONS FOR SHRIMP/LARGE MESH FISHERY EXEMPTIONS TO RIVER HERRING MANAGEMENT MEASURES

At the September 2011 NEFMC Meeting, the Council agreed to consider exemptions to the options in River Herring Alternatives 2 and 3 that would require 100% observer coverage, Closed Area I provisions, or closed areas (Alternative 3). These exemptions are being considered for the Northern Shrimp Fishery, which operates seasonally in the inshore Gulf of Maine, and for the large mesh groundfish fishery (using mesh greater than 5.5 inches). The following information is included in this document to provide some perspective on river herring and other bycatch occurring in these two fisheries so that the Council can make a more informed decision when it selects the final measures for Amendment 5 and considers any exemptions.

8.1 BACKGROUND INFORMATION – NORTHERN SHRIMP FISHERY

8.1.1 Overview

Management Plan and Status of the Stock

The Northern Shrimp Fishery is managed through the Interstate Fisheries Management Program (ISFMP) of the Atlantic States Marine Fisheries Commission (ASMFC). The Fishery Management Plan for Northern Shrimp was first approved under the ISFMP in October 1986. Amendment 1, implemented in 2004, established biological reference points for the first time in the shrimp fishery and expanded the tools available to manage the fishery. Management of northern shrimp under Amendment 1 resulted in a rebuilt stock and increased fishing opportunities. However, early season closures in the fishery occurred in the 2009/2010 and 2010/2011 fishing seasons because landing rates were far greater than anticipated. Furthermore, untimely reporting resulted in short notice of the season closures and an overharvest of the recommended total allowable catch (TAC) by 28% in 2010 and 48% in 2011. In response to these issues, Amendment 2, approved by the ASMFC Northern Shrimp Section in October 2011, provides management options to slow catch rates throughout the season, including trip limits, trap limits, and days out of the fishery.

Amendment 2 completely replaces the FMP, and modifies the fishing mortality reference points to include a threshold level, includes a more timely and comprehensive reporting system, and allows for the initiation of a limited entry program to be pursued through the adaptive management addendum process. At its fall 2010 meeting, the Section approved a 136-day season: December 1, 2010, through April 15, 2011, inclusive. The Section took emergency action to close the northern shrimp fishery on February 28, 2011 based on preliminary landings data that indicated that harvest was already at 4,192 metric tons, 192 metric tons in excess of the recommended landings level.

Regulations pertaining to the northern shrimp fishery in Federal waters can be found in 50 CFR Section 648.80(a)(5). Shrimp vessels may fish in the Gulf of Maine during the season established by ASMFC and using a properly configured finfish excluder device called the Nordmore grate (see more information below). In addition to shrimp, vessels are allowed to retain silver/offshore hake up to 3,500 pounds, American lobster up to 10% by weight of all other species on board, or 200 lobsters, whichever is less, and longhorn sculpin. Shrimp vessels are not allowed to retain any herring or river herring, so any incidental catch of these species must be discarded.

The current fishing mortality reference points as established by Amendment 2 and re-estimated by the NSTC in 2011 are *Ftarget* =0.32, *Fthreshold*= 0.41, and *Flimit*= 0.60. The terminal year estimate of fishing mortality from the base run of the stock assessment is *F2011*= 0.68, indicating that fishing mortality has exceeded the threshold, resulting in overfishing. The current biomass reference points as

established by Amendment 2 are *Bthreshold* = 9,000 mt and *Blimit* = 6,000 mt. The terminal year estimate of biomass is 6,500 mt, indicating that the biomass is below the threshold, resulting in an overfished condition. Amendment 2 states that if fishing mortality exceeds the limit level, and biomass is less than the threshold level, the Section must act immediately to reduce fishing mortality.

Shrimp Fishery Performance

In 2009, 2,500 mt were landed during a season that was market-limited. The proposed 180-day season for 2010 was cut short to 156 days due to the industry exceeding the committee's recommended landings cap for that year, and concerns about small shrimp. The preliminary landings for 2010 are 6,256 mt, which is more than double the landings observed in 2009, and well above the recommended limit of 4,900 mt.

