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OMNIBUS ESSENTIAL FISH HABITAT AMENDMENT 2
FINAL ENVIRONMENTAL IMPACT STATEMENT

Appendix E – Synopsis of Closed Area Technical Team analysis of juvenile groundfish habitats and groundfish spawning areas

Note – this appendix is adapted from a memorandum provided to the New England Fishery Maangement Council's Scientific and Statistical Committee on May 10, 2013.

TABLE OF CONTENTS

TABLES

FIGURES

MAPS

Analytical approach

Between January and April 2013, the Closed Area Technical Team developed an analysis of data to assist in identifying areas that more restrictive measures could reduce impacts on juvenile groundfish habitat and groundfish spawning. Instead of focusing on physical characteristics of the environment that might be damaged by fishing and could be suitable habitat for groundfish, the CATT took an approach that focuses on aggregations of small juvenile groundfish and large fully-mature groundfish.

The CATT made a few key decisions about how to focus the analysis to meet the objectives. First, the CATT decided that the primary data source it would use to analyze juvenile and mature groundfish distribution would be from the various fishery-independent surveys, conducted by NMFS and coastal states. Figure 6 shows the geographic distribution of the surveys used for this analysis. Certain other surveys, such as RSA surveys or the Canadian survey were not readily available. The NMFS, MA DMF, and ME/NH surveys were the most useful for identifying hotspots or clusters of large catches. The IBS (Industry Based Survey) cod survey was also suitable, but the spatial domain of the survey was limited. The IBS goosefish and yellowtail flounder surveys were potentially suitable and were included in the analysis, but the sampling density was low and the analysis yielded few hotspots.

One important issue with survey data that was recognized by the CATT and addressed was the apparent overdispersion and high amount of zero catch observations in the survey catch per tow data. As such, it was unlikely that the data would be suitable for parametric analysis embedded in the Getis-Ords G* (henceforth simply called G*) statistic, particularly when interpreting the p-value to distinguish clusters of significantly high catches. Although the G* statistics is valid using data that is not normally distributed, Zhang et al (2008) published a proof that the G* statistics are not accurate for overdispersed data. It is furthermore common practice to either use non-parametric tests or transform survey data before analysis. A Box-Cox procedure was applied in R and Systat to potentially identify a transformation yielding distributions that were approximately normal. None were satisfactory, including a log (or any other) transformation of N+1.

The CATT explored the issue by running several trials with untransformed and transformed data, but in the end followed the advice of Dr. Brian Kinlan to adjust the data in a two-step (Hurdle model like approach) procedure to down weight catches on tows that occur in strata having higher numbers of zero catch tows. The catch per tow was multiplied by the proportion of non-zero catches in a stratum during each year and survey, before applying a log transformation. This procedure yielded normally distributed data, adjusted for the proportion of zero tows in a stratum (i.e. catches in strata having higher proportions of no-catch tows were down weighted relative to strata where the catches were more consistently non-zero).

Size ranges that approximate age 0/1 were chosen by the CATT for the juvenile groundfish hotspot analysis. A size threshold was selected that included all of age 0 fish and about 90% of age 1 fish from regenerated age length keys for 2002-2012 for the spring and fall NMFS trawl surveys (Table 5). Size ranges derived from the spring survey were applied to measured groundfish for all spring and summer surveys. Size ranges derived from the fall survey were applied to measured groundfish for all fall and winter surveys The CATTs rationale for choosing these size thresholds was to key in on the smallest juvenile groundfish caught by the lined survey trawls, which are more likely to be associated with bottom habitat that could be adversely affected by fishing. The thresholds were always smaller than the L20 for that species maturity ogive, which had been re-estimated for 2002-2012 (Table 4).

In general, the L80 on the re-estimated maturity ogives were generally within 5 cm of the L50 and if used as a threshold for spawners would have favored identification of hotspots of small spawners. Instead, the CATT chose to focus the analysis on larger spawners which were thought to be more likely to have mature spawning behavior, higher fecundity, and better egg viability. Large spawners were identified using a threshold that larger fish made up about 20% of the total biomass in the 2002-2012 NMFS trawl surveys. Since growth at this size is typically slower than at younger ages, a single threshold was applied in all seasons for each species (see Table 8).

These transformed data were used to perform the G* hotspot analyses, following the steps outlined in Table 9. For each survey, species, and size range (juveniles and large spawners) a spatial autocorrelation analysis was performed to identify distances that had significant positive correlations. When they existed (see examples in Figure 20 to Figure 28), the first statistically significant peak was used to set the G* Zone of Indifference, defining the neighborhood that was considered for identifying clusters. At other times, there was no first peak in autocorrelation and the maximum peak was used instead. Generally, if there was no statistically significant spatial autocorrelation, the G* procedure also failed to identify any clusters or hotspots. The zone of indifference setting for each G* analysis performed is listed in Table 10.

Two important choices or assumptions were made in the hotspot analysis. One of these choices is the neighborhood of tows considered to be a potential hotspot. There are a variety of choices ranging from a fixed distance, inverse distance weighting, to a zone of indifference (with inverse distance weighting). The choice made by the CATT after considerable sensitivity analysis was a zone of indifference determined by a local maximum ("first peak") spatial autocorrelation. Unlike a fixed distance application, the zone of indifference was valid for all tows because no tows had no neighboring tows, a key violation of a fixed distance model which frequently gave warnings using the survey data. Only significant ($p<=0.05$) hotspots with above average catches were selected for further use as a hotspot (see Figure 10; Map 1). No standard p-value is available to determine significance, although p-values less than 0.05 were examined as a sensitivity analysis. For redfish, the hotspots tended to contract to a more centralized location in the Western Gulf of Maine with lower p-values.

Since the ultimate purpose of this analysis is to identify areas where a reduction in fishing would reduce impacts on juvenile groundfish habitat and groundfish spawning, for a variety of large mesh groundfish species, the CATT needed a way to summarize the hotspots across species and in shapes that were amenable to combinations into area options. The hotspots for all surveys were summarized in 100 km2 grids, compatible with SASI model outputs.

Juvenile groundfish hotspots for each stock were given an importance weight (Table 1), a simple arithmetic sum of four factors: Stock vulnerability, sub-population characteristics, residency characteristics, and substrate affinity. Stock vulnerability was chosen as a measure of how close the stock biomass is to the target biomass, i.e. B_{msy}/B. Stocks at the target had a value of 1, while overfished stocks had a value of 2 or more. Sub-population characteristics, residency characteristics, and substrate affinity were assigned a score from 1 to 3 based on published information and EFH source documents. More details are provided in a difference SSC document. Vulnerability or characteristics that were unknown (UNK) or could not be assigned were given a mean score as a proxy value in the final weighting sum.

Hotspots, i.e. clusters of significantly above average catches, of large mature groundfish were given similar importance weights using the same factors as applied for juvenile groundfish, but without the substrate affinity classification (Table 2), because the CATT decided that other factors (water temperature, moon phase, etc.) were more important to spawning of many groundfish species than was substrate affinity. Stocks were excluded from the seasonal hotspot summary gridding during seasons when the stock was not spawning (Table 2).

These weighted hotspot results were then summed by season over all species to guide the CATT to design potential juvenile groundfish area management options. The characteristics of these areas as well as those proposed by the Habitat PDT and Oversight Committee were analyzed for the number of juvenile and large spawner groundfish hotspots, Z-infinity scores from the SASI model, species diversity, potential displacement of net fishery revenue, etc. Hotspot grids and potential areas were compared (Figure 11 to Figure 13) with presence of observed developing, ripe, and running ripe groundfish to verify their location with respect to observations of spawning condition fish. Similarly the CATT intends to compare egg distribution from the ECOMON project with the results of the hotspot analysis as verification and to refine the timing of potential spawning closures.

Table 1. Selection of and weighting factors applied to juvenile groundfish hotspot data to sum hotspots across species and develop area management options. The final weighting sum was applied to the gridded hotspots for each species shaded in red. Grey shaded rows designate species that are not managed by catch shares.

Stock (Red cells indicate selected stocks for Option 3)	Juvenile size threshold Age 0 and 1 length (90th percentile, cm)	Length at 20% female maturity (cm) (re-estimated by CATT)	Vulnerability of species (Bmsy/B)[1]	Sub-populations[2]	Residency[3]	Substrate[4]	Final Weighting Sum
GB Cod	24 (Sp), 34 (Fa)	36	14.11	2	1	3	20.11
GOM Cod	24 (Sp), 34 (Fa)	36	5.53	3	1	3	12.53
GB Yellowtail Flounder	13 (Sp), 15 (Fa)	25	9.39	1	2	1	13.39
CC/GOM Yellowtail Flounder	13 (Sp), 15 (Fa)	25	4.21	1	2	1	8.21
SNE/MA Yellowtail Flounder	13 (Sp), 15 (Fa)	25	0.77	1	2	1	4.77
GOM Winter Flounder	18 (Sp), 28 (Fa)	27	UNK	UNK	2	1	10.04
GB Winter Flounder	18 (Sp), 28 (Fa)	27	1.22	3	2	1	7.22
SNE/MA Winter Flounder	18 (Sp), 28 (Fa)	27	6.17	3	2	1	12.17
White Hake	34 (Sp), 39 (Fa)	25	1.21	UNK	2	1	6.04
GOM Haddock	24 (Sp), 34 (Fa)	28	1.71	1	1	3	6.71
GB Haddock	24 (Sp), 34 (Fa)	28	0.75	1	1	3	5.75
Witch Flounder	20 (Sp), 19 (Fa)	28	2.45	3	2	1	8.45
American Plaice	12 (Sp), 18 (Fa)	24	1.70	UNK	1	1	5.54
Pollock	23 (Sp), 32 (Fa)	39	0.46	2	2	2	6.46
Acadian Redfish	14 (Sp), 13 (Fa)	19	0.76	1	2	3	6.76
Atlantic Halibut	see winter flounder	NA	28.82	UNK	2	2	34.66
Ocean Pout	29	29[6]	12.05	UNK	1	2	16.88
Northern (GOM-GB) Windowpane Flounder	see yellowtail flounder	18	3.48	UNK	2	1	8.31
Southern (SNE-MA) Windowpane Flounder	see yellowtail flounder	18	0.69	UNK	2	1	5.52
Atlantic Wolffish	47	47[7]	3.48	UNK	UNK	2	8.99
Sum							208.52
Mean			**5.21**	**1.83**	**1.68**	**1.70**	**10.43**

[1]Either SSBmsy/SSB or Bmsy/B used depending on what is reported in the assessment

[2]Derived from Table 81 in Framework 48 or from NEFSC biological data. 1=no subpopulations, 2=some evidence, 3=known subpopulations

[3]Based on information in literature. 1=less resident, more migratory; 2=more resident, less migratory

[4]Based on information in literature. 1=almost exclusively in mud or sand substrates, 2=occur in a variety of substrates including gravels, 3=strong affinity for coarse or hard substrates

[5]Sums include a mean value for unknowns

[6] From O'Brien et al. (1993)

[7] From Templeman (1986)

Table 2. Selection of and weighting factors applied to large spawner groundfish hotspot data to sum hotspots across species and develop area management options. The final weighting sum was applied by season to the gridded hotspots for each species shaded in red. Grey shaded rows designate species that are not managed by catch shares.

Stock	Large spawner threshold (20% of total biomass)	Length at 80% female maturity (cm) (re-estimated by CATT)	Vulnerability of species (Bmsy/B)[1]	Sub-populations[2]	Residency[3]	Final weighting Sum[4]	Spring multiplier	Summer multiplier	Fall multiplier	Winter multiplier
GB Cod	75	52	14.11	2	1	17.1	1	1	*0*	1
GOM Cod	75	52	5.53	3	1	9.5	1	1	*0*	1
GB Yellowtail Flounder	40	30	9.39	1	2	12.4	1	*0*	*0*	*0*
CC/GOM Yellowtail Flounder	40	30	4.21	1	2	7.2	1	*0*	*0*	*0*
SNE/MA Yellowtail Flounder	40	30	0.77	1	2	3.8	1	*0*	*0*	*0*
GOM Winter Flounder	45	31	UNK	UNK	2	9.0	1	*0*	*0*	1
GB Winter Flounder	45	31	1.22	3	2	6.2	1	*0*	*0*	1
SNE/MA Winter Flounder	45	31	6.17	3	2	11.2	1	*0*	*0*	1
White Hake	75	45	1.21	UNK	2	5.0	1	*0*	*0*	*0*
GOM Haddock	50	40	1.71	1	1	3.7	1	*0*	*0*	*0*
GB Haddock	50	40	0.75	1	1	2.7	1	*0*	*0*	*0*
Witch Flounder	45		2.45	3	2	7.5	1	1	1	*0*
American Plaice	40	32	1.70	UNK	1	4.5	1	*0*	*0*	*0*
Pollock	75	52	0.46	2	2	4.5	*0*	*0*	*0*	1
Acadian Redfish	30	25	0.76	1	2	3.8	1	1	*0*	*0*
Atlantic Halibut	45	NA	28.82	UNK	2	32.7	1	1	*1*	1
Ocean Pout	60	NA	12.05	UNK	1	14.9	*0*	1	*1*	1
Northern (GOM-GB) Windowpane Flounder	30	24	3.48	UNK	2	7.3	1	1	*1*	1
Southern (SNE-MA) Windowpane Flounder	30	24	0.69	UNK	2	4.5	1	1	*1*	1
Atlantic Wolffish	45	NA	3.48	UNK	UNK	7.0	1	*0*	*0*	*0*
Sum						174.5	18	8	5	10
Mean			**5.21**	**1.83**	**1.68**	**8.73**				

[1]Either SSBmsy/SSB or Bmsy/B used depending on what is reported in the assessment

2Derived from Table 81 in Framework 48 or from NEFSC biological data. 1=no subpopulations, 2=some evidence, 3=known subpopulations

3Based on information in literature. 1=less resident, more migratory; 2=more resident, less migratory

4Sums include a mean value for unknowns

The CATT also examined the suitability of sea sampling data and tagging data for this purpose as well. Sea sampling data were not suitable for this purpose because large areas are undersampled due to regulatory effects of area closures, regional catch limits, or other factors. To analyze catch distributions, the sea sampling data would further more have to be standardized with respect to vessel, gear, and possibly other factors. If not properly adjusted, clusters or hotspots using these data may have biases that identify areas where a single large vessel with large gear frequently fishes, rather than a localized high abundance or biomass of fish. Sea sampling data would also have very limited utility for analyzing distributions of groundfish due to selectivity.

Tagging data is potentially useful from two perspectives. Often, ripe and running ripe fish are identified by external examination (Figure 5). When the tag return data are adjusted for fishing effort to account for varying opportunities to catch tagged fish, the information could be useful to determine retention rates in existing or potential future closed areas. Fish that are retained for longer periods would tend to benefit more from closures than more transient fish. Unfortunately, the existing tag data tends to be relatively inaccessible (behind a Unix firewall in a foreign SQL data base), are not effort adjusted, and most tagging is done on only a few species. So the CATT felt that the tagging data had limited utility for identification of persistent spawning aggregations.

Other information was also examined or analyzed. Literature about regional groundfish spawning was examined, compiled, and taken into consideration (see Table 3and Figure 1 to Figure 5 below). Most papers were fairly general or focused on specific areas. A few, for example Ames 2004 and Deese 2005, provide broad-scale evaluation of spawning distributions, observed by fishermen. Working with Sam Truesdell at Universtiy of Maine Orono, the CATT also conducted a juvenile habitat association analysis for Gulf of Maine cod and Georges Bank cod and yellowtail flounder, applying a general additive model approach. Information from these sources was considered during the analysis and interpretation of the hotspot analysis results, but are not being reviewed in depth by the SSC.

With assistance from Owen Liu of EDF, the CATT also examined four case studies around the world where spatial management was employed in temperate fisheries that are managed with quotas. Conclusions about those studies may help influence the overall design of juvenile groundfish habitat and spawning areas.

Lastly, working with Sam Truesdell of University of Maine, Orono, the CATT developed an exploratory analysis of habitat association for three stocks: Gulf of Maine cod, Georges Bank cod, and Georges Bank yellowtail flounder. The results of this analysis were promising and for the Gulf of Maine largely corroborated the CATT's hotspot analysis for juvenile cod. A full report of this analysis is presented in a different SSC document. The results were not quantitatively used to design and propose juvenile groundfish area management options, but provided support for the options that were developed, particularly for a coastal juvenile groundfish habitat area option.

Based on the above analyses, the CATT proposed two area management options to conserve juvenile groundfish habitat. One option (Figure 14) includes all areas in the Gulf of Maine in depths less than 90 m and within 15 nm of the coastline. A second option (Figure 15) is a network of areas that include most of the weighted hotspots from the above analysis. These area management options would be applied year round to protect vulnerable juvenile groundfish habitat, even though some groundfish species utilize the habitat on a seasonal basis.

The CATT also proposed three area management options to reduce impacts on large spawning groundfish. These management options would limit fishing activity for gears capable of catching groundfish to reduce impacts on spawning behavior and activity of large mature groundfish.

One spawning area option (Figure 16) is a network of areas that encompass the majority of the weighted hotspots. These areas would close seasonally. Areas in the Western Gulf of Maine would close following a similar seasonal progression as the existing rolling closures they would replace. A second spawning area option (Figure 17 to Figure 19) is a modification of the existing rolling closures for sector vessels, which would include all of the existing Western Gulf of Maine area and run from March to June (instead of April to June). A third option would retain a spring closure for the existing Western Gulf of Maine area and all of Closed Area II.

Table 3. Summary of groundfish spawning and habitat associations.

	Identified Spawning Locations	Spawning Notes	Habitat Area Location/Characteristics	Habitat Notes
Cod	Gulf of Maine: Ames Study Areas (Ames 2004). Ipswich Bay (specific spawning aggregation at Whaleback feature)(Siceloff and Howell 2012). Cape Cod Bay, western Maine coast, Jeffries Ledge and Northern Mass. Bay (Deese 2005 and Dean et al. 2012), inshore aggregations in Area 133 in the western GOM (Morin 2000) Georges Bank: concentrated in the Northeast area (mostly gravel and complex relief levels)(Berlinsky 2009).	Spring spawning in northern GOM (Berlinsky 2009). Fall spawning in inshore areas from Cape Cod to Nantucket Shoal (Deese 2005). Winter spawning in southern GOM and Coxes Ledge (Deese 2005). Spawning occurs year-round but with peaks in the summer and from Nov – Feb (Tallack 2008). Spring and winter spawning in western GOM (Berlinsky 2009 and Morin 2000). Peak Georges Bank spawning activity occurs in February-March (Lough 2010)	Juveniles (age 0-1) prefer gravel substrates with lower bathymetric relief (Gregory et al. 1997) Older and larger cod would move to coarse substrates with higher bathymetric relief, such as humps and ridges (Gregory et al. 1997). Ipswich Bay, Mass. Bay and Cape Cod Bay (Howe et al 2002). Spread across Georges Bank in early summer, constant concentration in NE Georges Bank (Lough 2010).	Age 0 cod prefer shallower depths (<90') and move to deeper waters both in autumn and as they grow older (Howe et al. 2002) Young juveniles would hide in cobble to avoid predators, and would partially remain after the threat was removed (Gotceitas and Brown, 1993).
Haddock	Georges Bank: Concentrated in Eastern and Northeastern areas (Overholtz 1987).	Peak spawning in Georges Bank from late March-early April (Overholtz 1987) Ideal temperatures from 4-7°C at depths from 28-110' (Overholtz 1987)	Spread throughout Georges Bank	As pelagic juveniles grow, they move deeper in the water column (Lough and Potter 1994).
Yellowtail Flounder			Eastern Georges Bank, specifically within Closed Area II. (Pereira et al 2012)	Occupied area in Georges Bank doubled from ~4000 to ~8000 km^2 when abundance increased (Pereira et al 2012)

Winter Flounder	Plymouth Bay (minor activity in Plymouth Estuary) (DeCelles and Cadrin 2010)	Peak spawning in March-May in the Plymouth Bay (DeCelles and Cadrin 2010)		

Additional figures

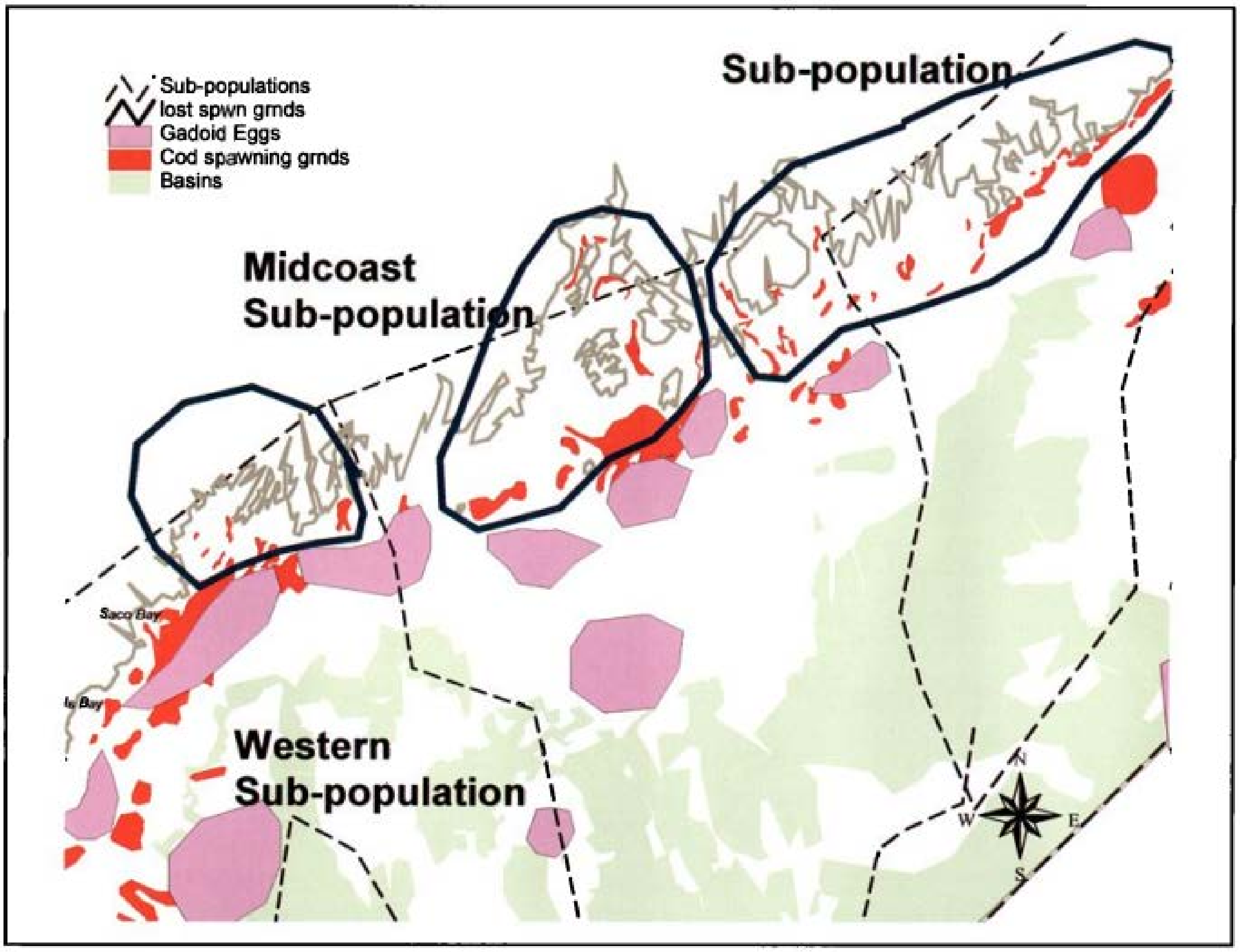


Figure 1. Map of indicated cod spawning areas. Circled areas indicate former spawning grounds that are no longer active. Ames, 2004.

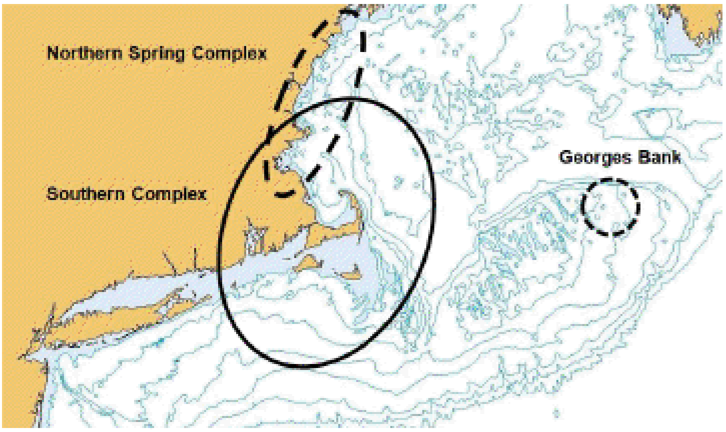


Figure 2. Proposed cod spawning complexes. Berlinsky, 2005.

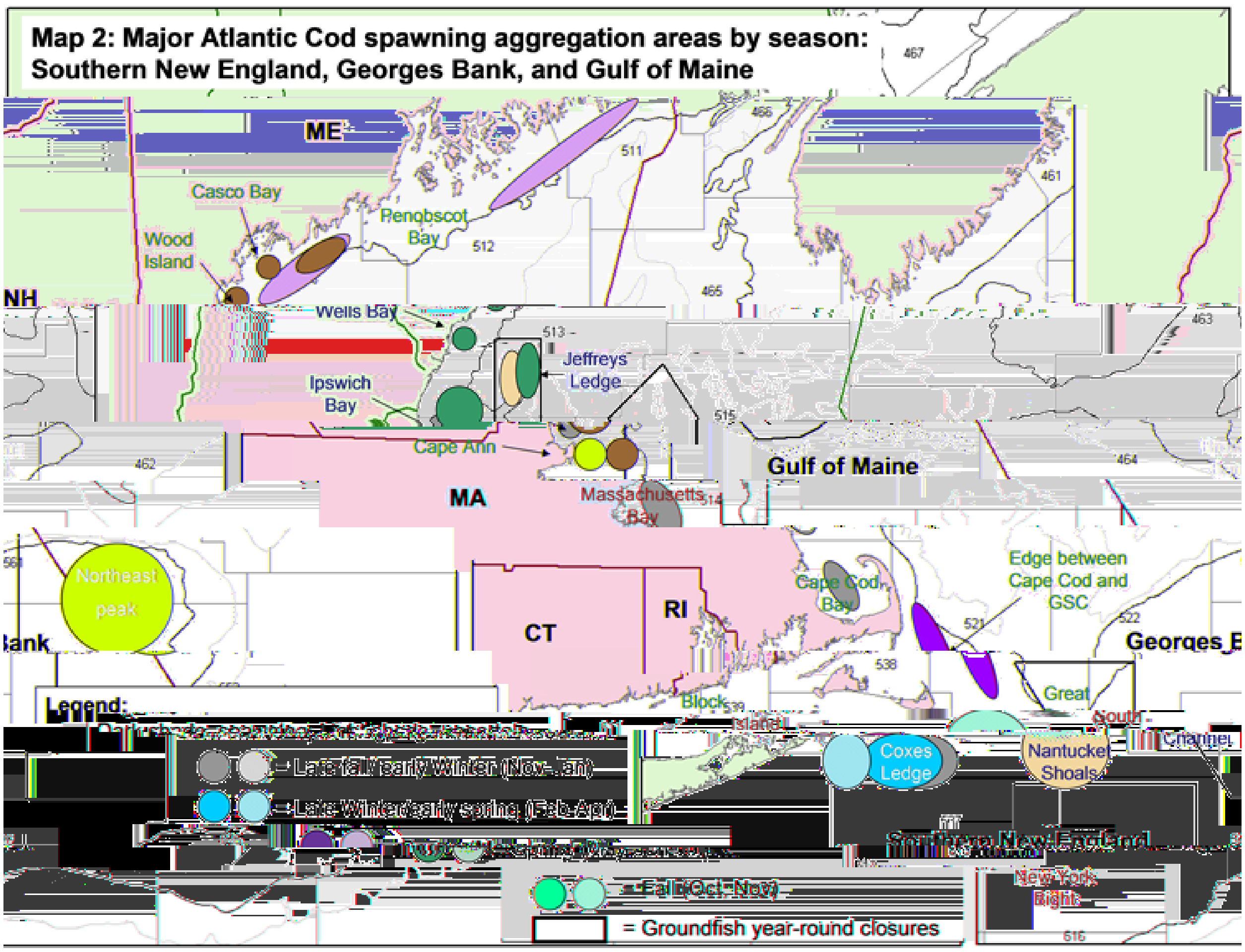


Figure 3. Summary of cod spawning areas. Deese, 2005.

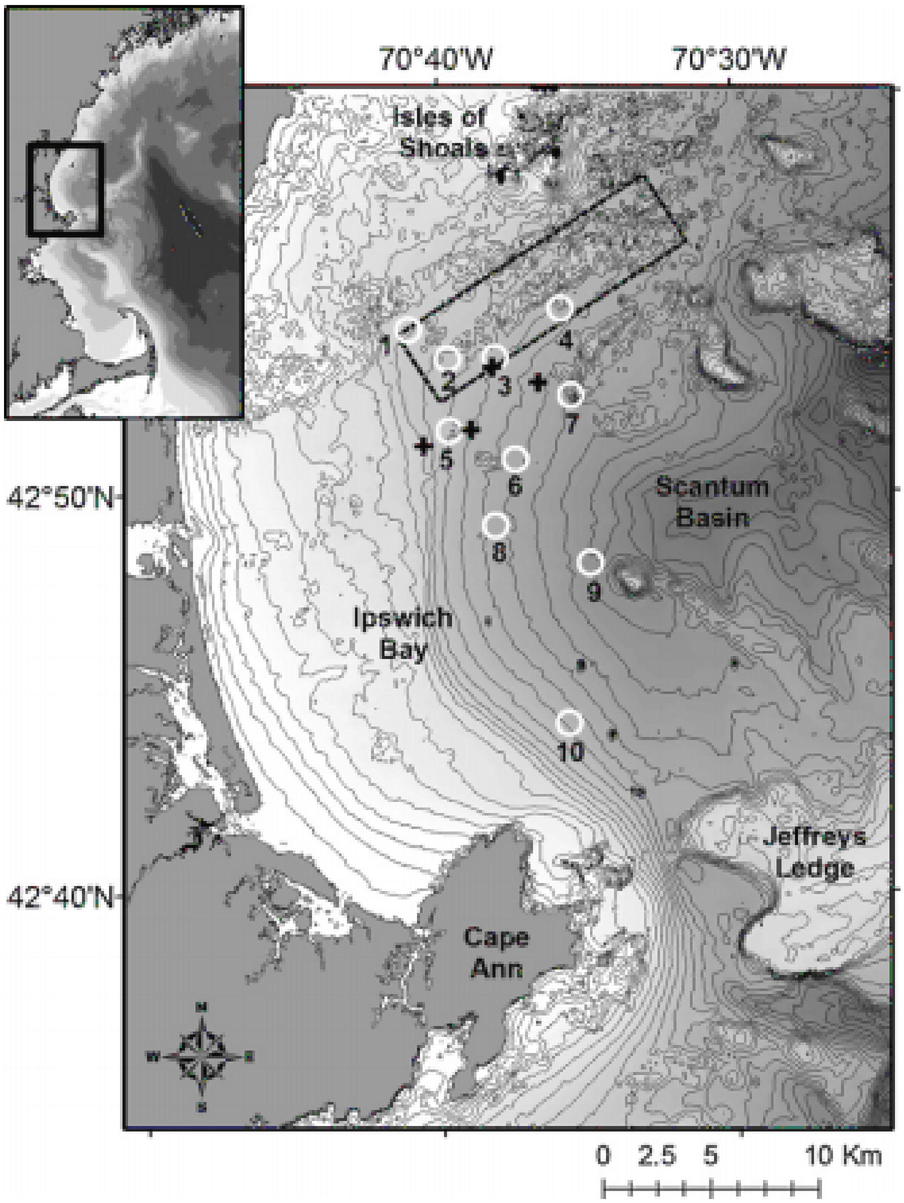


Figure 4. Bathymetric map of Ipswich Bay. Black dotted rectangle highlights the elevated bathymetric feature "Whaleback". Siceloff and Howell, 2012.

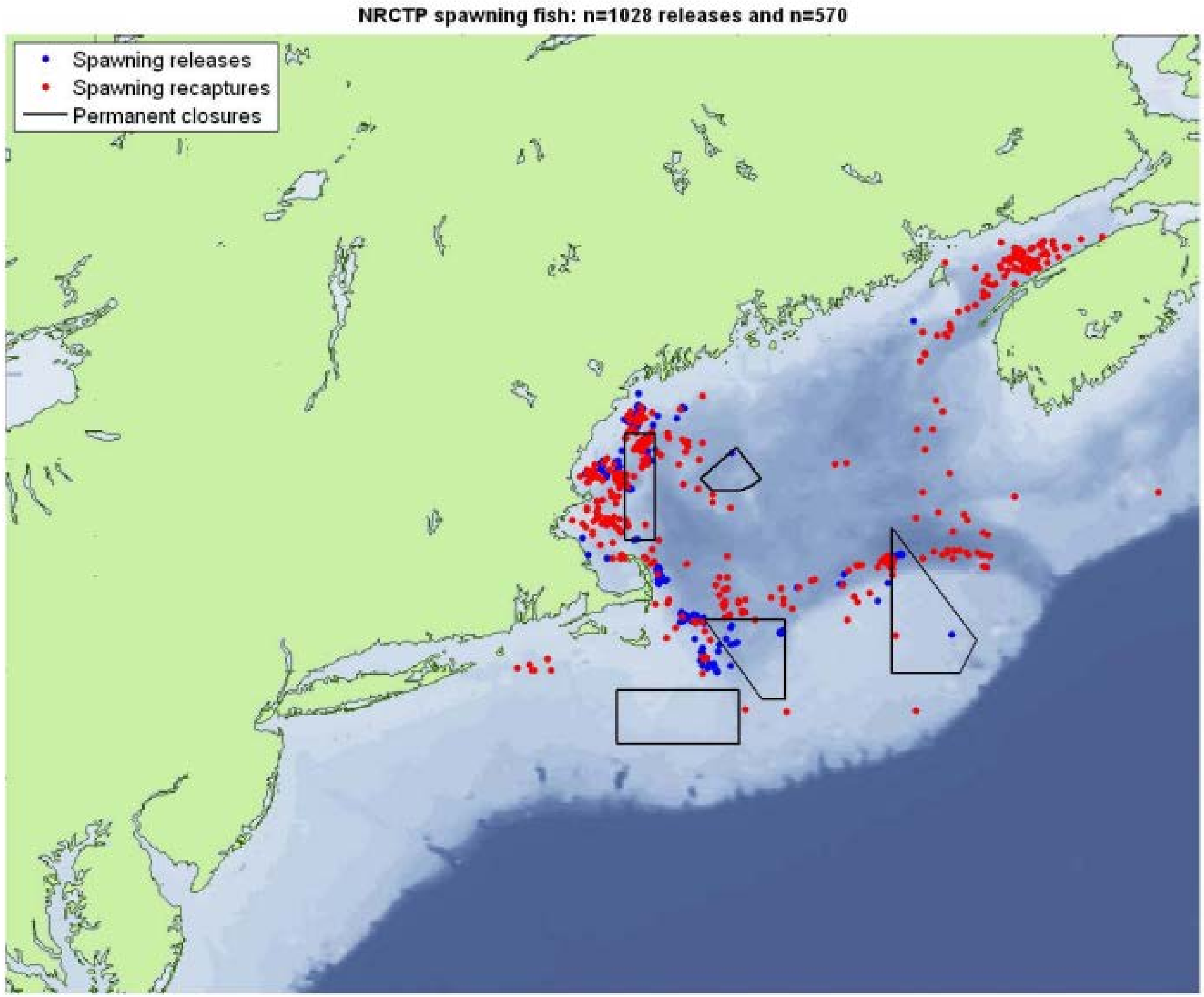


Figure 5. The distribution of tagged cod releases and recaptures in spawning condition, relative to closed areas and across all years. Tallack, 2008.

Juveniles and adults were distinguished based on lengths-at-maturity for each species, which was defined according to the length at which 50% of the fish in a population mature sexually. For most species, these sizes vary by sex and stock units. They also vary over time, according to changes in growth rate, sometimes considerably. Lengths used to distinguish juveniles and adults for most species were based on data reported by O'Brien et al. (1993). Lengths at maturity for the skate species were based on information included in EFH source documents. These lengths are listed in Table 4. In most cases, O'Brien et al. based 50% lengths at maturity on females; if there was more than one size available because of analyses that were performed at different time periods or for different stocks, they were averaged.

$r(l) = \{ \exp(a + bl) / [1+\exp(a + bl)] \}$

Table 4. Lengths-at-maturity used to distinguish juveniles and adults in EFH designations. Juveniles are less than the specified length; adults are equal to or larger.

Species	***Length (cm) at 50% Maturity O'Brien et al. (1993) and EFH Skate Source Document***	***Length (cm) at maturity (rounded to nearest 5 cm for analysis of juvenile and spawning distributions) Calculated from parameters in latest assessment, generally GARM III Red values are average L20/L50 and L80/L50 ratios of other species***			***Approximate length (rounded up to 5 cm increment) at greater than 80% Maturity from 2002-2012 spring and fall trawl survey data***
		L20	***L50***	***L80***	
American Plaice	27	23.6 (25)	27.6	31.6 (30)	30
Atlantic Cod	35	35.4-36.8 (35)	43-44.5	49.2-53.6 (50)	50
Atlantic Herring	25	(20)	NA	(25)	25
Barndoor Skate	102	(85)	NA	(115)	115*
Clearnose Skate	61	(50)	NA	(70)	
Deep-sea Red Crab	8		NA		
Goosefish	43	(35)	NA	(45)	45
Haddock	32	28.2-28.3 (30)	33-34.7	37.8-41.1 (40)	40
Little Skate	50	(45)		(55)	
Ocean Pout	29				
Offshore Hake	30	(25)		(35)	
Pollock	39	38.8 (40)	45.4	51.9 (50)	45
Red Hake	26	(20)		(35)	35
Redfish	22	19.2 (20)	22.0	24.8 (25)	25
Rosette Skate	46	(40)		(55)	
Sea Scallop	10				
Silver Hake	23	(20)		(30)	30
Smooth Skate	56	(50)		(65)	
Thorny Skate	84	(70)		(95)	

Species	***Length (cm) at 50% Maturity O'Brien et al. (1993) and EFH Skate Source Document***	***Length (cm) at maturity (rounded to nearest 5 cm for analysis of juvenile and spawning distributions)*** ***Calculated from parameters in latest assessment, generally GARM III*** ***Red values are average L20/L50 and L80/L50 ratios of other species***			***Approximate length (rounded up to 5 cm increment) at greater than 80% Maturity from 2002-2012 spring and fall trawl survey data***
		L20	***L50***	***L80***	
White Hake	35	25.0 (25)	35.1	45.2 (45)	60
Windowpane	22	17.5-18.2 (20)	20.5-21.3	23.5-24.4 (25)	
Winter Flounder	27	26.7 (25)	29-29.1	31.1 (30)	30
Winter Skate	85	(70)		(95)	
Witch Flounder	30	28.1 (30)	32.9	31.1 (40)	40
Yellowtail Flounder	27	24.6-25.8 (25)	27.4-28.2	30.2-30.7 (30)	30

Wolffish – 47 cm (Templeman 1986)

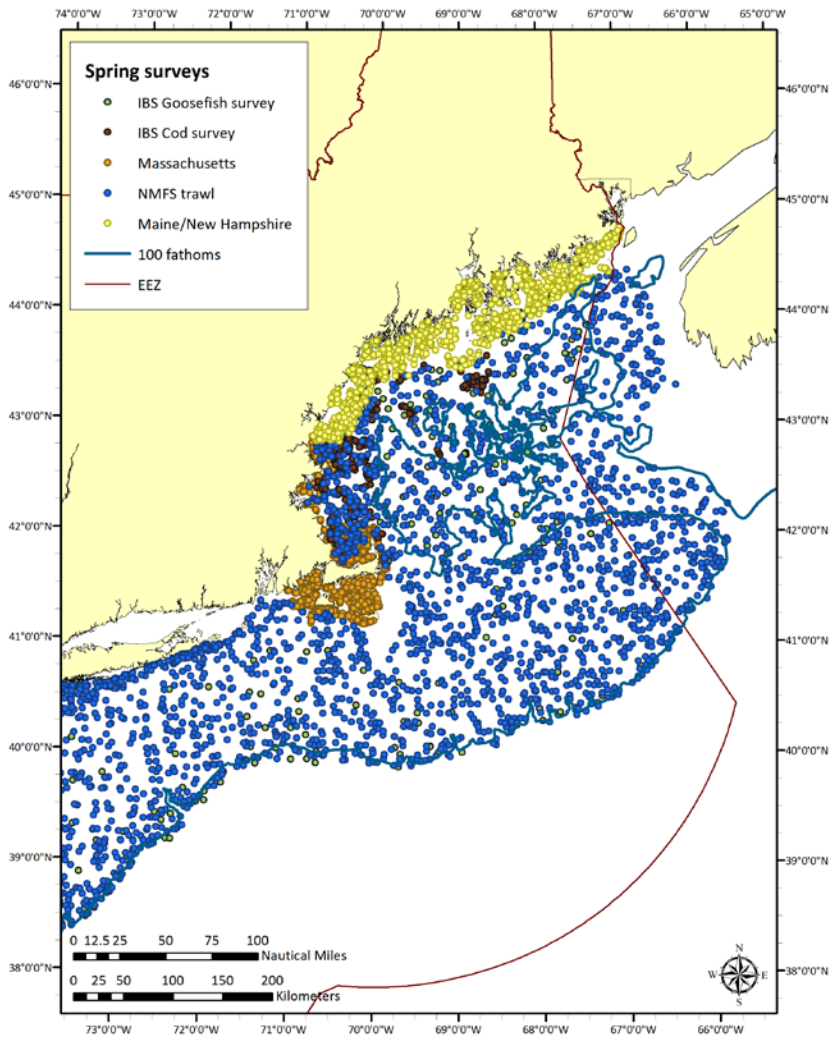
Table 5. Cumulative proportion of abundance at age by species, survey, and stock area. First line of data represents an approximate L20 for each species. Second line of data represents a size that approximates the 90th percentile of age 1 fish (some species use age 2) for the predominate stock area for each species.