As in 2010, the 2011 season was closed early. The season was scheduled to be 136 days, considerably shorter than the proposed 180-day season of 2010. On February 28, after emergency action by the Section, the 2011 season was closed due to harvest above the recommended limit, completing a 90-day season. A preliminary total of 5,940 mt of shrimp were landed, exceeding the recommended limit (4,000 mt) by approximately 2,000 mt. The average price per pound was $0.75 and the preliminary estimated landed value of the catch was $9.8 million.

The number of vessels participating in the fishery in recent years has varied from a high of 347 in 1996 to a low of 144 in 2006. In 2011, there were 276 vessels from Maine, 12 from Massachusetts, and 20 from New Hampshire, for a total of 308, according to federal VTR and Maine harvester logbook data (preliminary). Of the 276 vessels from Maine, 125 were trapping. The number of vessels participating in the fishery in recent years has varied from a high of 347 in 1996 to a low of 144 in 2006. In 2011, there were 276 vessels from Maine, 12 from Massachusetts, and 20 from New Hampshire, for a total of 308, according to federal VTR and Maine harvester logbook data (Table 49). Of the 276 vessels from Maine, 125 were trapping.

In 2009, the length of the shrimp fishery season was increased to 180 days while the effort decreased to 2,096 trips, likely caused by limited demand from the processors and poor market conditions. In what turned out to be a 156-day season in 2010, effort increased dramatically to 4,081 trips (preliminary data). The market conditions were improved from prior years due to Canada's limited supply and an increase in local markets. In 2011, the truncated 90-day season yielded and effort similar to 2010 with 4,711 trips. The high level of effort was again due in part to a limited supply in Canada and demand from local markets.

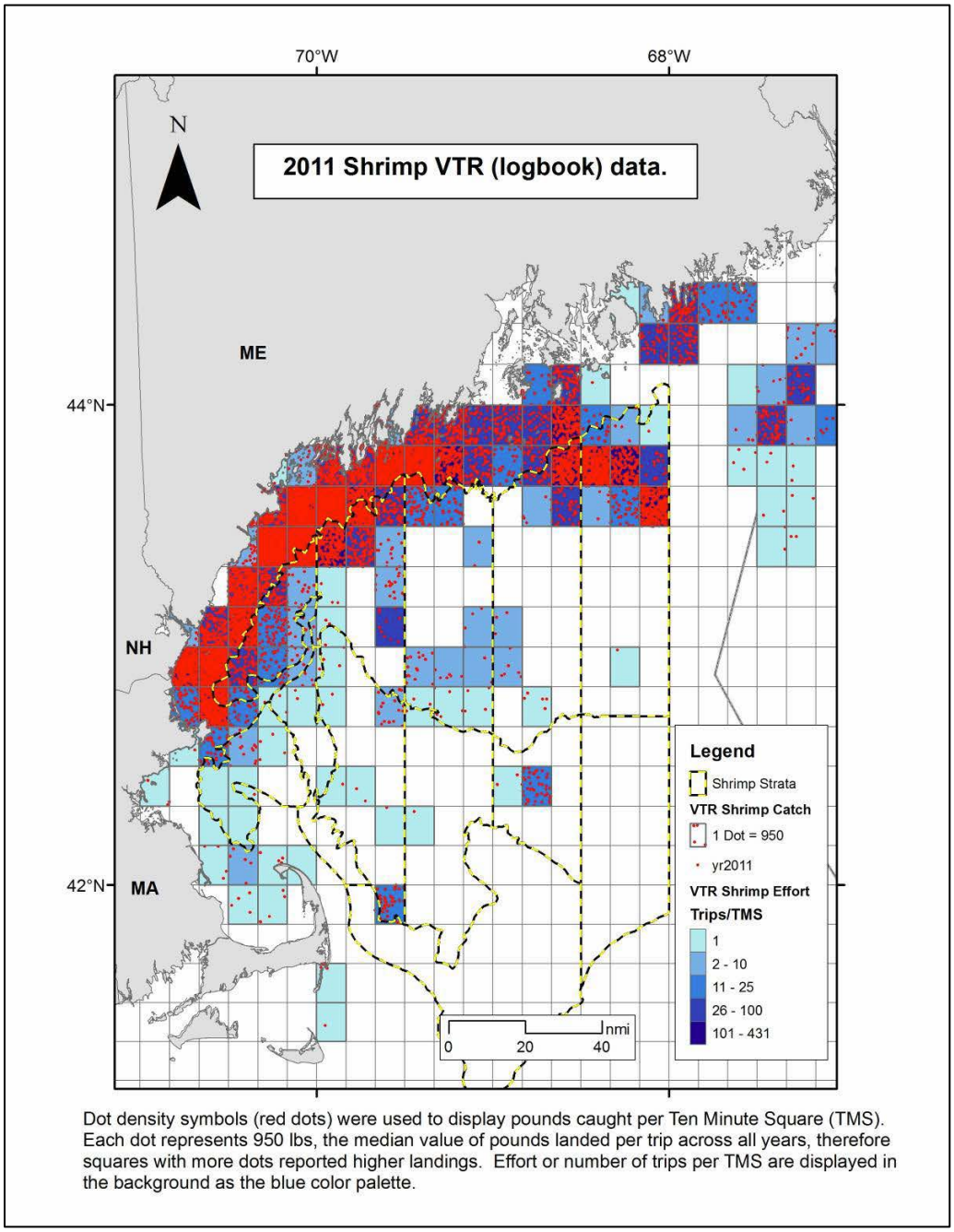
Table 49 U.S. Commercial Landings (mt) of Northern Shrimp in the Gulf of Maine