Spring 2002-2012 Region
Fall 2002-2011 Age

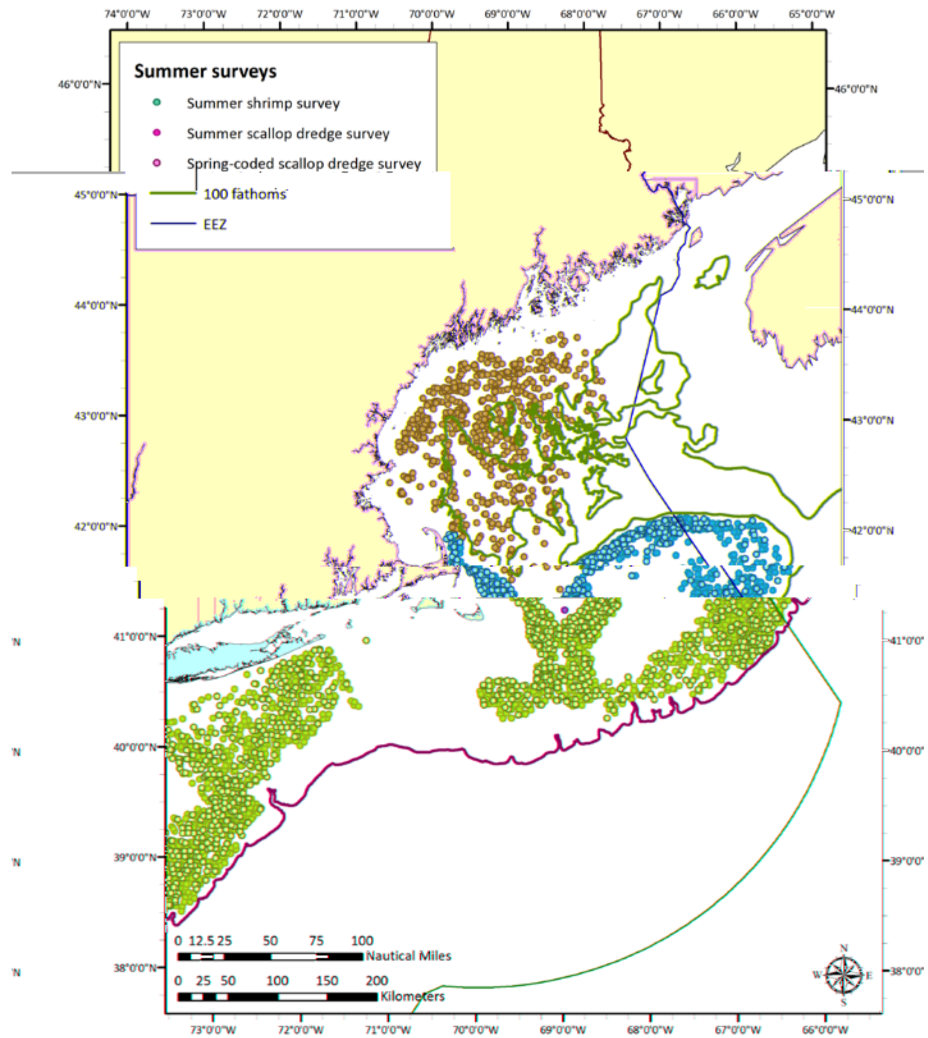
			Mid-Atlantic				Georges Bank				Gulf of Maine				Scotian Shelf			
Species	Survey	Length (cm)	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
American plaice	Spring	25						100.0%	99.4%	63.4%		100.0%	99.5%	86.3%		100.0%	98.6%	85.1%
		12						91.5%	4.3%	0.0%		84.2%	2.6%	0.0%		90.5%	0.0%	0.0%
	Fall	25					100.0%	100.0%	86.9%	37.7%	100.0%	100.0%	98.1%	65.7%	100.0%	100.0%	97.1%	57.1%
		18					100.0%	89.6%	16.4%	1.0%	100.0%	98.2%	35.4%	1.7%	100.0%	98.0%	16.2%	0.0%
Atlantic cod	Spring	35	100.0%	100.0%	15.0%	0.0%	100.0%	99.7%	29.5%	0.8%	100.0%	100.0%	75.9%	12.1%	100.0%	100.0%	45.8%	2.2%
		24	100.0%	41.4%	0.0%	0.0%	100.0%	65.2%	0.7%	0.0%	100.0%	90.6%	14.7%	0.0%	100.0%	95.3%	1.0%	0.0%
	Fall	35	100.0%		0.0%	0.0%	100.0%	66.4%	2.0%	0.0%	100.0%	94.0%	29.2%	2.7%	100.0%	84.9%	13.3%	2.7%
		34	100.0%		0.0%	0.0%	100.0%	58.6%	1.4%	0.0%	100.0%	91.3%	25.3%	1.5%	100.0%	80.2%	10.7%	0.0%
Atlantic herring	Spring	20		100.0%	99.5%	65.5%		100.0%	99.8%	73.1%	100.0%	100.0%	99.8%	75.8%		100.0%	100.0%	70.6%
		9		100.0%	0.3%	0.0%		91.7%	0.2%	0.0%	100.0%	94.1%	1.1%	0.0%		90.0%	7.1%	0.0%
	Fall	20		100.0%	84.2%	66.7%		100.0%	81.8%	12.0%		100.0%	84.1%	11.8%		100.0%	90.6%	10.2%
		16		100.0%	0.0%	0.0%		95.8%	3.2%	0.0%		96.9%	8.1%	0.0%		100.0%	10.4%	0.0%
Goosefish	Spring	35			100.0%	100.0%			100.0%	100.0%		100.0%	100.0%	100.0%			100.0%	
		28			100.0%	84.2%			100.0%	92.3%		100.0%	100.0%	93.0%			100.0%	
	Fall	35	100.0%	100.0%	100.0%	76.9%	100.0%	100.0%	100.0%	54.5%	100.0%	100.0%	100.0%	70.0%	100.0%	100.0%	100.0%	
		26	100.0%	100.0%	90.9%	0.0%	100.0%	100.0%	95.2%	0.0%	100.0%	100.0%	77.8%	0.0%	100.0%	100.0%	100.0%	
Haddock	Spring	30		100.0%	0.0%			99.9%	48.0%	7.5%		100.0%	35.9%	3.5%		100.0%	56.9%	11.7%
		24		67.4%	0.0%			88.6%	7.8%	0.0%		93.3%	1.4%	0.0%		95.0%	6.4%	3.3%
	Fall	30	100.0%	0.0%			100.0%	68.5%	10.5%	0.2%	100.0%	77.4%	4.9%	0.4%	100.0%	83.9%	8.1%	0.0%
		34	100.0%	100.0%			100.0%	93.5%	29.3%	7.8%	100.0%	97.4%	27.6%	3.3%	100.0%	99.1%	45.1%	9.4%
Ocean pout (all years)	Spring	29		100.0%	11.1%	3.8%		100.0%	18.8%	0.0%				75.0%				66.7%
	Fall																	
Pollock	Spring	40		100.0%	100.0%	100.0%		100.0%	100.0%	58.8%		100.0%	100.0%	88.0%		100.0%	100.0%	100.0%
		23		100.0%	70.0%	0.0%		78.9%	40.4%	0.0%		95.7%	21.5%	0.0%		95.5%	18.2%	0.0%
	Fall	40	100.0%	100.0%			100.0%	100.0%	87.1%	15.7%	100.0%	100.0%	91.8%	35.5%	100.0%	100.0%	89.6%	16.7%
		32	100.0%	100.0%			100.0%	89.5%	19.4%	0.0%	100.0%	96.7%	40.1%	1.8%	100.0%	93.3%	22.9%	0.0%
Red hake	Spring	20		91.7%	0.0%	0.0%		83.3%	0.0%	0.0%		95.0%	10.0%	0.0%		100.0%	20.0%	0.0%
		20		91.7%	0.0%	0.0%		83.3%	0.0%	0.0%		95.0%	10.0%	0.0%		100.0%	20.0%	0.0%
	Fall	20	100.0%	11.1%	0.0%	0.0%		6.7%	0.0%	0.0%	100.0%	35.2%	0.0%	0.0%	100.0%	12.5%	0.0%	
		28	100.0%	88.9%	30.0%	25.0%		93.3%	14.8%	4.0%	100.0%	92.6%	37.0%	2.2%	100.0%	87.5%	0.0%	
Redfish (all years)	Spring	20		100.0%		100.0%	0.0%		100.0%	100.0%		100.0%	100.0%	100.0%			100.0%	100.0%
		14		100.0%		33.3%	0.0%		100.0%	17.6%		100.0%	90.9%	72.7%			100.0%	50.0%
(2002-2011)	Fall	20						100.0%	100.0%	100.0%		100.0%	100.0%	100.0%		100.0%	100.0%	100.0%
		13						100.0%	92.6%	31.1%		100.0%	93.9%	29.5%		100.0%	100.0%	30.7%
Silver hake	Spring	20		94.6%	16.8%	0.0%		96.8%	31.8%	0.0%		98.6%	40.0%	0.1%		97.7%	44.0%	0.0%
		19		90.5%	12.7%	0.0%		93.2%	27.2%	0.0%		95.8%	32.6%	0.0%		93.1%	40.7%	0.0%
	Fall	20	98.7%	22.0%	0.0%	0.0%	100.0%	19.0%	0.0%	0.0%	100.0%	26.7%	0.0%	0.0%	100.0%	15.8%	0.0%	0.0%
		26	100.0%	87.1%	30.6%	0.0%	100.0%	91.0%	31.2%	5.1%	100.0%	91.4%	28.6%	3.3%	100.0%	86.7%	30.7%	3.0%
White hake	Spring	25			0.0%	0.0%		4.3%	0.0%	0.0%		26.3%	7.2%	0.0%			13.2%	0.0%
		34			25.0%	0.0%		78.3%	7.9%	0.0%		90.9%	55.8%	10.8%			83.8%	25.0%
	Fall	25		50.0%	0.0%	0.0%	77.4%	1.5%	0.0%	0.0%	46.3%	23.5%	0.0%	0.0%	100.0%	49.1%	0.0%	0.0%
		39		100.0%	25.0%	0.0%	100.0%	82.1%	32.1%	0.0%	100.0%	94.0%	27.0%	0.0%	100.0%	100.0%	43.1%	0.0%
Winter flounder	Spring	25		100.0%	44.5%	4.5%		100.0%	60.3%	10.3%		100.0%	97.8%	57.2%		100.0%	100.0%	79.3%
		18		92.6%	4.7%	0.0%		94.3%	6.6%	0.0%		97.5%	40.0%	4.7%		90.0%	44.1%	3.0%
	Fall	25		88.9%	19.2%	0.0%	100.0%	75.6%	8.6%	0.1%	100.0%	100.0%	77.0%	19.0%		100.0%	96.1%	45.2%
		28		99.2%	48.0%	4.2%	100.0%	91.8%	25.3%	1.2%	100.0%	100.0%	93.2%	50.4%		100.0%	98.7%	86.3%
Witch flounder	Spring	30			100.0%	100.0%		100.0%	100.0%	100.0%		100.0%	100.0%	100.0%		100.0%	100.0%	100.0%
		20			100.0%	84.0%		100.0%	91.7%	18.2%		100.0%	74.3%	14.7%		100.0%	33.3%	8.6%
	Fall	30	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	84.6%	100.0%	100.0%	100.0%	88.0%	100.0%	100.0%	100.0%	66.7%
		19	100.0%	100.0%	53.3%	11.3%	100.0%	100.0%	0.0%	0.0%	100.0%	88.9%	7.3%	1.4%	100.0%	100.0%	11.1%	0.0%
Yellowtail flounder	Spring	25		100.0%	23.6%	0.0%		100.0%	19.6%	0.0%		100.0%	62.0%	5.7%			30.0%	5.3%
		13		96.1%	0.0%	0.0%		92.5%	0.0%	0.0%		67.2%	0.0%	0.0%			0.0%	0.0%
	Fall	25	100.0%	95.9%	1.5%	0.0%	100.0%	80.8%	0.7%	0.0%	100.0%	91.1%	11.3%	0.3%	100.0%	25.0%	11.1%	0.0%
		15	73.7%	0.0%	0.0%	0.0%	93.2%	0.2%	0.0%	0.0%	100.0%	1.3%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%

Figure 6. Domain of surveys used in the hotspot analysis by season.

Spring

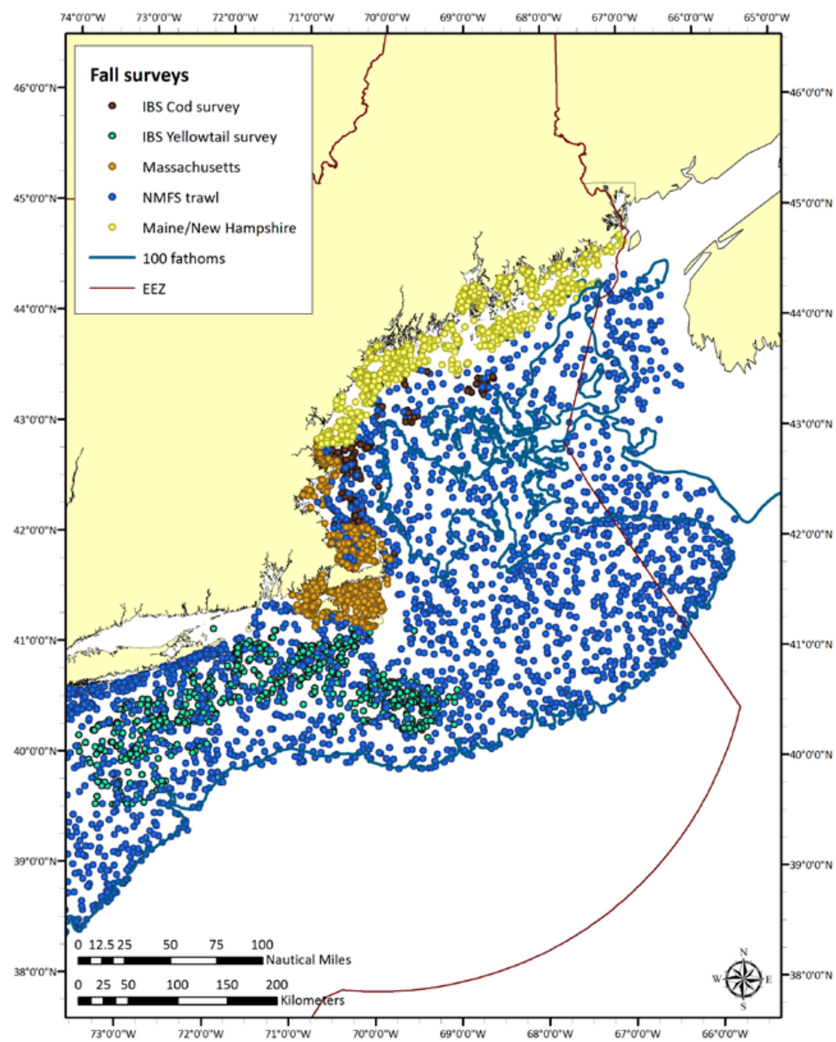


Summer



Fall

Winter


Fall surveys
IBS Cod survey
IBS Yellowtail survey
Massachusetts
NMFS trawl
Maine/New Hampshire
100 fathoms
EEZ
0 12.5 25 50 75 100
Nautical Miles
0 25 50 100 150 200
Kilometers

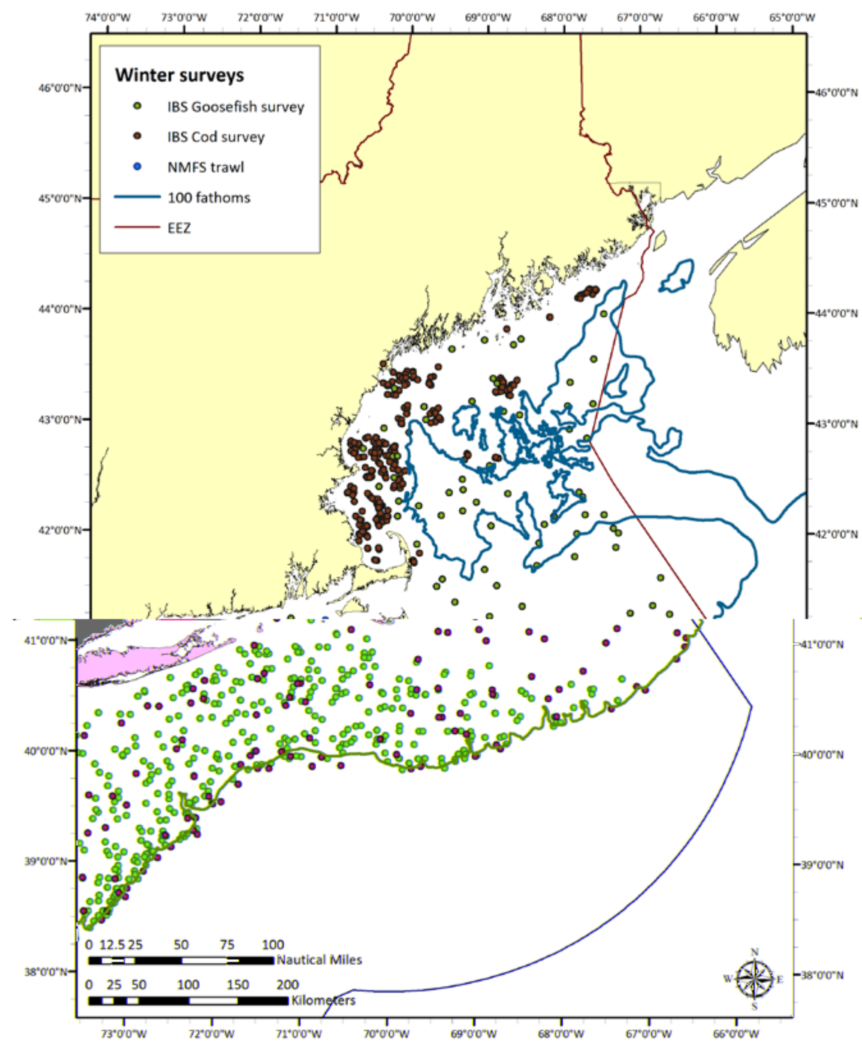
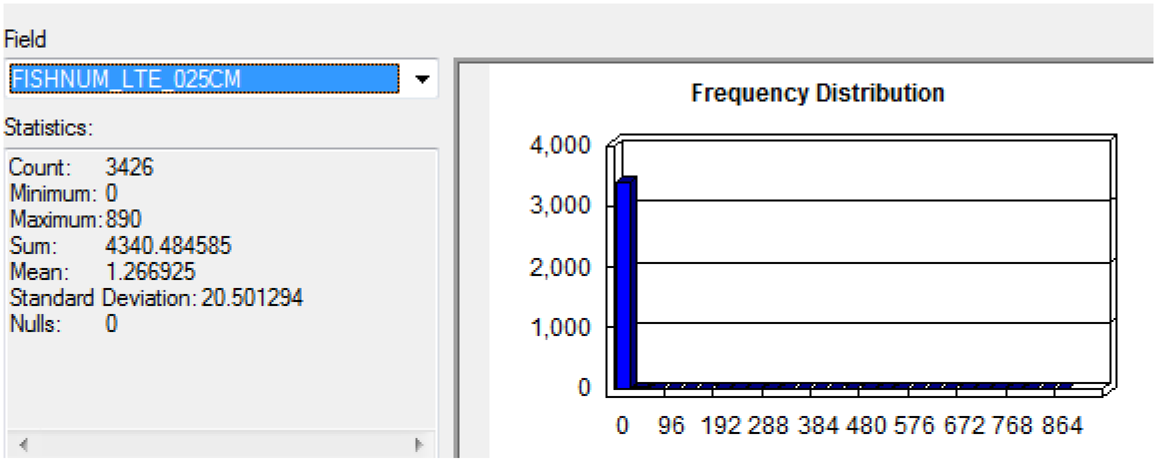
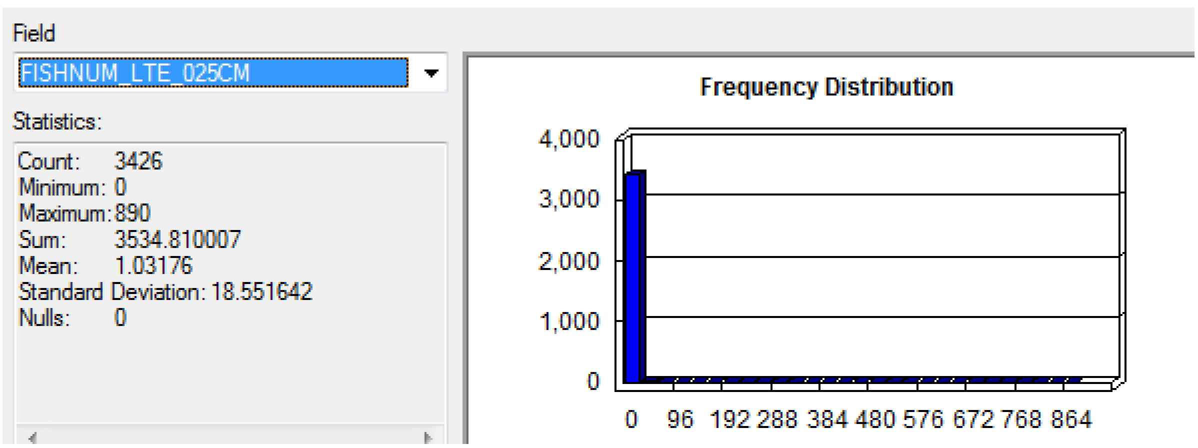

Winter surveys
IBS Goosefish survey
IBS Cod survey
NMFS trawl
100 fathoms
EEZ
0 12.5 25 50 75 100
Nautical Miles
0 25 50 100 150 200
Kilometers

Figure 7. Frequency distribution plots of 2002-2012 NMFS spring trawl catches of cod <= 25 cm. Top – untransformed kg/tow; Middle – Catches adjusted for the proportion of zero tows in strata; Bottom – Log transformed adjusted catches.





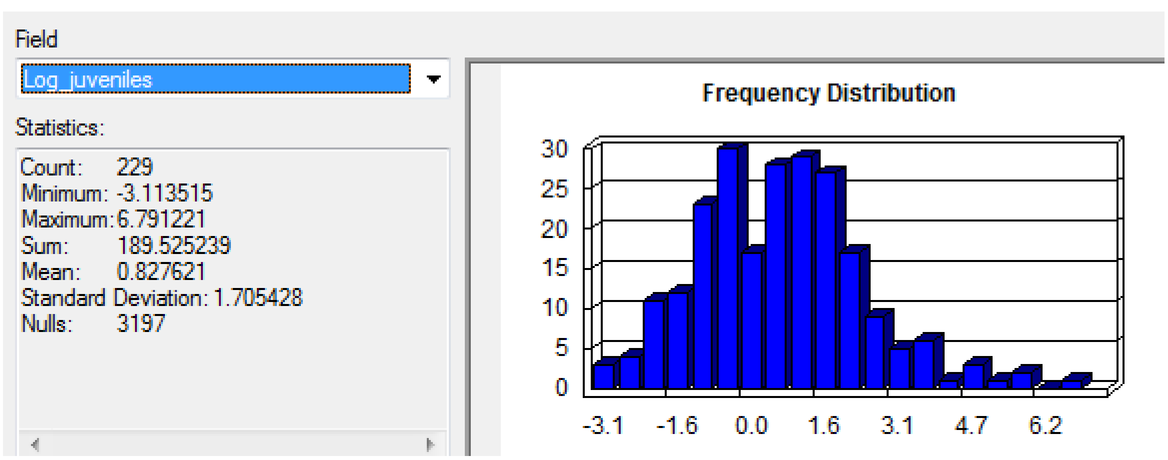


Table 6. Cumulative number of cod caught by survey over time by size range, compared to 20 percent of total abundance.

COMNAME	ATLANTIC COD							
REGION	(Multiple Items)							
Row Labels	20Pct total num	Num <= 5 cm	Num <= 10 cm	Num <= 15 cm	Num <= 20 cm	Num <= 25 cm	Num <= 30 cm	Num <= 35 cm
IBS Cod Spawning	**713**	**0**	**1**	**46**	**200**	**309**	**610**	**1,340**
WINTER	**353**	**0**	**1**	**31**	**99**	**128**	**270**	**737**
2002-2012	353	0	1	31	99	128	270	737
SPRING	**360**	**0**	**0**	**15**	**101**	**181**	**340**	**603**
2002-2012	360	0	0	15	101	181	340	603
NMFS trawl	**19,013**	**1,824**	**4,110**	**6,547**	**9,888**	**14,750**	**22,563**	**32,232**
WINTER	**602**	**2**	**21**	**98**	**247**	**419**	**514**	**599**
1963-1971	314	1	20	32	61	118	159	210
1972-1981	92	0	0	0	1	14	22	26
1992-2001	153	1	1	6	34	94	132	162
2002-2012	44	0	0	60	152	194	200	201
SPRING	**9,157**	**1,602**	**1,815**	**2,339**	**2,983**	**6,707**	**10,455**	**14,481**
[illegible]								

57,796	138,260	166,206	173,500	182,644	193,218	204,348	217,294	Grand Total

Table 7. Cumulative weight of cod caught by survey over time by size range, compared to 20 percent of total weight.

COMNAME	ATLANTIC COD								
REGION	(Multiple Items)								
Row Labels	**20 pct total weight**	**Wgt >= 50 cm**	**Wgt >= 55 cm**	**Wgt >= 60 cm**	**Wgt >= 65 cm**	**Wgt >= 70 cm**	**Wgt >= 75 cm**	**Wgt >= 80 cm**	**Wgt >= 85 cm**	**Wgt >= 90 cm**
IBS Cod Spawning	**747**	**2,408**	**2,110**	**1,855**	**1,624**	**1,347**	**1,064**	**798**	**593**	**430**
WINTER	**219**	**315**	**184**	**117**	**94**	**50**	**28**	**7**	**7**	**0**
2002-2012	219	315	184	117	94	50	28	7	7	0
SPRING	**528**	**2,093**	**1,926**	**1,738**	**1,530**	**1,296**	**1,036**	**791**	**587**	**430**
2002-2012	528	2,093	1,926	1,738	1,530	1,296	1,036	791	587	430
NMFS trawl	**30,250**	**126,234**	**116,874**	**105,602**	**91,915**	**78,010**	**64,149**	**52,264**	**40,675**	**31,445**
WINTER	**1,654**	**7,744**	**7,421**	**6,875**	**6,273**	**5,663**	**5,002**	**4,400**	**3,594**	**2,866**
1963-1971	1,071	5,112	4,959	4,720	4,403	4,013	3,596	3,173	2,661	2,128
1972-1981	306	1,452	1,397	1,246	1,127	1,070	1,010	923	777	632
1992-2001	269	1,159	1,046	891	724	570	395	305	156	105
2002-2012	8	21	18	18	18	9	2	0	0	0
SPRING	**14,558**	**59,891**	**55,579**	**50,284**	**43,393**	**36,609**	**29,872**	**24,347**	**18,652**	**14,302**
1963-1971	1,141	5,430	5,229	4,938	4,517	4,148	3,620	3,126	2,501	1,990
1972-1981	4,480	18,878	17,665	16,273	14,448	12,238	10,391	8,984	7,183	5,748
1982-1991	3,639	16,391	15,546	14,307	12,278	10,593	8,661	6,889	5,323	4,055
1992-2001	1,387	6,317	5,887	5,359	4,720	4,063	3,341	2,706	1,977	1,462
2002-2012	3,911	12,875	11,253	9,408	7,430	5,567	3,860	2,642	1,668	1,047
SUMMER	**2,879**	**12,728**	**11,567**	**10,206**	**8,948**	**7,525**	**6,234**	**4,992**	**3,984**	**3,132**
1963-1971	1,207	5,566	5,241	4,789	4,186	3,500	2,851	2,317	1,769	1,329
1972-1981	1,455	6,301	5,544	4,735	4,162	3,498	2,915	2,279	1,897	1,557
1982-1991	42	172	147	132	104	83	72	68	51	26
1992-2001	174	689	635	550	496	444	395	328	267	220
FALL	**11,158**	**45,872**	**42,307**	**38,236**	**33,302**	**28,213**	**23,040**	**18,526**	**14,445**	**11,145**
1963-1971	1,684	7,793	7,458	6,993	6,330	5,665	4,982	4,275	3,540	2,821
1972-1981	4,366	19,429	18,092	16,496	14,560	12,593	10,480	8,678	7,073	5,590
1982-1991	1,679	6,914	6,397	5,710	4,879	3,990	3,277	2,553	1,888	1,493
1992-2001	1,063	4,411	3,899	3,322	2,717	2,131	1,512	1,019	702	431
2002-2012	2,365	7,325	6,461	5,716	4,816	3,834	2,789	2,001	1,242	810
MADMF trawl	**2,206**	**5,354**	**4,219**	**3,313**	**2,459**	**1,767**	**1,129**	**736**	**546**	**409**
SPRING	**2,038**	**5,097**	**4,015**	**3,140**	**2,330**	**1,681**	**1,090**	**715**	**533**	**404**
1972-1981	407	836	627	445	297	208	149	110	87	71
1982-1991	414	742	533	369	264	180	148	122	101	60
1992-2001	320	633	475	347	225	155	105	60	35	20
2002-2012	896	2,886	2,381	1,980	1,544	1,138	688	423	310	252
FALL	**168**	**257**	**204**	**173**	**130**	**86**	**39**	**22**	**13**	**5**
1972-1981	61	53	44	37	27	25	16	13	13	5
1982-1991	16	11	9	7	4	3	0	0	0	0
1992-2001	13	12	4	2	0	0	0	0	0	0
2002-2012	78	182	147	126	98	57	23	9	0	0
Grand Total	**33,202**	**133,997**	**123,202**	**110,770**	**95,998**	**81,124**	**66,342**	**53,798**	**41,814**	**32,284**

Table 8. Cumulative biomass above 5 cm size ranges by species, survey, and decade, compared to 20% of total weight per tow (kg) and the size at estimated 80% maturity for females.

Approximate 20% of biomass (upper), L80 for maturity (lower)	Species	Row Labels	Sum of 20 pct total wgt	WGT >= 25cm	Wgt >= 30cm	Wgt >= 35cm	Wgt >= 40 cm	Wgt >= 45cm	Wgt >= 50cm	Wgt >= 55 cm	Wgt >= 60cm	Wgt >= 65cm	Wgt >= 70cm	Wgt >= 75cm	Wgt >= 80cm	Wgt >= 85cm	Wgt >= 90cm	Wgt >= 95cm	Wgt >= 100cm
75 cm	ATLANTIC COD	All	30,250	150,605	149,271	146,284	141,220	134,113	126,234	116,874	105,602	91,915	78,010	64,149	52,264	40,675	31,445	23,602	17,149
L80 = 50 cm	ATLANTIC COD	WINTER	1,654	8,247	8,226	8,202	8,141	7,983	7,744	7,421	6,875	6,273	5,663	5,002	4,400	3,594	2,866	1,978	1,353
	ATLANTIC COD	1963-1971	1,071	5,348	5,339	5,325	5,291	5,222	5,112	4,959	4,720	4,403	4,013	3,596	3,173	2,661	2,128	1,461	1,016
	ATLANTIC COD	1972-1981	306	1,530	1,528	1,527	1,517	1,488	1,452	1,397	1,246	1,127	1,070	1,010	923	777	632	460	312
	ATLANTIC COD	1992-2001	269	1,339	1,330	1,321	1,305	1,247	1,159	1,046	891	724	570	395	305	156	105	57	25
	ATLANTIC COD	2002-2012	8	30	29	29	28	26	21	18	18	18	9	2	0	0	0	0	0
	ATLANTIC COD	SPRING	14,558	72,457	71,801	70,561	68,244	64,198	59,891	55,579	50,284	43,393	36,609	29,872	24,347	18,652	14,302	10,866	7,891
	ATLANTIC COD	1963-1971	1,141	5,701	5,696	5,672	5,614	5,551	5,430	5,229	4,938	4,517	4,148	3,620	3,126	2,501	1,990	1,516	1,130
	ATLANTIC COD	1972-1981	4,480	22,342	22,248	22,062	21,645	20,446	18,878	17,665	16,273	14,448	12,238	10,391	8,984	7,183	5,748	4,489	3,320
	ATLANTIC COD	1982-1991	3,639	18,153	18,082	17,935	17,643	17,118	16,391	15,546	14,307	12,278	10,593	8,661	6,889	5,323	4,055	3,222	2,343
	ATLANTIC COD	1992-2001	1,387	6,923	6,906	6,864	6,778	6,591	6,317	5,887	5,359	4,720	4,063	3,341	2,706	1,977	1,462	1,007	675
	ATLANTIC COD	2002-2012	3,911	19,338	18,869	18,028	16,564	14,492	12,875	11,253	9,408	7,430	5,567	3,860	2,642	1,668	1,047	632	423
	ATLANTIC COD	SUMMER	2,879	14,357	14,282	14,124	13,863	13,478	12,728	11,567	10,206	8,948	7,525	6,234	4,992	3,984	3,132	2,334	1,736
	ATLANTIC COD	1963-1971	1,207	6,032	6,020	5,991	5,927	5,799	5,566	5,241	4,789	4,186	3,500	2,851	2,317	1,769	1,329	974	726
	ATLANTIC COD	1972-1981	1,455	7,252	7,197	7,088	6,936	6,745	6,301	5,544	4,735	4,162	3,498	2,915	2,279	1,897	1,557	1,169	874
	ATLANTIC COD	1982-1991	42	209	207	205	203	195	172	147	132	104	83	72	68	51	26	26	26
	ATLANTIC COD	1992-2001	174	864	858	840	796	739	689	635	550	496	444	395	328	267	220	166	111
	ATLANTIC COD	FALL	11,158	55,545	54,962	53,397	50,972	48,454	45,872	42,307	38,236	33,302	28,213	23,040	18,526	14,445	11,145	8,424	6,170
	ATLANTIC COD	1963-1971	1,684	8,407	8,379	8,292	8,177	8,005	7,793	7,458	6,993	6,330	5,665	4,982	4,275	3,540	2,821	2,220	1,622
	ATLANTIC COD	1972-1981	4,366	21,777	21,653	21,317	20,808	20,197	19,429	18,092	16,496	14,560	12,593	10,480	8,678	7,073	5,590	4,351	3,324
	ATLANTIC COD	1982-1991	1,679	8,367	8,280	8,078	7,697	7,259	6,914	6,397	5,710	4,879	3,990	3,277	2,553	1,888	1,493	1,046	724
	ATLANTIC COD	1992-2001	1,063	5,306	5,269	5,173	4,995	4,742	4,411	3,899	3,322	2,717	2,131	1,512	1,019	702	431	293	156
	ATLANTIC COD	2002-2012	2,365	11,688	11,380	10,536	9,295	8,252	7,325	6,461	5,716	4,816	3,834	2,789	2,001	1,242	810	514	344
40 cm	AMERICAN PLAICE	WINTER	62	310	300	261	202	130	76	47	22	0	0	0	0	0	0	0	0
L80 = 30 cm	AMERICAN PLAICE	1972-1981	17	85	83	75	63	41	32	27	16	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	1992-2001	44	219	212	182	136	88	44	21	6	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	2002-2012	1	6	5	5	4	1	0	0	0	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	SPRING	2,492	11,176	9,366	6,995	4,939	3,250	1,793	763	289	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	1963-1971	233	1,113	972	756	543	359	194	109	68	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	1972-1981	1,076	4,968	4,453	3,662	2,815	1,951	1,089	482	167	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	1982-1991	453	2,007	1,647	1,216	861	601	366	137	45	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	1992-2001	338	1,498	1,173	757	457	234	105	33	8	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	2002-2012	392	1,589	1,122	603	264	106	38	2	0	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	SUMMER	924	4,013	3,153	2,062	1,264	793	424	171	62	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	1963-1971	81	385	331	244	172	104	65	36	20	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	1972-1981	434	1,875	1,556	1,196	835	544	296	125	38	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	1982-1991	81	350	216	73	20	11	6	0	0	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	1992-2001	328	1,402	1,049	549	237	134	57	11	4	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	FALL	2,690	12,037	10,086	7,423	5,086	3,152	1,750	768	244	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	1963-1971	171	812	706	540	368	224	138	79	39	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	1972-1981	1,248	5,780	5,148	4,197	3,186	2,113	1,221	535	169	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	1982-1991	412	1,777	1,418	982	673	422	234	103	28	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	1992-2001	504	2,217	1,785	1,119	578	265	109	33	8	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	2002-2012	355	1,452	1,030	586	281	128	48	18	0	0	0	0	0	0	0	0	0
	AMERICAN PLAICE	All	6,168	27,535	22,904	16,741	11,491	7,327	4,042	1,750	617	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	WINTER	304	765	85	4	2	0	0	0	0	0	0	0	0	0	0	0	0
L80 = 25 cm	ATLANTIC HERRING	1963-1971	8	23	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1972-1981	9	22	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1992-2001	260	670	77	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	2002-2012	27	49	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	SPRING	2,253	4,363	255	4	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1963-1971	10	23	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1972-1981	239	649	83	2	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1982-1991	321	1,063	104	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1992-2001	778	1,738	46	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	2002-2012	906	890	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	SUMMER	1,782	5,508	927	69	2	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1963-1971	229	1,088	615	68	1	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1972-1981	64	220	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1982-1991	484	1,224	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1992-2001	1,006	2,976	164	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	FALL	4,896	12,628	1,070	6	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1963-1971	71	318	99	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1972-1981	32	148	57	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1982-1991	651	2,285	513	4	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	1992-2001	1,713	5,766	368	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	2002-2012	2,429	4,112	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ATLANTIC HERRING	All	9,235	23,264	2,337	83	4	0	0	0	0	0	0	0	0	0	0	0	0

Approximate 20% of biomass (upper), L80 for maturity (lower)	Species	Row Labels	Sum of 20 pct total wgt	WGT >= 25cm	Wgt >= 30cm	Wgt >= 35cm	Wgt >= 40 cm	Wgt >= 45cm	Wgt >= 50cm	Wgt >= 55 cm	Wgt >= 60cm	Wgt >= 65cm	Wgt >= 70cm	Wgt >= 75cm	Wgt >= 80cm	Wgt >= 85cm	Wgt >= 90cm	Wgt >= 95cm	Wgt >= 100cm
50 cm	**HADDOCK**	**All**	**51,238**	**243,899**	**226,195**	**201,572**	**172,426**	**140,490**	**103,964**	**68,131**	**41,692**	**23,073**	**11,224**	**4,337**	**1,219**	**0**	**0**	**0**	**0**
L80 = 40 cm	**HADDOCK**	**WINTER**	**3,338**	**15,592**	**14,832**	**12,926**	**10,452**	**8,468**	**6,770**	**5,048**	**3,350**	**1,972**	**898**	**340**	**66**	**0**	**0**	**0**	**0**
	HADDOCK	1963-1971	2,933	14,261	13,566	11,708	9,309	7,389	5,820	4,306	2,744	1,578	682	265	49	0	0	0	0
	HADDOCK	1972-1981	141	707	707	706	703	686	620	471	394	292	168	58	0	0	0	0	0
	HADDOCK	1992-2001	228	491	432	400	333	291	230	183	136	56	27	11	11	0	0	0	0
	HADDOCK	2002-2012	35	133	127	112	108	102	99	88	76	46	21	6	6	0	0	0	0
	HADDOCK	**SPRING**	**16,040**	**75,439**	**69,873**	**65,941**	**59,644**	**50,826**	**38,933**	**25,459**	**16,166**	**9,113**	**4,571**	**1,736**	**510**	**0**	**0**	**0**	**0**
	HADDOCK	1963-1971	1,416	7,060	7,043	7,001	6,831	6,388	5,732	4,366	2,789	1,492	574	170	27	0	0	0	0
	HADDOCK	1972-1981	4,819	23,073	22,141	21,302	18,842	15,899	12,933	9,283	6,487	3,895	2,040	796	258	0	0	0	0
	HADDOCK	1982-1991	1,803	8,905	8,755	8,478	7,793	6,900	5,682	4,175	2,996	1,951	1,150	551	189	0	0	0	0
	HADDOCK	1992-2001	1,535	7,494	7,330	7,103	6,404	5,589	4,553	3,179	2,049	995	479	121	25	0	0	0	0
	HADDOCK	2002-2012	6,467	28,907	24,604	22,058	19,774	16,050	10,034	4,455	1,844	780	326	99	11	0	0	0	0
	HADDOCK	**SUMMER**	**6,262**	**30,338**	**27,797**	**24,468**	**20,319**	**14,428**	**10,562**	**7,379**	**4,708**	**2,538**	**1,262**	**478**	**124**	**0**	**0**	**0**	**0**
	HADDOCK	1963-1971	4,349	20,828	18,542	15,937	12,591	9,914	7,824	5,390	3,277	1,657	770	209	39	0	0	0	0
	HADDOCK	1972-1981	1,877	9,338	9,085	8,364	7,570	4,367	2,601	1,872	1,356	844	475	255	85	0	0	0	0
	HADDOCK	1982-1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	HADDOCK	1992-2001	36	172	171	166	158	147	137	117	76	37	18	14	0	0	0	0	0
	HADDOCK	**FALL**	**25,598**	**122,530**	**113,693**	**98,237**	**82,011**	**66,768**	**47,700**	**30,245**	**17,469**	**9,451**	**4,493**	**1,783**	**519**	**0**	**0**	**0**	**0**
	HADDOCK	1963-1971	3,186	15,626	15,119	14,014	12,557	10,651	8,649	6,386	4,247	2,411	1,158	401	70	0	0	0	0
	HADDOCK	1972-1981	6,409	31,571	31,068	27,606	23,347	19,954	15,446	11,065	7,138	4,220	2,278	1,086	343	0	0	0	0
	HADDOCK	1982-1991	1,664	8,112	7,873	6,994	6,116	5,337	4,397	3,164	1,966	1,114	562	214	88	0	0	0	0
	HADDOCK	1992-2001	2,978	14,762	14,573	13,737	12,317	10,554	7,506	4,677	2,542	1,235	401	68	18	0	0	0	0
	HADDOCK	2002-2012	11,361	52,459	45,060	35,885	27,674	20,272	11,703	4,953	1,576	470	94	12	0	0	0	0	0
100 cm	**BARNDOOR SKATE**	**WINTER**	**659**	**3,294**	**3,292**	**3,275**	**3,254**	**3,211**	**3,153**	**3,074**	**2,991**	**2,848**	**2,684**	**2,535**	**2,331**	**2,175**	**1,995**	**1,777**	**1,601**
L80 = 115 cm	**BARNDOOR SKATE**	1963-1971	207	1,033	1,032	1,032	1,032	1,026	1,018	1,001	981	946	895	853	781	720	648	586	559
	BARNDOOR SKATE	1972-1981	6	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29	29
	BARNDOOR SKATE	1992-2001	150	750	749	743	736	722	706	682	657	602	566	523	485	458	432	379	331
	BARNDOOR SKATE	2002-2012	297	1,483	1,483	1,472	1,457	1,435	1,400	1,362	1,324	1,271	1,196	1,131	1,037	969	886	783	682
	BARNDOOR SKATE	**SPRING**	**495**	**2,471**	**2,469**	**2,463**	**2,452**	**2,433**	**2,401**	**2,341**	**2,272**	**2,171**	**2,040**	**1,873**	**1,765**	**1,645**	**1,520**	**1,420**	**1,330**
	BARNDOOR SKATE	1963-1971	46	228	228	228	228	227	226	219	211	193	180	163	163	156	153	143	143
	BARNDOOR SKATE	1972-1981	9	47	47	47	47	47	47	45	43	36	34	34	34	34	21	21	21
	BARNDOOR SKATE	1982-1991	0	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0
	BARNDOOR SKATE	1992-2001	52	258	258	257	256	254	253	247	240	228	221	211	196	196	192	176	164
	BARNDOOR SKATE	2002-2012	387	1,936	1,934	1,929	1,920	1,904	1,874	1,831	1,778	1,714	1,606	1,465	1,373	1,260	1,154	1,080	1,001
	BARNDOOR SKATE	**SUMMER**	**89**	**443**	**443**	**443**	**443**	**441**	**439**	**433**	**416**	**392**	**361**	**330**	**301**	**265**	**257**	**218**	**183**
	BARNDOOR SKATE	1963-1971	89	443	443	443	443	441	439	433	416	392	361	330	301	265	257	218	183
	BARNDOOR SKATE	1972-1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BARNDOOR SKATE	1982-1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BARNDOOR SKATE	1992-2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BARNDOOR SKATE	**FALL**	**688**	**3,438**	**3,435**	**3,431**	**3,421**	**3,401**	**3,351**	**3,279**	**3,175**	**3,047**	**2,919**	**2,734**	**2,556**	**2,410**	**2,242**	**2,059**	**1,893**
	BARNDOOR SKATE	1963-1971	151	756	756	756	756	753	744	731	707	658	614	554	498	446	409	378	334
	BARNDOOR SKATE	1972-1981	7	34	34	34	34	34	33	30	25	23	23	19	16	16	16	16	16
	BARNDOOR SKATE	1982-1991	5	26	26	26	26	26	26	24	23	21	18	14	14	14	10	5	0
	BARNDOOR SKATE	1992-2001	82	410	410	410	409	407	402	397	389	381	374	350	328	303	288	269	263
	BARNDOOR SKATE	2002-2012	442	2,210	2,208	2,204	2,196	2,181	2,146	2,097	2,031	1,964	1,890	1,797	1,700	1,632	1,518	1,390	1,279
	BARNDOOR SKATE	**All**	**1,930**	**9,646**	**9,639**	**9,612**	**9,570**	**9,486**	**9,344**	**9,127**	**8,854**	**8,457**	**8,005**	**7,472**	**6,953**	**6,496**	**6,014**	**5,474**	**5,008**
75 cm	**GOOSEFISH**	**WINTER**	**1,048**	**5,221**	**5,175**	**5,070**	**4,902**	**4,569**	**4,093**	**3,474**	**2,916**	**2,491**	**2,014**	**1,615**	**1,288**	**1,019**	**759**	**0**	**0**
L80 = 45 cm	**GOOSEFISH**	1963-1971	414	2,067	2,064	2,059	2,054	2,036	2,005	1,959	1,882	1,722	1,481	1,256	1,030	848	628	0	0
	GOOSEFISH	1972-1981	36	179	178	178	177	175	173	171	154	142	123	112	91	75	75	0	0
	GOOSEFISH	1992-2001	329	1,629	1,599	1,543	1,444	1,245	944	621	440	331	244	151	113	67	56	0	0
	GOOSEFISH	2002-2012	270	1,346	1,334	1,289	1,226	1,112	971	723	441	296	167	96	54	29	0	0	0
	GOOSEFISH	**SPRING**	**1,828**	**9,086**	**9,024**	**8,920**	**8,749**	**8,487**	**8,074**	**7,556**	**6,979**	**6,317**	**5,548**	**4,716**	**3,957**	**3,177**	**2,449**	**0**	**0**
	GOOSEFISH	1963-1971	113	563	562	560	557	551	536	511	488	463	389	329	266	159	129	0	0
	GOOSEFISH	1972-1981	1,017	5,073	5,050	5,017	4,957	4,863	4,692	4,449	4,187	3,907	3,540	3,083	2,638	2,132	1,615	0	0
	GOOSEFISH	1982-1991	308	1,537	1,528	1,517	1,500	1,471	1,429	1,364	1,272	1,156	1,011	861	759	694	589	0	0
	GOOSEFISH	1992-2001	171	833	815	780	732	669	585	506	445	345	286	224	137	96	63	0	0
	GOOSEFISH	2002-2012	218	1,080	1,068	1,045	1,003	932	831	726	588	446	322	218	157	95	53	0	0
	GOOSEFISH	**SUMMER**	**646**	**3,209**	**3,182**	**3,140**	**3,077**	**3,007**	**2,923**	**2,807**	**2,720**	**2,563**	**2,291**	**2,041**	**1,778**	**1,461**	**1,097**	**0**	**0**
	GOOSEFISH	1963-1971	218	1,090	1,090	1,086	1,081	1,069	1,051	1,017	984	921	799	688	576	449	281	0	0
	GOOSEFISH	1972-1981	334	1,669	1,667	1,664	1,662	1,644	1,631	1,595	1,565	1,492	1,368	1,272	1,121	940	765	0	0
	GOOSEFISH	1982-1991	9	44	39	33	27	23	16	9	9	5	5	0	0	0	0	0	0
	GOOSEFISH	1992-2001	84	406	386	357	307	271	225	185	162	144	119	81	81	72	51	0	0
	GOOSEFISH	**FALL**	**2,515**	**12,508**	**12,425**	**12,304**	**12,131**	**11,852**	**11,447**	**10,816**	**10,154**	**9,227**	**8,234**	**7,074**	**6,002**	**4,823**	**3,740**	**0**	**0**
	GOOSEFISH	1963-1971	514	2,568	2,563	2,561	2,550	2,535	2,502	2,444	2,330	2,152	1,927	1,606	1,297	1,056	828	0	0
	GOOSEFISH	1972-1981	1,204	6,011	6,001	5,978	5,947	5,882	5,800	5,612	5,407	5,073	4,626	4,133	3,590	2,964	2,375	0	0
	GOOSEFISH	1982-1991	322	1,599	1,587	1,572	1,547	1,517	1,447	1,335	1,227	1,076	940	804	702	541	427	0	0
	GOOSEFISH	1992-2001	242	1,178	1,137	1,083	1,017	925	833	716	626	513	430	322	260	171	82	0	0
	GOOSEFISH	2002-2012	234	1,152	1,136	1,111	1,070	994	866	709	564	412	310	209	154	91	28	0	0
	GOOSEFISH	**All**	**6,036**	**30,023**	**29,807**	**29,433**	**28,858**	**27,915**	**26,536**	**24,652**	**22,769**	**20,598**	**18,086**	**15,445**	**13,025**	**10,479**	**8,045**	**0**	**0**