	No. Vessels	Trawl Trips	Landings (mt)
2009 **Dec. 1 – May 29**	170	2,096	2,501.2
2010 **Dec. 1 – May 5**	254	4,081	6,256.1
2011 **Dec. 1 – Feb. 28**	308	4,711	5,943.9

Seasonal trends in distribution of trawl effort can be evaluated from port interview data. The relative magnitude of offshore fishing effort (deeper than 55 fathoms) has varied, reflecting seasonal movements of mature females (inshore in early winter and offshore following larval hatching), but also reflecting harvesters' choices for fishing on concentrations of shrimp. Of the 176 interviews of Maine trawl

fishermen in 2011, 87% fished inshore and 13% fished offshore. The highest proportion of inshore trips from 153 interviews occurred in January (51%), followed by February (45%), and in December comprised 4% of the trips. Of the offshore trips, 74% were in December, decreasing to about 17% in January and 9% in February based on a total of 23 harvesters reporting offshore trips during port interviewsLocations of 2011 fishing trips and landings from federal and state VTRs are plotted by 10-minute square in Figure 59.

Figure 59 Pounds Caught and Numbers of Trips During the 2011 Northern Shrimp Fishing Season by 10-minute-square



Dot density symbols (red dots) were used to display pounds caught per Ten Minute Square (TMS). Each dot represents 950 lbs, the median value of pounds landed per trip across all years, therefore squares with more dots reported higher landings. Effort or number of trips per TMS are displayed in the background as the blue color palette.

Utilization of the Nordmore Grate

The finfish-excluder device (FED), the Nordmore grate, has been mandatory in the Gulf of Maine Northern shrimp (*Pandalus borealis*) fishery since April 1992. Prior to its use, juvenile groundfish bycatch in the shrimp fishery was of primary concern (Howell and Langan 1992). Groundfish bycatch has been substantially reduced through the use of the Nordmore grate (Richards and Hendrickson 2006), and a new gear innovation, the "topless" trawl, also greatly reduces pelagic fish bycatch (He et al. 2007).