Approximate 20% of biomass (upper), L80 for maturity (lower)	Species	Row Labels	Sum of 20 pct total wgt	WGT >= 25cm	Wgt >= 30cm	Wgt >= 35cm	Wgt >= 40 cm	Wgt >= 45cm	Wgt >= 50cm	Wgt >= 55 cm	Wgt >= 60cm	Wgt >= 65cm	Wgt >= 70cm	Wgt >= 75cm	Wgt >= 80cm	Wgt >= 85cm	Wgt >= 90cm	Wgt >= 95cm	Wgt >= 100cm
50 cm	LITTLE SKATE	**WINTER**	**4,589**	**22,768**	**22,311**	**21,183**	**19,260**	**13,916**	**2,149**	**124**	**34**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
L80 = 55 cm	LITTLE SKATE	1963-1971	457	2,285	2,281	2,257	2,170	1,624	277	32	6	0	0	0	0	0	0	0	0
	LITTLE SKATE	1972-1981	144	707	688	637	574	482	221	83	25	0	0	0	0	0	0	0	0
	LITTLE SKATE	1992-2001	2,721	13,488	13,186	12,366	11,071	7,779	1,152	8	3	0	0	0	0	0	0	0	0
	LITTLE SKATE	2002-2012	1,266	6,288	6,156	5,923	5,444	4,031	498	1	0	0	0	0	0	0	0	0	0
	LITTLE SKATE	**SPRING**	**4,842**	**23,884**	**23,220**	**22,036**	**20,462**	**16,028**	**3,493**	**178**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	LITTLE SKATE	1963-1971	297	1,476	1,459	1,424	1,360	1,104	239	18	0	0	0	0	0	0	0	0	0
	LITTLE SKATE	1972-1981	1,399	6,915	6,758	6,428	5,958	4,685	1,034	74	3	0	0	0	0	0	0	0	0
	LITTLE SKATE	1982-1991	1,088	5,359	5,205	4,978	4,665	3,583	795	36	4	0	0	0	0	0	0	0	0
	LITTLE SKATE	1992-2001	872	4,277	4,112	3,858	3,554	2,752	604	22	0	0	0	0	0	0	0	0	0
	LITTLE SKATE	2002-2012	1,187	5,857	5,686	5,349	4,925	3,905	820	28	0	0	0	0	0	0	0	0	0
	LITTLE SKATE	**SUMMER**	**506**	**2,519**	**2,505**	**2,478**	**2,405**	**2,005**	**487**	**53**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	LITTLE SKATE	1963-1971	191	951	949	942	918	720	132	30	5	0	0	0	0	0	0	0	0
	LITTLE SKATE	1972-1981	271	1,348	1,338	1,320	1,279	1,101	231	4	0	0	0	0	0	0	0	0	0
	LITTLE SKATE	1982-1991	0	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0
	LITTLE SKATE	1992-2001	44	218	217	214	206	182	123	19	0	0	0	0	0	0	0	0	0
	LITTLE SKATE	**FALL**	**4,375**	**21,686**	**21,347**	**20,638**	**19,327**	**15,447**	**3,816**	**213**	**27**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	LITTLE SKATE	1963-1971	342	1,708	1,696	1,666	1,603	1,298	285	41	3	0	0	0	0	0	0	0	0
	LITTLE SKATE	1972-1981	1,383	6,853	6,764	6,598	6,256	5,192	1,308	80	16	0	0	0	0	0	0	0	0
	LITTLE SKATE	1982-1991	859	4,242	4,137	3,927	3,547	2,701	727	27	0	0	0	0	0	0	0	0	0
	LITTLE SKATE	1992-2001	940	4,668	4,604	4,477	4,255	3,403	829	39	7	0	0	0	0	0	0	0	0
	LITTLE SKATE	2002-2012	851	4,215	4,145	3,970	3,666	2,853	666	27	0	0	0	0	0	0	0	0	0
	LITTLE SKATE	**All**	**14,312**	**70,856**	**69,383**	**66,335**	**61,454**	**47,397**	**9,944**	**568**	**73**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
60 cm	OCEAN POUT	**WINTER**	**1,476**	**7,370**	**7,359**	**7,310**	**7,176**	**6,915**	**6,414**	**5,599**	**4,314**	**2,888**	**1,919**	**1,135**	**584**	**213**	**81**	**0**	**0**
NA	OCEAN POUT	1963-1971	540	2,700	2,699	2,696	2,689	2,672	2,615	2,459	2,124	1,622	1,219	813	454	177	63	0	0
	OCEAN POUT	1972-1981	41	203	203	202	200	199	191	168	154	125	83	46	24	8	4	0	0
	OCEAN POUT	1992-2001	848	4,235	4,225	4,181	4,056	3,823	3,416	2,805	1,909	1,076	575	257	99	29	14	0	0
	OCEAN POUT	2002-2012	46	232	232	232	231	221	192	166	126	65	41	20	6	0	0	0	0
	OCEAN POUT	**SPRING**	**2,483**	**12,390**	**12,343**	**12,201**	**11,861**	**11,029**	**9,865**	**8,242**	**6,549**	**4,631**	**3,047**	**1,720**	**904**	**381**	**137**	**0**	**0**
	OCEAN POUT	1963-1971	146	728	728	725	718	684	607	549	467	370	283	159	94	41	24	0	0
	OCEAN POUT	1972-1981	710	3,541	3,527	3,484	3,363	2,974	2,517	2,010	1,575	1,128	743	455	281	125	43	0	0
	OCEAN POUT	1982-1991	1,111	5,546	5,529	5,473	5,343	5,078	4,685	3,986	3,196	2,271	1,468	829	410	175	67	0	0
	OCEAN POUT	1992-2001	353	1,764	1,759	1,742	1,706	1,621	1,471	1,209	914	598	392	201	89	33	3	0	0
	OCEAN POUT	2002-2012	163	810	801	776	732	671	585	489	397	264	162	76	31	6	0	0	0
	OCEAN POUT	**SUMMER**	**277**	**1,384**	**1,375**	**1,345**	**1,277**	**1,170**	**1,042**	**918**	**787**	**629**	**453**	**273**	**146**	**55**	**26**	**0**	**0**
	OCEAN POUT	1963-1971	95	473	472	471	466	459	452	439	407	340	236	128	62	28	12	0	0
	OCEAN POUT	1972-1981	127	631	625	608	578	531	456	396	329	269	203	143	84	28	13	0	0
	OCEAN POUT	1982-1991	15	73	72	70	62	46	32	22	13	10	8	2	0	0	0	0	0
	OCEAN POUT	1992-2001	42	207	205	197	171	134	101	62	38	10	6	0	0	0	0	0	0
	OCEAN POUT	**FALL**	**446**	**2,216**	**2,188**	**2,088**	**1,908**	**1,663**	**1,358**	**1,027**	**729**	**481**	**293**	**183**	**114**	**59**	**28**	**0**	**0**
	OCEAN POUT	1963-1971	54	271	269	264	251	231	205	166	137	104	60	38	25	11	11	0	0
	OCEAN POUT	1972-1981	151	752	744	725	686	620	526	404	291	185	137	97	63	40	13	0	0
	OCEAN POUT	1982-1991	85	422	416	395	364	315	243	182	119	77	49	23	13	4	4	0	0
	OCEAN POUT	1992-2001	111	552	546	523	465	395	312	233	158	102	45	25	13	4	0	0	0
	OCEAN POUT	2002-2012	45	219	212	182	142	102	72	42	25	14	1	0	0	0	0	0	0
	OCEAN POUT	**All**	**4,682**	**23,360**	**23,265**	**22,943**	**22,221**	**20,777**	**18,679**	**15,786**	**12,378**	**8,629**	**5,712**	**3,311**	**1,748**	**707**	**273**	**0**	**0**
75 cm	POLLOCK	**WINTER**	**621**	**3,094**	**3,071**	**3,039**	**2,934**	**2,838**	**2,712**	**2,576**	**2,384**	**2,143**	**1,800**	**1,466**	**1,051**	**607**	**311**	**139**	**0**
L80 = 50 cm	POLLOCK	1963-1971	505	2,518	2,495	2,463	2,359	2,266	2,142	2,013	1,845	1,630	1,351	1,094	761	416	195	89	0
	POLLOCK	1972-1981	106	529	529	528	528	525	523	517	498	473	413	340	273	174	105	40	0
	POLLOCK	1992-2001	10	48	48	48	47	47	47	45	41	39	36	32	17	17	10	10	0
	POLLOCK	2002-2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	POLLOCK	**SPRING**	**5,183**	**25,770**	**25,582**	**25,096**	**24,484**	**23,329**	**22,026**	**20,190**	**17,838**	**15,673**	**13,483**	**11,170**	**8,798**	**6,597**	**4,321**	**2,219**	**0**
	POLLOCK	1963-1971	459	2,286	2,280	2,270	2,257	2,233	2,194	2,158	2,077	1,996	1,964	1,859	1,608	1,166	632	244	0
	POLLOCK	1972-1981	1,753	8,743	8,651	8,337	8,009	7,547	7,201	6,720	6,088	5,590	5,054	4,547	3,889	3,065	1,997	1,040	0
	POLLOCK	1982-1991	1,630	8,125	8,093	8,038	7,951	7,600	6,981	6,114	5,196	4,457	3,650	2,950	2,385	1,964	1,481	851	0
	POLLOCK	1992-2001	513	2,533	2,500	2,448	2,305	2,036	1,818	1,589	1,351	1,079	864	643	377	170	100	44	0
	POLLOCK	2002-2012	828	4,084	4,058	4,003	3,961	3,914	3,833	3,609	3,126	2,551	1,951	1,171	540	232	110	40	0
	POLLOCK	**SUMMER**	**812**	**3,975**	**3,913**	**3,881**	**3,805**	**3,705**	**3,616**	**3,459**	**3,285**	**3,089**	**2,738**	**2,273**	**1,797**	**1,298**	**820**	**458**	**0**
	POLLOCK	1963-1971	349	1,747	1,746	1,735	1,694	1,614	1,538	1,427	1,343	1,244	1,093	847	575	304	132	48	0
	POLLOCK	1972-1981	429	2,076	2,025	2,012	1,982	1,964	1,950	1,909	1,827	1,745	1,578	1,395	1,204	976	677	399	0
	POLLOCK	1982-1991	1	5	4	4	3	2	2	2	0	0	0	0	0	0	0	0	0
	POLLOCK	1992-2001	33	147	138	131	126	125	125	121	115	100	67	32	19	19	11	11	0
	POLLOCK	**FALL**	**4,206**	**20,989**	**20,736**	**20,392**	**19,826**	**18,807**	**17,416**	**15,918**	**14,777**	**13,520**	**11,736**	**9,743**	**7,499**	**5,375**	**3,642**	**2,017**	**0**
	POLLOCK	1963-1971	681	3,404	3,400	3,378	3,319	3,158	2,965	2,864	2,780	2,646	2,318	1,837	1,256	794	504	285	0
	POLLOCK	1972-1981	1,975	9,874	9,845	9,803	9,614	9,158	8,848	8,506	8,104	7,553	6,771	5,849	4,797	3,631	2,526	1,376	0
	POLLOCK	1982-1991	489	2,434	2,393	2,342	2,260	2,169	1,975	1,706	1,528	1,414	1,274	1,105	884	673	446	266	0
	POLLOCK	1992-2001	321	1,582	1,501	1,373	1,246	1,120	924	749	578	462	323	199	143	88	54	31	0
	POLLOCK	2002-2012	741	3,694	3,597	3,497	3,387	3,202	2,703	2,092	1,786	1,446	1,050	754	419	188	112	59	0
	POLLOCK	**All**	**10,822**	**53,828**	**53,302**	**52,408**	**51,049**	**48,678**	**45,770**	**42,143**	**38,284**	**34,426**	**29,757**	**24,652**	**19,145**	**13,877**	**9,095**	**4,834**	**0**

Approximate 20% of biomass (upper), L80 for maturity (lower)	Species	Row Labels	Sum of 20 pct total wgt	WGT >= 25cm	Wgt >= 30cm	Wgt >= 35cm	Wgt >= 40 cm	Wgt >= 45cm	Wgt >= 50cm	Wgt >= 55 cm	Wgt >= 60cm	Wgt >= 65cm	Wgt >= 70cm	Wgt >= 75cm	Wgt >= 80cm	Wgt >= 85cm	Wgt >= 90cm	Wgt >= 95cm	Wgt >= 100cm
35 cm	RED HAKE	**WINTER**	**818**	**3,968**	**2,731**	**1,249**	**497**	**199**	**83**	**30**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
L80 = 35 cm	RED HAKE	1963-1971	317	1,570	1,470	892	395	178	77	29	0	0	0	0	0	0	0	0	0
	RED HAKE	1972-1981	2	11	11	7	4	2	2	2	0	0	0	0	0	0	0	0	0
	RED HAKE	1992-2001	419	2,046	1,185	336	96	19	4	0	0	0	0	0	0	0	0	0	0
	RED HAKE	2002-2012	80	341	67	15	2	0	0	0	0	0	0	0	0	0	0	0	0
	RED HAKE	**SPRING**	**2,156**	**10,414**	**8,692**	**5,260**	**2,749**	**1,180**	**438**	**128**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	RED HAKE	1963-1971	80	393	367	257	139	69	32	10	0	0	0	0	0	0	0	0	0
	RED HAKE	1972-1981	718	3,501	3,185	2,149	1,224	562	237	78	0	0	0	0	0	0	0	0	0
	RED HAKE	1982-1991	427	2,066	1,871	1,298	737	337	117	33	0	0	0	0	0	0	0	0	0
	RED HAKE	1992-2001	427	2,064	1,662	912	435	156	40	4	0	0	0	0	0	0	0	0	0
	RED HAKE	2002-2012	504	2,390	1,607	644	214	56	13	3	0	0	0	0	0	0	0	0	0
	RED HAKE	**SUMMER**	**825**	**4,045**	**3,797**	**2,714**	**1,508**	**667**	**249**	**88**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	RED HAKE	1963-1971	191	928	858	562	282	135	56	21	0	0	0	0	0	0	0	0	0
	RED HAKE	1972-1981	383	1,887	1,817	1,357	790	355	143	54	0	0	0	0	0	0	0	0	0
	RED HAKE	1982-1991	30	147	143	109	59	33	9	1	0	0	0	0	0	0	0	0	0
	RED HAKE	1992-2001	221	1,083	980	686	376	144	41	12	0	0	0	0	0	0	0	0	0
	RED HAKE	**FALL**	**3,613**	**17,177**	**14,333**	**9,416**	**4,954**	**2,143**	**744**	**223**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	RED HAKE	1963-1971	257	1,246	1,113	786	403	200	75	15	0	0	0	0	0	0	0	0	0
	RED HAKE	1972-1981	1,087	5,270	4,767	3,458	1,895	844	322	107	0	0	0	0	0	0	0	0	0
	RED HAKE	1982-1991	762	3,681	3,152	2,259	1,314	633	225	68	0	0	0	0	0	0	0	0	0
	RED HAKE	1992-2001	838	3,878	3,129	1,919	979	376	99	24	0	0	0	0	0	0	0	0	0
	RED HAKE	2002-2012	670	3,102	2,172	994	363	90	22	10	0	0	0	0	0	0	0	0	0
	RED HAKE	**All**	**7,413**	**35,603**	**29,554**	**18,639**	**9,708**	**4,190**	**1,514**	**469**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
30 cm	ACADIAN REDFISH	**WINTER**	**745**	**3,127**	**1,895**	**705**	**35**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
L80 = 25 cm	ACADIAN REDFISH	1963-1971	745	3,127	1,895	705	35	3	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	1972-1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	1992-2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	2002-2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	**SPRING**	**9,999**	**40,176**	**23,508**	**8,686**	**1,887**	**307**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	ACADIAN REDFISH	1963-1971	1,010	4,384	3,038	1,333	190	13	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	1972-1981	2,415	11,202	8,598	4,513	1,259	269	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	1982-1991	646	3,049	2,471	1,219	292	20	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	1992-2001	2,212	6,703	3,099	687	94	2	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	2002-2012	3,716	14,838	6,303	934	52	4	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	**SUMMER**	**2,449**	**10,299**	**6,804**	**2,913**	**463**	**28**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	ACADIAN REDFISH	1963-1971	1,859	8,020	5,280	2,060	274	23	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	1972-1981	401	1,787	1,298	779	170	5	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	1982-1991	12	29	13	5	0	0	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	1992-2001	178	464	212	69	18	0	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	**FALL**	**14,447**	**57,004**	**33,362**	**12,479**	**2,454**	**95**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	ACADIAN REDFISH	1963-1971	2,272	9,463	6,746	2,739	349	19	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	1972-1981	2,895	13,232	10,478	5,990	1,477	46	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	1982-1991	865	3,812	2,990	1,545	382	12	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	1992-2001	2,188	6,929	2,720	727	167	8	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	2002-2012	6,227	23,569	10,428	1,478	80	10	0	0	0	0	0	0	0	0	0	0	0
	ACADIAN REDFISH	**All**	**27,641**	**110,606**	**65,569**	**24,782**	**4,839**	**433**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	ROSETTE SKATE	**WINTER**	**6**	**31**	**30**	**29**	**24**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
L80 = 55 cm	ROSETTE SKATE	1963-1971	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	1972-1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	1992-2001	2	12	12	12	11	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	2002-2012	4	18	18	17	13	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	**SPRING**	**1**	**3**	**3**	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	ROSETTE SKATE	1963-1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	1972-1981	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	1982-1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	1992-2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	2002-2012	0	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	**SUMMER**	**0**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	ROSETTE SKATE	1963-1971	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	1972-1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	1982-1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	1992-2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	**FALL**	**4**	**19**	**18**	**17**	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	ROSETTE SKATE	1963-1971	0	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	1972-1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	1982-1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	1992-2001	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	2002-2012	3	16	15	14	7	0	0	0	0	0	0	0	0	0	0	0	0
	ROSETTE SKATE	**All**	**11**	**54**	**53**	**50**	**37**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Approximate 20% of biomass (upper), L80 for maturity (lower)	Species	Row Labels	Sum of 20 pct total wgt	WGT >= 25cm	Wgt >= 30cm	Wgt >= 35cm	Wgt >= 40 cm	Wgt >= 45cm	Wgt >= 50cm	Wgt >= 55 cm	Wgt >= 60cm	Wgt >= 65cm	Wgt >= 70cm	Wgt >= 75cm	Wgt >= 80cm	Wgt >= 85cm	Wgt >= 90cm	Wgt >= 95cm	Wgt >= 100cm
30 cm	SILVER HAKE	WINTER	530	1,815	675	312	134	78	44	13	0	0	0	0	0	0	0	0	0
L80 = 30 cm	SILVER HAKE	1963-1971	208	775	443	241	108	64	40	11	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1972-1981	4	19	15	9	7	6	3	2	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1992-2001	280	919	185	51	17	6	1	0	0	0	0	0	0	0	0	0	0
	SILVER HAKE	2002-2012	39	102	33	11	3	2	0	0	0	0	0	0	0	0	0	0	0
	SILVER HAKE	SPRING	3,994	12,959	6,550	2,564	1,024	508	284	152	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1963-1971	70	298	189	102	49	26	8	2	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1972-1981	1,714	6,911	4,682	1,876	727	381	219	115	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1982-1991	484	1,678	789	289	118	52	30	18	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1992-2001	1,045	2,517	486	183	90	33	20	13	0	0	0	0	0	0	0	0	0
	SILVER HAKE	2002-2012	681	1,555	404	114	40	16	6	4	0	0	0	0	0	0	0	0	0
	SILVER HAKE	SUMMER	1,639	5,840	3,990	1,837	853	467	277	125	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1963-1971	571	2,651	1,873	821	354	184	114	50	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1972-1981	438	1,927	1,579	807	414	242	135	64	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1982-1991	94	206	108	42	9	7	4	0	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1992-2001	535	1,056	430	167	75	34	24	11	0	0	0	0	0	0	0	0	0
	SILVER HAKE	FALL	6,532	23,582	13,035	5,751	2,586	1,322	727	364	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1963-1971	569	2,436	1,754	911	528	339	198	94	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1972-1981	1,417	6,111	4,801	2,432	1,091	630	401	222	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1982-1991	1,525	6,284	3,577	1,470	577	189	55	26	0	0	0	0	0	0	0	0	0
	SILVER HAKE	1992-2001	1,530	4,656	1,738	554	243	112	46	14	0	0	0	0	0	0	0	0	0
	SILVER HAKE	2002-2012	1,491	4,093	1,167	384	148	53	27	8	0	0	0	0	0	0	0	0	0
	SILVER HAKE	All	12,695	44,196	24,250	10,463	4,597	2,376	1,332	654	0	0	0	0	0	0	0	0	0
55 cm	SMOOTH SKATE	WINTER	33	165	162	154	142	128	109	67	18	0	0	0	0	0	0	0	0
L80 = 65 cm	SMOOTH SKATE	1963-1971	16	78	76	72	66	60	52	29	7	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1972-1981	10	52	50	47	43	39	34	24	5	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1992-2001	7	35	35	34	33	29	23	14	5	0	0	0	0	0	0	0	0
	SMOOTH SKATE	2002-2012	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
	SMOOTH SKATE	SPRING	226	1,115	1,095	1,057	995	900	712	382	109	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1963-1971	23	116	115	113	108	103	91	54	18	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1972-1981	77	382	376	365	344	309	250	141	46	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1982-1991	35	172	169	165	159	149	127	74	27	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1992-2001	25	124	122	116	112	102	75	36	4	0	0	0	0	0	0	0	0
	SMOOTH SKATE	2002-2012	66	322	313	298	272	236	168	76	15	0	0	0	0	0	0	0	0
	SMOOTH SKATE	SUMMER	26	129	127	124	118	107	90	55	17	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1963-1971	12	58	58	57	56	51	42	26	10	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1972-1981	5	27	27	26	25	21	18	10	3	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1982-1991	2	12	11	11	9	9	8	4	0	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1992-2001	7	32	31	30	28	26	22	15	3	0	0	0	0	0	0	0	0
	SMOOTH SKATE	FALL	247	1,219	1,199	1,166	1,118	1,041	892	511	152	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1963-1971	39	191	188	182	173	162	141	82	22	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1972-1981	58	291	289	285	278	261	223	124	43	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1982-1991	39	195	192	189	182	173	154	97	34	0	0	0	0	0	0	0	0
	SMOOTH SKATE	1992-2001	55	272	266	257	246	223	187	104	28	0	0	0	0	0	0	0	0
	SMOOTH SKATE	2002-2012	56	271	264	253	240	222	188	105	25	0	0	0	0	0	0	0	0
	SMOOTH SKATE	All	532	2,628	2,583	2,502	2,373	2,176	1,804	1,015	296	0	0	0	0	0	0	0	0
85 cm	THORNY SKATE	WINTER	592	2,945	2,927	2,893	2,852	2,795	2,723	2,614	2,482	2,320	2,130	1,920	1,640	1,205	854	468	189
L80 = 95 cm	THORNY SKATE	1963-1971	486	2,422	2,410	2,389	2,368	2,334	2,291	2,218	2,123	2,005	1,864	1,685	1,467	1,130	829	450	189
	THORNY SKATE	1972-1981	83	413	409	404	395	382	362	339	313	280	243	215	158	69	25	18	0
	THORNY SKATE	1992-2001	22	109	107	98	87	76	69	56	46	35	23	20	16	6	0	0	0
	THORNY SKATE	2002-2012	0	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0
	THORNY SKATE	SPRING	2,268	11,258	11,162	11,035	10,829	10,557	10,115	9,495	8,737	7,931	7,090	6,159	5,186	4,047	2,771	1,691	869
	THORNY SKATE	1963-1971	474	2,354	2,338	2,324	2,295	2,250	2,166	2,094	1,979	1,871	1,710	1,556	1,371	1,094	779	494	290
	THORNY SKATE	1972-1981	1,059	5,262	5,223	5,162	5,068	4,944	4,757	4,448	4,088	3,683	3,288	2,801	2,353	1,914	1,280	833	450
	THORNY SKATE	1982-1991	495	2,459	2,435	2,406	2,355	2,297	2,207	2,057	1,881	1,660	1,460	1,256	1,013	721	508	279	96
	THORNY SKATE	1992-2001	134	663	654	643	625	599	556	510	446	397	353	309	254	168	103	41	22
	THORNY SKATE	2002-2012	105	520	512	501	486	468	429	385	344	320	279	237	195	149	102	43	10
	THORNY SKATE	SUMMER	952	4,741	4,719	4,687	4,642	4,576	4,483	4,330	4,095	3,821	3,498	3,089	2,636	2,053	1,528	847	321
	THORNY SKATE	1963-1971	527	2,627	2,617	2,607	2,587	2,554	2,504	2,437	2,329	2,199	2,050	1,862	1,627	1,324	1,086	660	275
	THORNY SKATE	1972-1981	315	1,570	1,566	1,553	1,539	1,515	1,493	1,440	1,354	1,255	1,119	934	772	562	339	152	45
	THORNY SKATE	1982-1991	35	174	171	169	168	165	160	157	150	146	134	116	91	64	31	9	0
	THORNY SKATE	1992-2001	75	369	364	359	349	342	325	296	262	221	195	177	147	104	72	26	0
	THORNY SKATE	FALL	3,659	18,194	18,090	17,923	17,687	17,342	16,831	16,030	14,937	13,700	12,420	10,676	9,031	6,884	4,928	2,952	1,212
	THORNY SKATE	1963-1971	1,141	5,679	5,651	5,609	5,559	5,484	5,392	5,245	5,032	4,760	4,461	4,037	3,575	2,969	2,339	1,565	691
	THORNY SKATE	1972-1981	1,627	8,103	8,067	8,005	7,913	7,769	7,553	7,162	6,642	6,008	5,388	4,509	3,696	2,675	1,790	947	347
	THORNY SKATE	1982-1991	489	2,427	2,408	2,379	2,329	2,268	2,172	2,049	1,866	1,695	1,482	1,244	1,023	745	535	326	160
	THORNY SKATE	1992-2001	284	1,408	1,396	1,377	1,351	1,303	1,230	1,139	1,014	897	786	618	513	349	184	96	10
	THORNY SKATE	2002-2012	118	576	567	554	536	517	484	434	383	339	303	269	224	146	80	19	3
	THORNY SKATE	All	7,471	37,138	36,898	36,538	36,010	35,271	34,152	32,469	30,252	27,771	25,138	21,845	18,493	14,188	10,081	5,958	2,590

Approximate 20% of biomass (upper), L80 for maturity (lower)	Species	Row Labels	Sum of 20 pct total wgt	WGT >= 25cm	Wgt >= 30cm	Wgt >= 35cm	Wgt >= 40 cm	Wgt >= 45cm	Wgt >= 50cm	Wgt >= 55 cm	Wgt >= 60cm	Wgt >= 65cm	Wgt >= 70cm	Wgt >= 75cm	Wgt >= 80cm	Wgt >= 85cm	Wgt >= 90cm	Wgt >= 95cm	Wgt >= 100cm
75 cm	WHITE HAKE	**WINTER**	**302**	**1,502**	**1,483**	**1,427**	**1,349**	**1,248**	**1,134**	**1,051**	**955**	**813**	**639**	**515**	**445**	**397**	**352**	**313**	**295**
L80 = 45 cm	WHITE HAKE	1963-1971	258	1,286	1,270	1,247	1,194	1,107	1,024	952	878	755	609	491	421	378	339	300	282
	WHITE HAKE	1972-1981	18	90	90	79	71	69	54	49	40	31	16	13	13	13	13	13	13
	WHITE HAKE	1992-2001	19	93	90	74	61	53	43	38	28	21	14	11	11	6	0	0	0
	WHITE HAKE	2002-2012	7	33	33	27	23	20	14	11	8	5	0	0	0	0	0	0	0
	WHITE HAKE	**SPRING**	**3,694**	**18,429**	**18,187**	**17,524**	**16,803**	**15,598**	**14,114**	**12,786**	**11,344**	**9,412**	**7,425**	**5,441**	**3,983**	**2,905**	**2,405**	**1,950**	**1,581**
	WHITE HAKE	1963-1971	170	849	839	816	769	690	614	561	506	432	364	321	273	240	212	171	138
	WHITE HAKE	1972-1981	1,691	8,445	8,358	8,125	7,843	7,410	6,813	6,296	5,769	5,008	4,198	3,157	2,331	1,610	1,320	1,118	961
	WHITE HAKE	1982-1991	795	3,967	3,900	3,712	3,538	3,270	2,966	2,698	2,346	1,919	1,413	981	695	572	494	422	356
	WHITE HAKE	1992-2001	450	2,246	2,211	2,115	2,014	1,802	1,523	1,289	1,088	786	523	339	210	148	121	84	44
	WHITE HAKE	2002-2012	587	2,923	2,879	2,756	2,639	2,425	2,198	1,942	1,636	1,267	927	643	475	334	259	155	82
	WHITE HAKE	**SUMMER**	**1,171**	**5,840**	**5,741**	**5,426**	**4,997**	**4,494**	**3,956**	**3,489**	**3,087**	**2,507**	**1,885**	**1,381**	**1,013**	**719**	**587**	**504**	**437**
	WHITE HAKE	1963-1971	355	1,776	1,770	1,745	1,700	1,614	1,515	1,417	1,300	1,088	822	566	426	333	272	236	204
	WHITE HAKE	1972-1981	414	2,070	2,062	1,998	1,861	1,722	1,561	1,416	1,290	1,089	884	715	537	369	316	268	233
	WHITE HAKE	1982-1991	135	672	652	562	436	343	247	174	124	73	32	20	9	0	0	0	0
	WHITE HAKE	1992-2001	266	1,322	1,257	1,121	1,000	815	633	482	374	258	147	80	40	16	0	0	0
	WHITE HAKE	**FALL**	**5,519**	**27,377**	**26,873**	**26,313**	**24,673**	**22,062**	**19,488**	**17,049**	**14,531**	**11,918**	**9,129**	**6,826**	**5,143**	**3,764**	**2,940**	**2,370**	**1,933**
	WHITE HAKE	1963-1971	779	3,885	3,826	3,725	3,542	3,217	2,909	2,616	2,284	1,899	1,509	1,136	897	716	651	528	490
	WHITE HAKE	1972-1981	2,231	11,109	10,951	10,783	10,258	9,366	8,471	7,547	6,702	5,769	4,647	3,640	2,803	2,033	1,654	1,371	1,151
	WHITE HAKE	1982-1991	1,080	5,307	5,164	5,020	4,548	3,881	3,308	2,822	2,313	1,840	1,354	960	628	402	243	182	142
	WHITE HAKE	1992-2001	801	3,968	3,891	3,798	3,537	3,120	2,646	2,188	1,705	1,237	788	533	412	329	231	168	73
	WHITE HAKE	2002-2012	628	3,108	3,042	2,988	2,787	2,478	2,154	1,876	1,527	1,173	830	558	404	284	162	120	76
	WHITE HAKE	**All**	**10,687**	**53,149**	**52,284**	**50,691**	**47,823**	**43,402**	**38,693**	**34,375**	**29,917**	**24,650**	**19,078**	**14,164**	**10,583**	**7,784**	**6,285**	**5,138**	**4,247**
30 cm	WINDOWPANE	**WINTER**	**1,033**	**4,331**	**1,304**	**119**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
L80 = 25 cm	WINDOWPANE	1963-1971	28	134	77	13	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	1972-1981	15	66	44	13	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	1992-2001	869	3,573	978	79	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	2002-2012	121	557	205	14	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	**SPRING**	**834**	**3,681**	**1,863**	**426**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	WINDOWPANE	1963-1971	20	91	51	8	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	1972-1981	439	1,948	948	186	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	1982-1991	238	1,074	638	211	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	1992-2001	75	306	124	15	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	2002-2012	62	262	102	6	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	**SUMMER**	**101**	**484**	**327**	**76**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	WINDOWPANE	1963-1971	19	94	67	7	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	1972-1981	81	387	260	69	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	1982-1991	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	1992-2001	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	**FALL**	**1,097**	**4,636**	**2,200**	**420**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	WINDOWPANE	1963-1971	54	230	109	19	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	1972-1981	370	1,668	955	200	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	1982-1991	251	1,055	607	157	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	1992-2001	263	1,077	374	35	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	2002-2012	159	607	155	10	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINDOWPANE	**All**	**3,066**	**13,132**	**5,695**	**1,041**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
45 cm	WINTER FLOUNDER	**WINTER**	**271**	**1,340**	**1,287**	**1,140**	**910**	**620**	**316**	**126**	**15**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
L80 = 30 cm	WINTER FLOUNDER	1963-1971	157	782	767	718	600	415	192	78	12	3	0	0	0	0	0	0	0
	WINTER FLOUNDER	1972-1981	43	214	209	188	165	132	87	40	3	0	0	0	0	0	0	0	0
	WINTER FLOUNDER	1992-2001	57	278	250	183	115	55	27	9	0	0	0	0	0	0	0	0	0
	WINTER FLOUNDER	2002-2012	14	67	61	50	31	17	10	0	0	0	0	0	0	0	0	0	0
	WINTER FLOUNDER	**SPRING**	**2,113**	**9,986**	**8,765**	**6,791**	**4,642**	**2,690**	**1,090**	**344**	**94**	**11**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	WINTER FLOUNDER	1963-1971	149	739	722	686	551	382	202	52	14	0	0	0	0	0	0	0	0
	WINTER FLOUNDER	1972-1981	650	3,164	2,906	2,392	1,698	1,003	431	169	53	3	0	0	0	0	0	0	0
	WINTER FLOUNDER	1982-1991	551	2,606	2,312	1,788	1,193	626	220	65	21	7	0	0	0	0	0	0	0
	WINTER FLOUNDER	1992-2001	279	1,323	1,161	834	535	271	96	23	0	0	0	0	0	0	0	0	0
	WINTER FLOUNDER	2002-2012	484	2,154	1,663	1,092	665	408	141	34	5	0	0	0	0	0	0	0	0
	WINTER FLOUNDER	**SUMMER**	**799**	**3,690**	**3,069**	**2,101**	**1,314**	**693**	**349**	**154**	**38**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	WINTER FLOUNDER	1963-1971	159	794	776	709	564	305	140	62	18	3	0	0	0	0	0	0	0
	WINTER FLOUNDER	1972-1981	529	2,437	1,978	1,274	709	382	208	92	20	0	0	0	0	0	0	0	0
	WINTER FLOUNDER	1982-1991	6	25	16	8	2	0	0	0	0	0	0	0	0	0	0	0	0
	WINTER FLOUNDER	1992-2001	105	434	300	110	39	6	0	0	0	0	0	0	0	0	0	0	0
	WINTER FLOUNDER	**FALL**	**3,111**	**14,859**	**12,977**	**9,244**	**5,730**	**3,254**	**1,584**	**584**	**153**	**35**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	WINTER FLOUNDER	1963-1971	234	1,165	1,136	1,064	895	611	348	169	66	23	0	0	0	0	0	0	0
	WINTER FLOUNDER	1972-1981	762	3,719	3,392	2,690	1,858	1,095	575	225	52	12	0	0	0	0	0	0	0
	WINTER FLOUNDER	1982-1991	396	1,857	1,579	1,097	664	332	128	34	14	0	0	0	0	0	0	0	0
	WINTER FLOUNDER	1992-2001	812	3,868	3,282	1,969	997	475	205	59	8	0	0	0	0	0	0	0	0
	WINTER FLOUNDER	2002-2012	906	4,250	3,587	2,424	1,315	741	328	97	13	0	0	0	0	0	0	0	0
	WINTER FLOUNDER	**All**	**6,294**	**29,876**	**26,098**	**19,277**	**12,596**	**7,257**	**3,339**	**1,208**	**301**	**53**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Approximate 20% of biomass (upper), L80 for maturity (lower)	Species	Row Labels	Sum of 20 pct total wgt	WGT >= 25cm	Wgt >= 30cm	Wgt >= 35cm	Wgt >= 40 cm	Wgt >= 45cm	Wgt >= 50cm	Wgt >= 55 cm	Wgt >= 60cm	Wgt >= 65cm	Wgt >= 70cm	Wgt >= 75cm	Wgt >= 80cm	Wgt >= 85cm	Wgt >= 90cm	Wgt >= 95cm	Wgt >= 100cm
85 cm	WINTER SKATE	**WINTER**	**4,668**	**23,318**	**23,259**	**22,960**	**22,031**	**20,363**	**18,249**	**16,314**	**14,709**	**13,096**	**11,643**	**9,629**	**7,502**	**5,206**	**3,107**	**1,294**	**0**
L80 = 95 cm	WINTER SKATE	1963-1971	383	1,913	1,913	1,910	1,891	1,815	1,599	1,377	1,251	1,145	1,070	925	752	543	313	153	0
	WINTER SKATE	1972-1981	262	1,312	1,311	1,307	1,296	1,273	1,243	1,179	1,122	1,007	903	704	418	244	112	44	0
	WINTER SKATE	1992-2001	2,655	13,268	13,234	12,982	12,226	10,878	9,282	7,891	6,776	5,746	4,860	3,816	2,991	2,132	1,446	827	0
	WINTER SKATE	2002-2012	1,368	6,824	6,802	6,760	6,618	6,397	6,126	5,867	5,560	5,198	4,811	4,185	3,341	2,286	1,236	270	0
	WINTER SKATE	**SPRING**	**9,956**	**49,756**	**49,672**	**49,296**	**48,195**	**46,627**	**44,769**	**42,691**	**40,306**	**37,361**	**34,054**	**29,903**	**24,996**	**18,536**	**12,538**	**7,691**	**0**
	WINTER SKATE	1963-1971	390	1,949	1,948	1,945	1,928	1,891	1,809	1,685	1,480	1,239	1,005	727	544	390	232	143	0
	WINTER SKATE	1972-1981	1,357	6,783	6,776	6,753	6,686	6,593	6,480	6,283	6,024	5,661	5,132	4,454	3,557	2,387	1,305	736	0
	WINTER SKATE	1982-1991	5,405	27,006	26,950	26,715	26,134	25,429	24,699	23,936	23,122	22,029	20,807	19,070	16,886	13,331	9,715	6,253	0
	WINTER SKATE	1992-2001	1,238	6,187	6,180	6,132	5,921	5,490	4,899	4,333	3,764	3,172	2,612	2,105	1,572	1,004	631	373	0
	WINTER SKATE	2002-2012	1,567	7,832	7,819	7,751	7,527	7,225	6,882	6,454	5,916	5,260	4,497	3,547	2,437	1,424	655	185	0
	WINTER SKATE	**SUMMER**	**1,968**	**9,839**	**9,836**	**9,821**	**9,780**	**9,693**	**9,524**	**9,339**	**9,120**	**8,869**	**8,522**	**7,951**	**6,903**	**5,141**	**3,275**	**1,814**	**0**
	WINTER SKATE	1963-1971	318	1,589	1,588	1,586	1,580	1,551	1,459	1,342	1,217	1,102	964	784	589	394	233	114	0
	WINTER SKATE	1972-1981	1,633	8,163	8,162	8,152	8,124	8,071	7,997	7,933	7,844	7,716	7,514	7,128	6,285	4,735	3,035	1,699	0
	WINTER SKATE	1982-1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	WINTER SKATE	1992-2001	17	86	86	83	75	71	68	64	60	51	44	39	29	12	6	0	0
	WINTER SKATE	**FALL**	**13,916**	**69,553**	**69,461**	**69,078**	**68,009**	**66,538**	**64,471**	**61,888**	**58,517**	**54,479**	**49,958**	**44,159**	**36,580**	**26,821**	**17,513**	**10,275**	**0**
	WINTER SKATE	1963-1971	431	2,151	2,146	2,126	2,096	2,020	1,852	1,678	1,453	1,234	1,028	810	589	412	347	233	0
	WINTER SKATE	1972-1981	2,861	14,300	14,276	14,209	14,065	13,848	13,580	13,290	12,953	12,471	11,813	10,649	8,916	6,472	4,068	2,342	0
	WINTER SKATE	1982-1991	4,979	24,882	24,842	24,731	24,468	24,113	23,667	23,194	22,527	21,721	20,782	19,427	17,664	14,260	9,876	6,158	0
	WINTER SKATE	1992-2001	2,415	12,069	12,059	12,010	11,823	11,453	10,773	9,770	8,573	7,222	5,984	4,843	3,587	2,396	1,543	910	0
	WINTER SKATE	2002-2012	3,231	16,151	16,138	16,002	15,557	15,105	14,600	13,956	13,010	11,831	10,352	8,429	5,823	3,280	1,678	632	0
	WINTER SKATE	**All**	**30,508**	**152,466**	**152,229**	**151,154**	**148,015**	**143,222**	**137,014**	**130,231**	**122,652**	**113,805**	**104,177**	**91,643**	**75,982**	**55,703**	**36,432**	**21,074**	**0**
45 cm	WITCH FLOUNDER	**WINTER**	**217**	**1,079**	**1,018**	**951**	**788**	**545**	**336**	**181**	**41**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
L80 = 40 cm	WITCH FLOUNDER	1963-1971	118	586	582	564	526	441	319	178	40	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	1972-1981	2	9	9	9	9	7	3	0	0	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	1992-2001	54	271	269	255	185	71	11	3	2	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	2002-2012	43	213	158	123	69	26	3	0	0	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	**SPRING**	**997**	**4,916**	**4,748**	**4,332**	**3,715**	**3,006**	**2,039**	**926**	**186**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	WITCH FLOUNDER	1963-1971	140	697	692	674	636	528	324	147	38	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	1972-1981	508	2,511	2,457	2,328	2,118	1,854	1,320	589	103	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	1982-1991	153	757	735	684	602	482	348	172	42	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	1992-2001	70	334	297	220	123	68	33	15	3	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	2002-2012	126	618	568	426	235	75	15	2	0	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	**SUMMER**	**278**	**1,356**	**1,314**	**1,224**	**1,092**	**925**	**690**	**366**	**94**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	WITCH FLOUNDER	1963-1971	129	642	635	616	554	456	324	182	44	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	1972-1981	107	530	522	505	472	423	334	169	42	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	1982-1991	11	48	43	31	20	15	10	4	2	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	1992-2001	31	135	114	72	46	30	22	11	6	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	**FALL**	**980**	**4,842**	**4,663**	**4,294**	**3,750**	**3,055**	**2,176**	**1,093**	**267**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	WITCH FLOUNDER	1963-1971	286	1,427	1,413	1,368	1,263	1,041	719	334	90	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	1972-1981	405	2,012	1,969	1,895	1,784	1,579	1,183	604	123	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	1982-1991	106	526	507	466	402	314	225	140	53	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	1992-2001	97	460	390	271	153	74	38	14	1	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	2002-2012	86	418	384	293	148	47	10	0	0	0	0	0	0	0	0	0	0
	WITCH FLOUNDER	**All**	**2,472**	**12,193**	**11,744**	**10,800**	**9,345**	**7,530**	**5,241**	**2,566**	**589**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
40 cm	YELLOWTAIL FLOUNDER	**WINTER**	**1,267**	**6,287**	**5,679**	**3,978**	**1,812**	**394**	**49**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
L80 = 30 cm	YELLOWTAIL FLOUNDER	1963-1971	213	1,028	958	767	406	116	18	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	1972-1981	61	303	283	234	112	38	10	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	1992-2001	918	4,582	4,117	2,767	1,230	230	20	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	2002-2012	75	374	321	210	65	11	0	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	**SPRING**	**3,196**	**15,625**	**14,140**	**8,588**	**3,313**	**766**	**133**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	YELLOWTAIL FLOUNDER	1963-1971	221	1,062	921	655	314	113	27	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	1972-1981	530	2,584	2,284	1,671	835	262	64	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	1982-1991	258	1,240	1,056	680	343	113	22	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	1992-2001	309	1,524	1,377	832	325	80	13	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	2002-2012	1,878	9,214	8,502	4,749	1,496	199	7	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	**SUMMER**	**520**	**2,529**	**2,253**	**1,549**	**673**	**166**	**31**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	YELLOWTAIL FLOUNDER	1963-1971	305	1,504	1,360	1,009	428	102	19	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	1972-1981	200	952	833	523	241	63	12	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	1982-1991	2	7	6	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	1992-2001	13	66	54	16	3	1	0	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	**FALL**	**3,581**	**17,198**	**15,714**	**9,999**	**4,108**	**918**	**126**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	YELLOWTAIL FLOUNDER	1963-1971	463	2,175	1,999	1,306	567	146	22	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	1972-1981	791	3,760	3,436	2,424	1,148	369	70	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	1982-1991	182	841	673	375	158	35	7	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	1992-2001	557	2,716	2,504	1,672	751	210	24	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	2002-2012	1,588	7,706	7,103	4,222	1,483	159	4	0	0	0	0	0	0	0	0	0	0
	YELLOWTAIL FLOUNDER	**All**	**8,564**	**41,640**	**37,786**	**24,113**	**9,905**	**2,244**	**339**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 9. Summary of cluster analysis procedures applied to survey catch of juveniles (number) and large spawners (weight).