Richards and Hendrickson (2006) examined bycatch before and after use of the Nordmore grate in the shrimp fishery, using observer data from NEFOP and MA DMF. Primarily, they examined individual groundfish and flatfish species bycatch, but they did also summarize pelagic species bycatch as a group. In their analysis, pelagic species included alewife (*Alosa pseudoharengus*), butterfish (*Peprilus triacanthus*), blueback herring (*Alosa aestivalus*), Atlantic herring (*Clupea harengus*), unidentified herring (Clupeidae), Atlantic mackerel (*Scomber scombrus*), Atlantic menhaden (*Brevoortia tyrannus*), American shad (*Alosa sapidissima*), and hickory shad (*Alosa mediocris*). Prior to the use of the Nordmore grate, primary bycatch species included groundfish and flatfish, and secondarily pelagic fish (see Table 3). With the grate in place, groundfish and flatfish bycatch was greatly reduced, while pelagic fish bycatch shifted up in importance based on percentage bycatch composition.

For these reasons, additional gear modifications have been investigated to reduce pelagic species bycatch. Previous experiments demonstrate that the "topless trawl" used with the Nordmore grate further reduces finfish bycatch especially for pelagic species in the shrimp fishery (He et al. 2007). Bycatch of Atlantic herring was reduced by 86.6% with some increase in the catch of shrimp and flatfish bycatch. Modest reductions in blueback herring were also evident from the experiments.

GMRI monitored and documented bycatch of regulated groundfish and non-regulated species for the 2008-2009 Northern shrimp fishing season, augmenting NEFOP data collection during the same time (Eayrs et al. 2009). Eayrs et al. (2009) found that shrimp catch was 96% (GMRI data) and 92% (NOAA data) of total catch weight, of this less than 2% of total catch weight was regulated bycatch, rarely exceeding 5% of total catch weight in a single haul (roughly 55 lbs of regulated bycatch per haul in GMRI data). Eayrs et al. (2009) also looked at the effect of Nordmore grate orientation and noted orientation did not appear to impact performance, but noted limitations of the preliminary study. Eayrs et al. (2009) indicated data collection included river herring and Atlantic herring length measurements. Analysis, however, focuses on groundfish species, and therefore results for herring species are not directly provided.

Recent preliminary work suggests that spatial and temporal characteristics in bycatch in the Northern shrimp fishery may inform bycatch reduction strategies (Rillahan and He 2011). Rillahan and He (2011) analyzed 300 research tows using standard shrimp trawl nets by shrimp fishing vessels in New Hampshire and Maine between the months of February and June from 2004 to 2010. They noted that bycatch levels varied from 0.7 to 86.7% of total catch within a tow, with overall bycatch less than 20% of total catch observed. They identified 26 bycatch species, of which silver hake (*Merluccius bilinearis*) was the primary bycatch species. Silver hake bycatch predominately occurred in late spring with May landings the highest (average at 89.5% of all bycatch by weight). They noted that other pelagic bycatch species included Atlantic and blueback herring as primary bycatch species in February and March. Flatfish species including American Plaice (*Hippoglossoides platessoides*) and witch flounder (*Glyptocephalus cynoglossus*) were also important bycatch species in April, May and June. Preliminary length-frequency analysis of silver hake, American plaice and Atlantic herring suggests that the majority of species ranged from 10-25 cm total length. Forthcoming analysis will examine patterns in more detail to improve bycatch mitigation strategies.

8.1.2 River Herring Bycatch in the Northern Shrimp Fishery

To consider an exemption to the river herring measures proposed in Amendment 5, river herring bycatch in the small mesh Northern shrimp fishery in the Gulf of Maine was investigated. Observer data for 2005-2010 was queried from the database. Results are presented in Table 50 and Table 51 (below). The data summarized in these tables represents all observer data on trips using the Nordmore grate in the Gulf of Maine between 2005-2010, regardless of target species (a Nordmore grate is required in the Northern shrimp fishery) and regardless of whether or not the vessels possess a herring permit.

In total, from 2005-2010, 97 shrimp trips were observed, representing less than 1% of the fishery when the State-only vessels are included (Table 50). Small amounts of river herring were observed in the catch (Table 51), but the low level of observer coverage precludes expansion of the bycatch numbers to develop an estimate of bycatch across the fishery; low sampling would lead to an extremely high CV and is not appropriate in this case.

State-permitted vessels represent the majority of the fishery. These vessels do not have herring permits. In 2010, VTR records indicate that 705 trips were taken by federally permitted vessels in the shrimp fishery (Table 52), while the total number of trips including the state vessels was 1,954.