Procedures run individually on age 0/1 juveniles[1] and large spawners[2]	Process	Sample size or effect	
Hurdle model approach adjustment	Adjust cumulative catch at size, multiplying by the proportion of	All tows included	
Log transform	Transform non-zero catches to a normalized distribution	Zero catches are ignored (reduced number of tows analyzed)	
Select tows for analysis	Select by survey, season, and decade	Reduces number of tows; analysis occurs in desired time period and season; surveys analyzed separately due to catchability differences. Remaining tows may be insufficient number to analyze spatial autocorrelation or hotspots.	
Spatial autocorrelation (Moran's I)	Determine range of highest spatial autocorrelation to set Zone of Indifference parameter for hotspot analysis	Analyzes untransformed tows, including zero catch tows. Procedure may not detect a significant positive spatial autocorrelation. If peak is weak or undetected by analysis, a reasonable alternative was applied for hot spot analysis.	
Hot spot analysis (Getis-Ord's G*) and selection	Identifies hotspots, filtered for significant ($p<0.05$) hotspots above the mean.	Procedure may not identify any significant hotspots at $p<0.05$ level.	
Grid hotspots	Number of significant hotspots for a species within a 100 km^2 SASI grid is summed.	All surveys in a season are included, since the hotspot data are standardized relative to each survey's mean.	
Weight layers by importance factor	Number of hotspots in a grid is multiplied by importance factor	Final grid for a season includes all surveys where significant hotspots	

[1] For aged species, upper size threshold that approximated 90th percentile of age 1 fish. Threshold set at the approximate L20 for maturity for unaged species.
[2] Lower size threshold set where fish at or larger than the threshold comprised 20% of estimated biomass in the spring (applied to spring and summer) and fall (applied to fall and winter) NMFS trawl surveys.

Procedures run individually on age 0/1 juveniles[1] and large spawners[2]	Process	Sample size or effect	
	and summed over species.	were identified by the analysis, weighted by the relative importance of the effect that spatial management will have on regulated groundfish.	

Table 10. Summary of peak spatial autocorrelation results and alternative trial peaks in parantheses. NA = analysis not attempted due to infrequent catch or data not yet available. NP = No significant peak autocorrelation detected. NSHS = No significant hotspots of above average catches detected or produced by the hotspot analysis. IC = insufficient catch to conduct either a spatial autocorrelation or hotspot analysis.

	Survey: NMFS spring		Survey: MADMF spring		Survey: ME/NH spring	
Species	Juvenile	Spawner	Juvenile	Spawner	Juvenile	Spawner
Cod	8510 (11510)	11510	10528 (15528)	10525 (17528)	4620 (10620)	30620
Haddock	8010 (10010)	8010 (20010)	16528	10528	4620 (6620)	13620 (NSHS)
Yellowtail flounder	11510	11510 (16510)	9528 (14528)	8528 (17528)	IC	IC
American plaice	14510	10510	8528 (17528)	11528	15620	17620
Atlantic wolffish	IC (2 + tows)	NP (20010)	NA	NA	NA	NA
Ocean pout	21510 (12 + tows)	10510	15528 (22528)	13528	5620	17620 NSHS
Pollock	13510	10510	NP (21 + tows)	IC	3620 (7620)	IC
Red Hake	11510 (14510)	NP (14510)	8528	8528	9620	5620
Redfish	9510	10510	IC	11528 (NSHS)	3620 (9620)	4620 (17620) NSHS
Silver hake	10510	32510	20639	10528	6620	11620
White hake	NP (20010)	8510 (21510)	NP (7528)	IC	8620	NP (10620)
Winter flounder	11510	8510 (15510)	7528	8528	3620 (14620)	NP 912620) NSHS
Witch flounder	13510	8510	NP (8528)	IC	7620	NP (3620) NSHS
Windowpane flounder	10510 (23510)	8510	8528 NSHS	8528	4320 NSHS	NP NSHS
Alewife	NA	NA	NA	NA	7620	3620 (20620)
Atlantic herring	NA	NA	NA	NA	4620 (7620)	5620 (23620)
Atlantic halibut	NA	NA	NA	NA	12620	NP NSHS
Goosefish	NA	NA	NA	NA	NA	NA
Barndoor skate	NA	NA	NA	NA	NA	NA

	Survey: IBS Cod spring		Survey: IBS Goosefish spring		Survey: NMFS dredge summer	
Species	Juvenile	Spawner	Juvenile	Spawner	Juvenile	Spawner
Cod	4534 (13534)	NP (28534)	IC	36226	10338 IC	IC
Haddock	11534	7534	NP (48226) NSHS	34226	7338 (16338)	9338 (13338)
Yellowtail flounder	IC	13534 NSHS	IC	34226	5338	5338
American plaice	6534 (9534)	8534	NA	NA	NA	NA
Atlantic wolffish	IC	IC	NA	NA	NA	NA
Ocean pout	IC	IC	NA	NA	NA	NA
Pollock	5334	5334 IC	NA	NA	NA	NA
Red Hake	IC	IC	NA	NA	NP (19338)	IC
Redfish	26534 (5534)	2634 (5534)	NA	NA	NA	NA
Silver hake	IC	IC	NA	NA	NA	NA
White hake	6534 (14534)	6534 (14534)	NA	NA	NA	NA
Winter flounder	5534	5534	NA	NA	16338	17338
Witch flounder	6534 NSHS	6534 NSHS	NA	NA	NA	NA
Windowpane flounder	IC	IC	NA	NA	NA	NA
Alewife	NA	NA	NA	NA	NA	NA
Atlantic herring	NA	NA	NA	NA	NA	NA
Atlantic halibut	NA	NA	NA	NA	NA	NA
Goosefish	NA	NA	35226	NP	NP (19764)	5338 (23338)
Barndoor skate	NA	NA	NA	NA	NP (15338)	11338 (15338)

	Survey: NMFS shrimp summer		Survey: NMFS fall		Survey: MADMF fall	
Species	Juvenile	Spawner	Juvenile	Spawner	Juvenile	Spawner
Cod	8528 (16528)	7528 (13528)	8624 (18624)	8624 (17624)	7365 (9365)	NP (5365) NSHS
Haddock	8528	20528 (26528)	13624	13624	6365 (strong SAC)	22365
Yellowtail flounder	NA	NA	9624	14264	NP (31365) NSHS	4365 (22365) NSHS
American plaice	12528 (18528)	9528 (15528)	9624	10624	4365	6365 (strong peak)
Atlantic wolffish	IC	IC	IC	NP	IC	IC
Ocean pout	IC	10528 NSHS	24624	9624 (23624)	22365 NSHS	18365 NSHS
Pollock	20528 NSHS	18528 (27528) NSHS	11624 (15624)	8624 (27624)	12365	IC
Red Hake	8528	14528	33624	8624 (33624)	8365	7365 (13365)
Redfish	8528	12528	17624	9624 (17624)	12365 IC	5365
Silver hake	8528 (28528)	9528 (15528)	14624	13624	10365	14365
White hake	12528 (18528)	10528	18624	9624 (18624)	4365	IC
Winter flounder	19528	NC	25624	8624	9365	10365 (22365)
Witch flounder	NP (18528)	8528 (13528)	8964 (22624)	8624 (11624)	17365 IC	10365 NSHS
Windowpane flounder	13528	IC	8964 (22624)	33624	5365 (9365) (strong 2nd peak)	6365 (10365) (strong 2nd peak)
Alewife	NA	NA	NA	NA	NA	NA
Atlantic herring	NP	NP	12624	16624	11365	5365 NSHS
Atlantic halibut	NA	NA	NA	NA	NA	NA
Goosefish	11528	28528 NSHS	13624	9624 (12624) NSHS	11365 (13365) NSHS	5365 NSHS
Barndoor skate	NA	NA	NA	NA	NA	NA

	Survey: ME/NH fall		Survey: IBS Cod fall		Survey: IBS YTF fall	
Species	Juvenile	Spawner	Juvenile	Spawner	Juvenile	Spawner
Cod	5988 (7988)	4988 (21998)	7313	9313	IC	IC
Haddock	29998	NP IC	7313	20913	IC	IC
Yellowtail flounder	8988 NSHS	NP IC	IC	5313	24642 NSHS	16642
American plaice	24988	3988	5313	NP (25313)	NA	NA
Atlantic wolffish	NA	NA	IC	IC	NA	NA
Ocean pout	4998	IC	NA	NA	NA	NA
Pollock	NP (18998)	IC	NP (11313) NSHS	12313	NA	NA
Red Hake	16998 (strong peak)	10998 (strong peak)	IC	IC	NA	NA
Redfish	5998 (17998)	NP 6998	12313	NP (8313)	NA	NA
Silver hake	13998	9988	IC	IC	NA	NA
White hake	17998	6998 IC	10313	IC	NA	NA
Winter flounder	17998	NP IC	5313 (17313)	7313	IC	IC
Witch flounder	4998 (14998)	8998 (17998) NSHS	NP	5313 (9313)	NA	NA
Windowpane flounder	8988	3988 IC	IC	7313	NA	NA
Alewife	16988	7988 (17988)	NA	NA	NA	NA
Atlantic herring	5998	3988	NA	NA	NA	NA
Atlantic halibut	12998 IC	3998 IC	NA	NA	NA	NA
Goosefish	11998 NSHS	IC	5313 (9313)	NP (23313)	NP IC	IC
Barndoor skate	NA	NA	NA	NA	NA	NA

	Survey: NMFS winter		Survey: IBS Cod winter		Survey: IBS GSF winter	
Species	Juvenile	Spawner	Juvenile	Spawner	Juvenile	Spawner
Cod	15806	27806	9728 (12728)	NP (7728)	NP (31083) NSHS	NP
Haddock	17806	NP (23806)	17728 (31728)	10728	NP	49083
Yellowtail flounder	21806	12806 (28806)	IC	NP (3728)	IC	NP
American plaice	IC	24806	8728	6728	59083 NSHS	35083 NSHS
Atlantic wolffish	NA	NA	IC	IC	NA	NA
Ocean pout	14806 (16806)	14806	IC	IC	NA	NA
Pollock	IC	IC	IC	NP (15728)	NA	NA
Red Hake	20806 (27806)	12806	NA	NA	NA	NA
Redfish	NA	NA	NA	NA	NA	NA
Silver hake	19806	12806 (31806)	NA	NA	NA	NA
White hake	NA	NA	11728	NP IC		
Winter flounder	12806 (16806)	21806	5728 (20728)	NP (24728) NSHS	35083	NP NSHS
Witch flounder	19806	12806 (14806)	7728 (12728)	8728	IC	36083 (40083)
Windowpane flounder	15806 (17806)	14806 (37806)	IC	6728	NA	NA
Alewife	NA	NA	NA	NA	NA	NA
Atlantic herring	NA	NA	NA	NA	NA	NA
Atlantic halibut	NA	NA	NA	NA	NA	NA
Goosefish	12806 (25806)	32806	6728 (21728)	NP	35083 (44083)	34083
Barndoor skate	NA	NA	NA	NA	40083 NSHS	NP NSHS

Table 11. Summary of significant hotspots of above average catches identified by survey and species for age 0/1 juvenile (upper) and for large spawners (lower), 2002-2012.

Survey	Years	Tows	Mean to ne	StdDev	90th pctle	95th pctle	Alewife	Am Plaice	Atlantic Herring	Atlantic halibut	Atlantic Wolffish	Barndoor skate	Cod	Goosefish	Haddock	Ocean pout	Pollock	Red hake	Redfish	Silver hake	White hake	Winter flounder	Witch flounder	Windowpane flounder	Yellowtail flounder	Total survey
NMFS spring	2002-2012	3,426	4,012.0	3,630.0	7,509.5	9,014.9		85	0				35		31	0	0	122	25	167	70	53	7	3	11	609
NMFS shrimp		677	3,088.9	2,328.5	6,527.5	8,258.9		114					1	48	4			23	161	87	112		56			606
NMFS scallop	2002-2011	4,634	1,538.7	1,454.9	3,337.7	4,269.8						81	18	250	61			0				14			7	431
NMFS fall	2002-2011	3,413	4,004.0	2,634.0	7,624.0	8,979.0		91	1				33	30	80	0	1	286	69	254	77	132	19	4	5	1082
NMFS winter	2002-2007	659	6,212.4	5,272.9	11,805.6	13,468.3		0					2	3	1	1		18		59		8	3	4	0	99
MADMF spring	2002-2012	936	832.9	655.3	1,798.9	2,184.9		44					80		8	0	3	19	0	41	4	150		0	17	366
MADMF fall	2002-2011	714	1,096.8	835.9	2,364.8	2,807.9		24	1				5	0	4	0	0	58	0	88	2	131		2		315
MENH spring		1,194	1,078.7	1,156.7	2,619.4	3,298.2	187	269	51	19			85		36	9	16	70	116	317	71	264	57	149	0	1716
MENH fall		812	1,271.7	1,436.0	2,987.9	3,859.1	192	233	92	11			29	0	15	4	4	186	329	275	209	187	46	134	0	1946
IBS cod spring		449	1,513.1	1,643.0	3,533.9	4,638.3		77					54		25				18		10	16	0			200
IBS cod fall		175	2,202.4	2,559.9	4,312.8	6,101.3		12					21	7	8		0		2		8	28	0			86
IBS cod winter		274	2,064.9	3,114.4	3,728.0	5,131.3							2	10	10						14	65	1			102
IBS goosefish spring		229	15,551.0	13,125.6	30,226.1	34,028.5								13	0											13
IBS goosefish winter		198	16,992.9	9,778.9	31,082.6	34,286.3							2		0											2
IBS YTF fall		709	3,382.5	14,471.1	5,642.0	7,373.3																			0	0
					Total species hotspots =		379	949	145	30	0	81	367	361	283	14	24	782	720	1288	577	1048	189	296	40	7573

Survey	Years	Tows	Mean to ne	StdDev	90th pctle	95th pctle	Alewife	Am Plaice	Atlantic Herring	Atlantic halibut	Atlantic Wolffish	Barndoor skate	Cod	Goosefish	Haddock	Ocean pout	Pollock	Red hake	Redfish	Silver hake	White hake	Winter flounder	Witch flounder	Windowpane flounder	Yellowtail flounder	Total survey
NMFS spring	2002-2012	3,426	4,012.0	3,630.0	7,509.5	9,014.9		43	67				22		145	14	6	92	19	174	7	5	4	35	30	663
NMFS shrimp		677	3,088.9	2,328.5	6,527.5	8,258.9		23	66				1	0	16	0	0	139	71		0	4				320
NMFS scallop	2002-2011	4,634	1,538.7	1,454.9	3,337.7	4,269.8						1	1		3							24			17	46
NMFS fall	2002-2011	3,413	4,004.0	2,634.0	7,624.0	8,979.0		14					16	0	91	1	13	259	51	141	13		4	51	39	693
NMFS winter	2002-2007	659	6,212.4	5,272.9	11,805.6	13,468.3							0	3	1	14		2		31			0	20	3	74
MADMF spring	2002-2012	936	832.9	655.3	1,798.9	2,184.9	127	3					0		1	30		9		24		5		29	29	257
MADMF fall	2002-2011	714	1,096.8	835.9	2,364.8	2,807.9		1	0				0	0	0	0		24		30			0	2		57
MENH spring		1,194	1,078.7	1,156.7	2,619.4	3,298.2		73	74	0	0		0		0			15	0	38		0	0		0	200
MENH fall		812	1,271.7	1,436.0	2,987.9	3,859.1	19	2	23	0			2					57	39	54	0		0	0		196
IBS cod spring		449	1,513.1	1,643.0	3,533.9	4,638.3		14					7		28		1		6			0	0	1	0	57
IBS cod fall		175	2,202.4	2,559.9	4,312.8	6,101.3		0					8	0	6		0		1				3	2	4	24
IBS cod winter		274	2,064.9	3,114.4	3,728.0	5,131.3		2					6	0	13		4						0	0	3	28
IBS goosefish spring		229	15,551.0	13,125.6	30,226.1	34,028.5							1	1	5											7
IBS goosefish winter		198	16,992.9	9,778.9	31,082.6	34,286.3		5				0	0	2	3								4	0	0	14
IBS YTF fall		709	3,382.5	14,471.1	5,642.0	7,373.3																			65	65
					Total species hotspots =		146	180	230	0	0	1	64	6	312	59	24	597	187	492	20	38	15	140	190	2701

Figure 8. Data processing flowchart for spatial autocorrelation and hotspot analyses for juvenile (upper) and large spawner (lower) life stages. The example analyzes witch flounder juvenile and large spawner distribution in the 2009 IBS winter goosefish survey.