Table 50 Number of Observed Trips and Percent Coverage in the Gulf of Maine Northern Shrimp Fishery, 2005-2010

Year	No. Trips Observed	Total No. Trips	Percent Coverage
2005	17	2,261	0.75
2006	20	2,838	0.70
2007	14	1,566	0.89
2008	19	2,635	0.72
2009	12	3,510	0.34
2010	15	1,954	0.77
Total	**97**	**14,764**	

Table 51 Total Catch Observed in the Northern Shrimp Fishery (Retained and Discarded) in Pounds by Species (2005-2010)

Species	Pounds caught
HAKE, SILVER (WHITING)	7,811
HERRING, ATLANTIC	2,488
FLOUNDER, AMERICAN PLAICE	1,846
LOBSTER, AMERICAN	796
REDFISH, NK (OCEAN PERCH)	738
SCULPIN, LONGHORN	697
FLOUNDER, WINTER (BLACKBACK)	621
HAKE, WHITE	557
HERRING, NK	447
ALEWIFE	443
HAKE, RED (LING)	412
HERRING, BLUEBACK	392
FLOUNDER, WITCH (GREY SOLE)	327
POLLOCK	185
FLOUNDER, SAND DAB (WINDOWPANE)	182
DOGFISH, SPINY	123
SKATE, LITTLE	95
FLOUNDER, YELLOWTAIL	88
COD, ATLANTIC	86
MONKFISH (GOOSEFISH)	84
MACKEREL, ATLANTIC	73
BUTTERFISH	72
HAKE, RED/WHITE MIX	56
MENHADEN, ATLANTIC	50
HADDOCK	46
FLOUNDER, FOURSPOT	39
SKATE, WINTER (BIG)	38
SKATE, NK	36
STARFISH, SEASTAR,NK	33
SEAWEED, NK	30
SCALLOP, SEA	24
FISH, NK	21
WRYMOUTH	21
CUSK	20
SMELT, RAINBOW	20
RAVEN, SEA	17
ROCKLING, FOURBEARD	15
HALIBUT, GREENLAND	14
SQUID, SHORT-FIN	10
HAKE, SPOTTED	10

Table 52 shows the number of shrimp trips during 2010 that were taken by federally permitted herring vessels and other federally permitted vessels that do not possess a herring permit. Of the herring-permitted vessels, Category C vessels are most active in the northern shrimp fishery; these vessels took 495 trips in 2010. Of all 705 trips that occurred by federally permitted vessels in 2010 (601 trips by herring vessels), only seven (7) were taken when declared into the herring fishery (and therefore subject to the herring FMP requirements). It appears that the vast majority of shrimp vessels declare out of the herring fishery to avoid the additional herring requirements (pre-landing notification), as there is no allowance for herring landings in the shrimp fishery anyway.

Table 52 Number of Shrimp Trips in 2010 by Herring and Non-Herring Permit Categories

Permit Category	Trip Count
Herring A	35
Herring B	71
Herring C	495
Non-herring	104
Total	**705**

**Does not include trips taken by State-only vessels.*

8.2 BACKGROUND INFORMATION – LARGE-MESH GROUNDFISH FISHERY

Because of haddock interactions (offshore) and measures under consideration to address midwater trawl access to groundfish closed areas, the Northeast multispecies (groundfish) fishery is identified as one of the "Other Fisheries" included for the analyses of the measures proposed in Amendment 5. A more complete description of the groundfish fishery can be found in Volume I.

Observer data suggest that large-mesh bottom trawls are catching river herring, alewife, and shad in amounts that appear to be insignificant. Table 53 summarizes observer data for 113 trips taken on 21 bottom trawl vessels with a Category A or B permit using large mesh. Table 54 summarizes observer data for 194 trips on 41 bottom trawl vessels with a Category C permit using large mesh. And Table 55 summarizes observer data for 1,832 trips on 471 bottom trawl vessels with a Category D permit using large mesh. Observed bycatch of river herring/shad appears to be slightly higher during the second half of the fishing year, but still very low. The percent coverage levels for the groups of vessels represented in these tables was not determined.

Table 53 Catch and Discards of All Species on Observed Trips, 2009-2010, Bottom Otter Trawl, Permit Category A and B, Large Mesh (>5.5 inch)

Species	January - June			July-December		
	Lbs Disc	Lbs Kept	Total Lbs	Lbs Disc	Lbs Kept	Total Lbs
ALEWIFE	158		**158**	39		**39**
FISH, NK	787		**787**	340		**340**
HERRING, ATLANTIC	284		**284**	182		**182**
HERRING, BLUEBACK	1		**1**	17		**17**
HERRING, NK	2		**2**	13		**13**
SHAD, AMERICAN	164	6	**170**	74		**74**

Table 54 Catch and Discards of All Species on Observed Trips, 2009-2010, Bottom Otter Trawl, Permit Category C, Large Mesh (>5.5)

Species	January - June			July-December		
	Lbs Disc	Lbs Kept	Total Lbs	Lbs Disc	Lbs Kept	Total Lbs
ALEWIFE	27		**27**	7		**7**
FISH, NK	235		**235**	46		**46**
HERRING, ATLANTIC	139	4	**143**	715	200	**915**
HERRING, BLUEBACK	6		**6**	53		**53**
HERRING, NK						
SHAD, AMERICAN	13		**13**	42		**42**

Table 55 Catch and Discards of All Species on Observed Trips, 2009-2010, Bottom Otter Trawl, Permit Category D, Large Mesh (>5.5 inch)

Species	January - June			July-December		
	Lbs Disc	Lbs Kept	Total Lbs	Lbs Disc	Lbs Kept	Total Lbs
ALEWIFE	698		**698**	1,272	6	**1,278**
FISH, NK	12,812	310	**13,122**	2,845	6	**2,851**
HERRING, ATLANTIC	1,188	97	**1,285**	4,983	41	**5,024**
HERRING, BLUEBACK	351	3	**354**	542	70	**612**
HERRING, NK	212		**212**	79		**79**
SHAD, AMERICAN	1,249	18	**1,267**	538	2	**540**

8.3 POTENTIAL IMPACTS OF PROPOSED EXEMPTIONS

It is difficult to predict the impact on river herring catch that is likely to result from exempting the shrimp and/or large mesh groundfish fishery from the Amendment 5 river herring measures. Certainly, the more restrictive the management measures in this amendment and the fewer exemptions, the more likely the measures are to benefit the river herring resource. However, river herring catch in the northern shrimp and large-mesh groundfish fisheries appears to be relatively small.

The proposed exemptions would have positive impacts on some fishing operations by providing opportunities to participate in other fisheries that may overlap the river herring monitoring or protection areas. If the vessels in the shrimp fishery and large mesh groundfish fishery are exempted, they may continue their fishing operations in areas that would otherwise require 100% observer coverage, increased sampling, possible closure, among other measures. Vessels in these two fisheries that also have a herring permit would be able to declare out of the herring fishery and prosecute shrimp or groundfish in the areas that those fisheries operate. This increases opportunities and may mitigate some of the negative impacts of the proposed river herring measures.

Category A vessels took 35 shrimp trips in 2010, Category B vessels took 71 shrimp trips, and Category C vessels took 495 shrimp trips in 2010. Category C vessels are the most dependent of the herring vessels on the shrimp fishery; these vessels are likely smaller (less than 80 feet) and hail from ME, NH, and MA. The proposed exemption for the shrimp fishery would especially benefit these vessels because of their higher level of participation in the shrimp fishery and lower level of participation in the herring fishery; some of the measures proposed in this amendment are likely to produce a significant cost on the industry, and Category C vessels land less than 3% of herring during the fishing year.

9.0 IMPACTS OF ALTERNATIVES TO ADDRESS RIVER HERRING BYCATCH ON VECS

The impacts of each of the management alternatives under consideration to address river herring bycatch on the VECs identified in the Amendment 5 are discussed in Volume I of the Amendment 5 Draft EIS document.