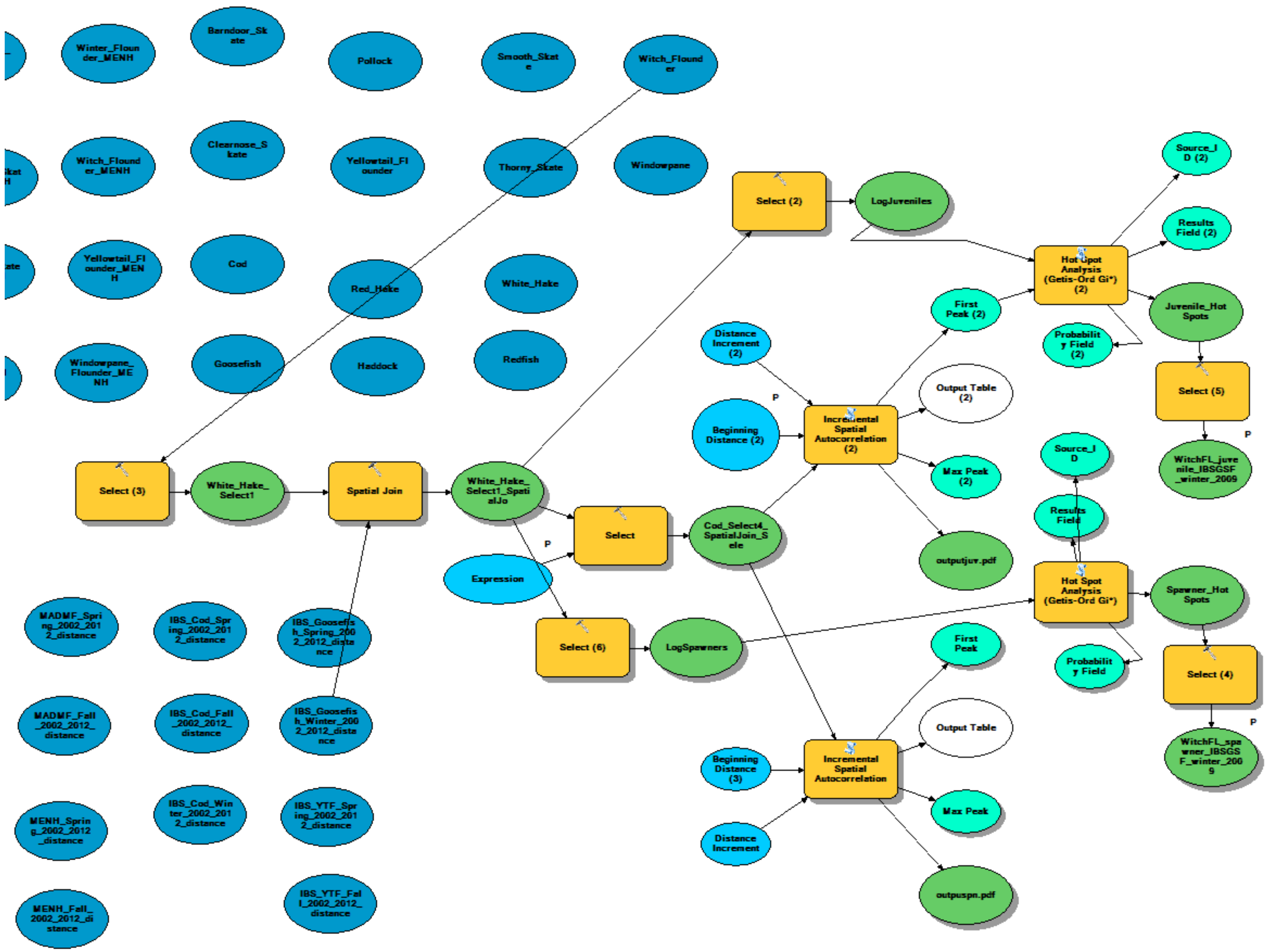


Figure 9. Workflow for merging and gridding weighted number of hotspots for a season.

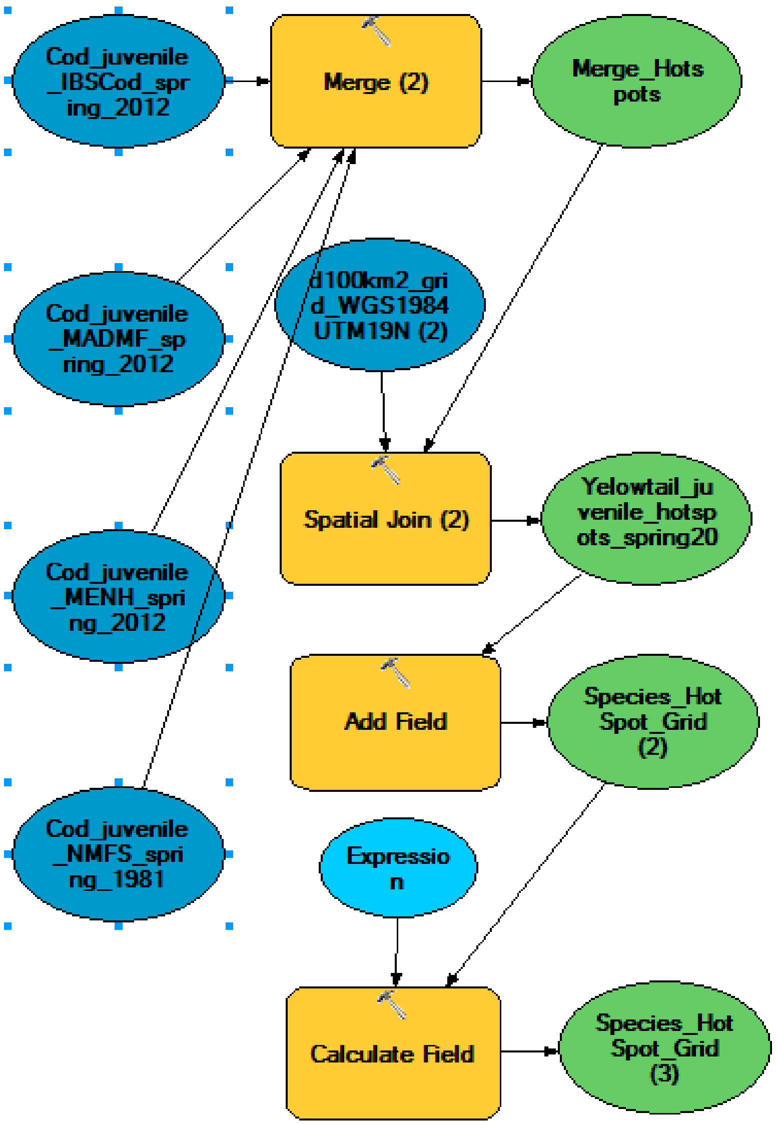
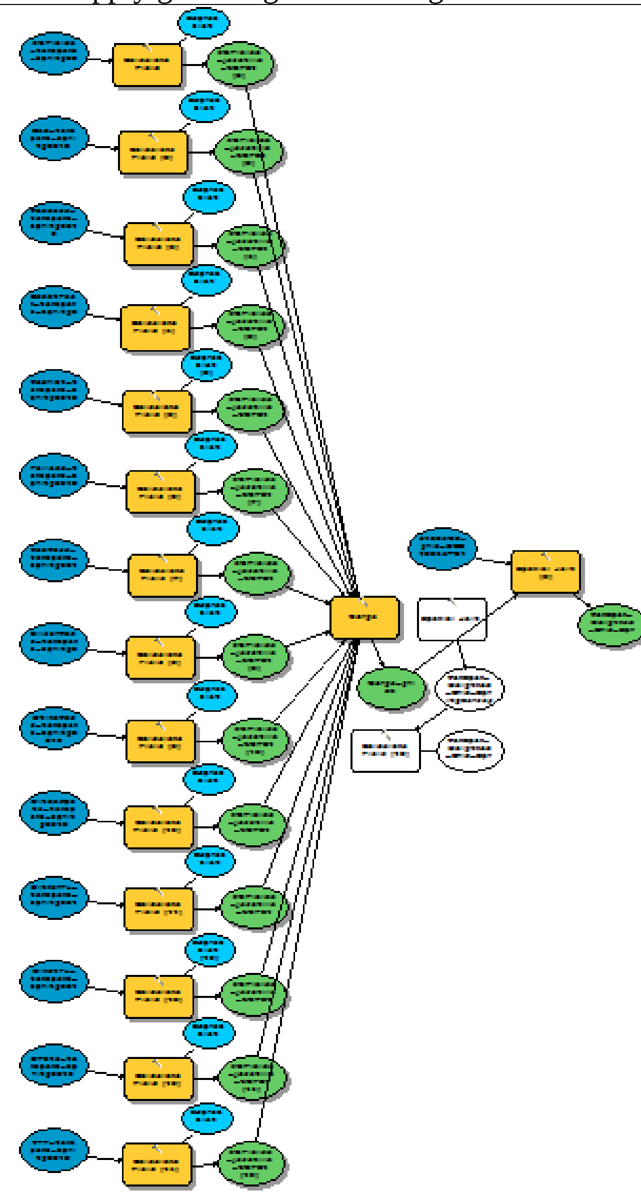
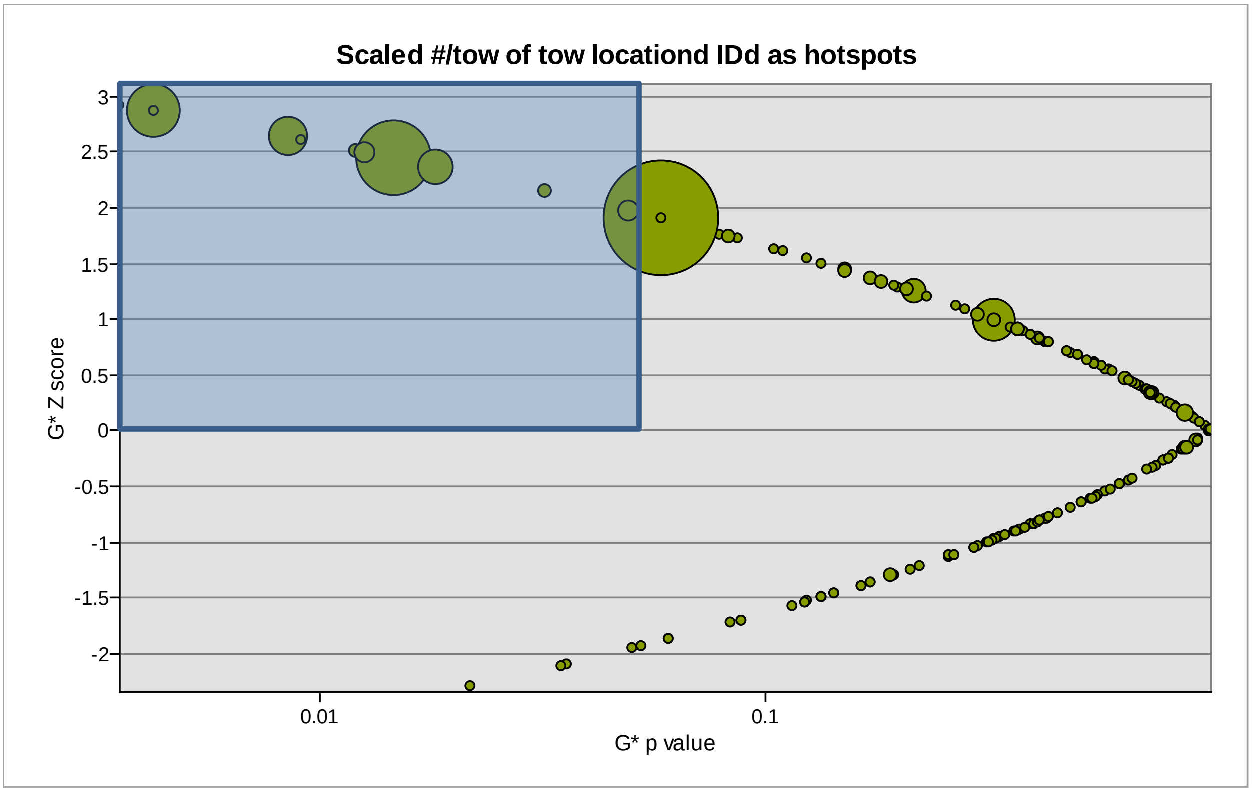
Merge survey layers and grid for a species	Apply grid weights and merge for a season
	

Figure 10. Juvenile cod (<= 25 cm) per tow in 2002-2012 NMFS spring trawl surveys vs. Getis-Ords G* hotspot statistics for 229 hotspots derived from 3426 tow locations. All tows are non-zero and the diameter is scaled to untransformed catch per tow. Low p values represent significant clusters. Positive Z scores are above the mean of non-zero tows. Tows that fall within the light blue box represent high catch rates derived from significant (p<=0.05) clusters.



Map 1. Location of above average significant hotspots (blue circles) compared to all clusters (shaded circles) overlaying scaled <= 25 cm cod/tow (pink squares), NMFS spring trawl survey 2002-2012.

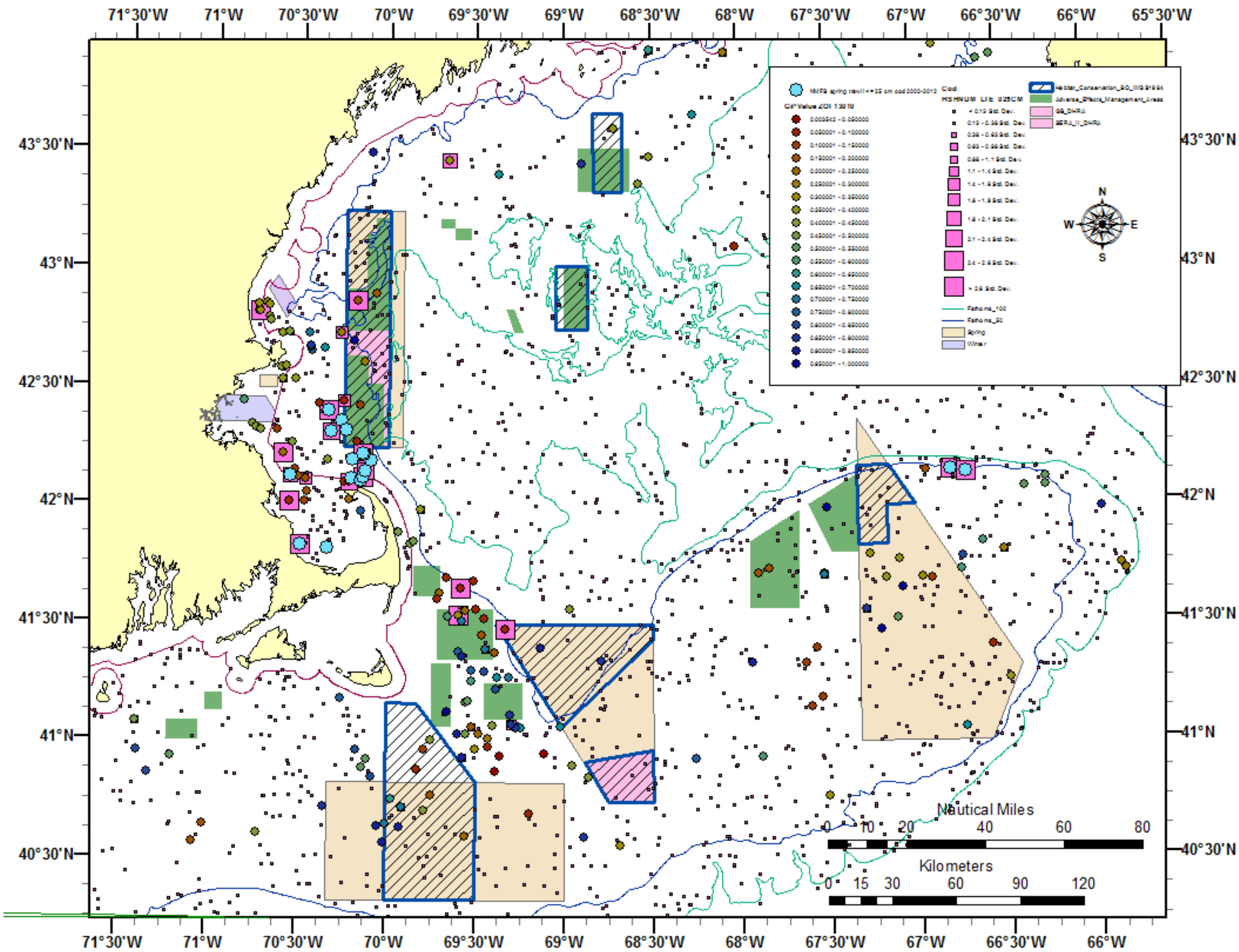


Figure 11. Presence (red)/absence (red) of cod in spawning condition observed during the 2002-2012 NMFS spring trawl surveys.

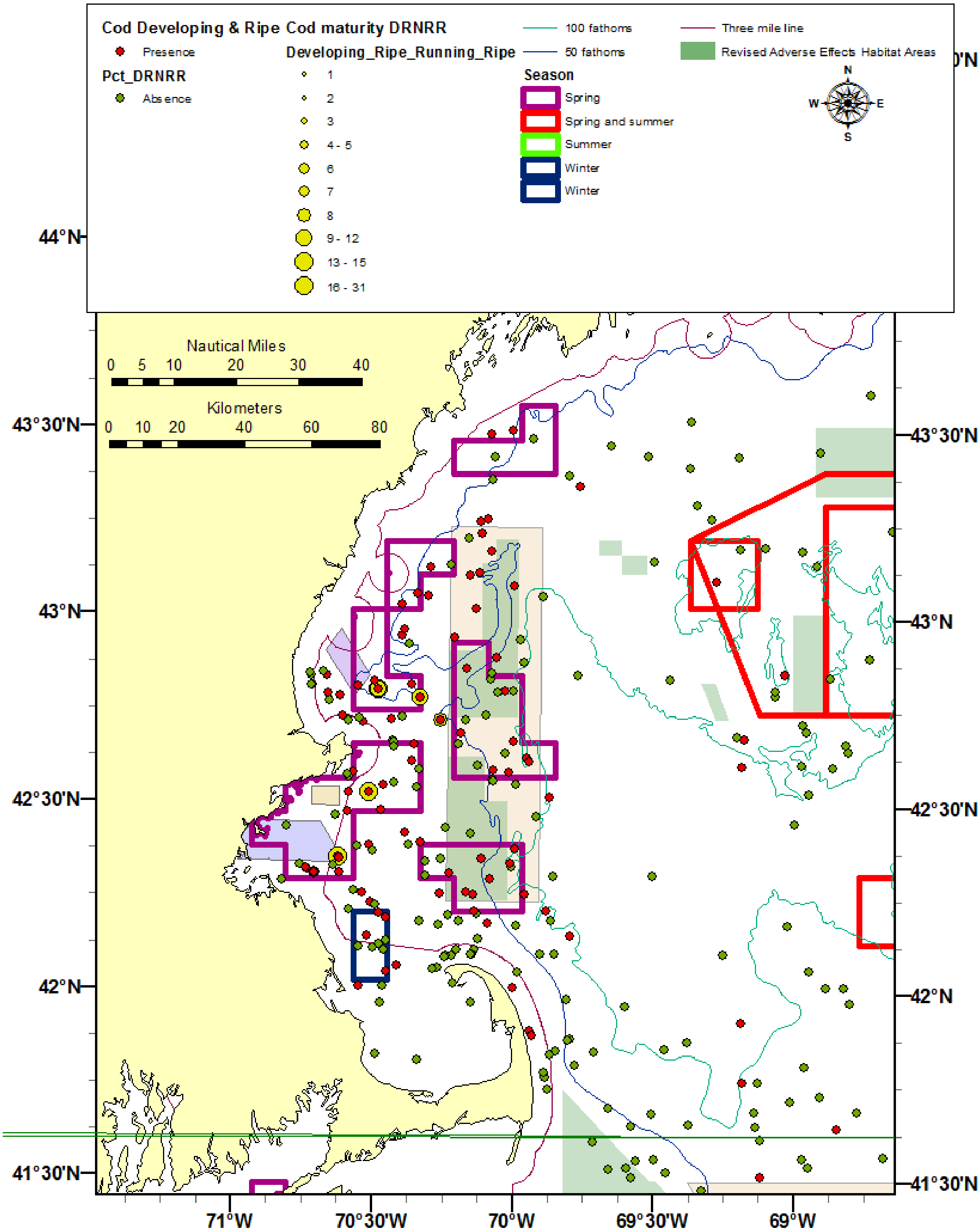


Figure 12. Presence (red)/absence (red) of haddock in spawning condition observed during the 2002-2012 NMFS spring trawl surveys.

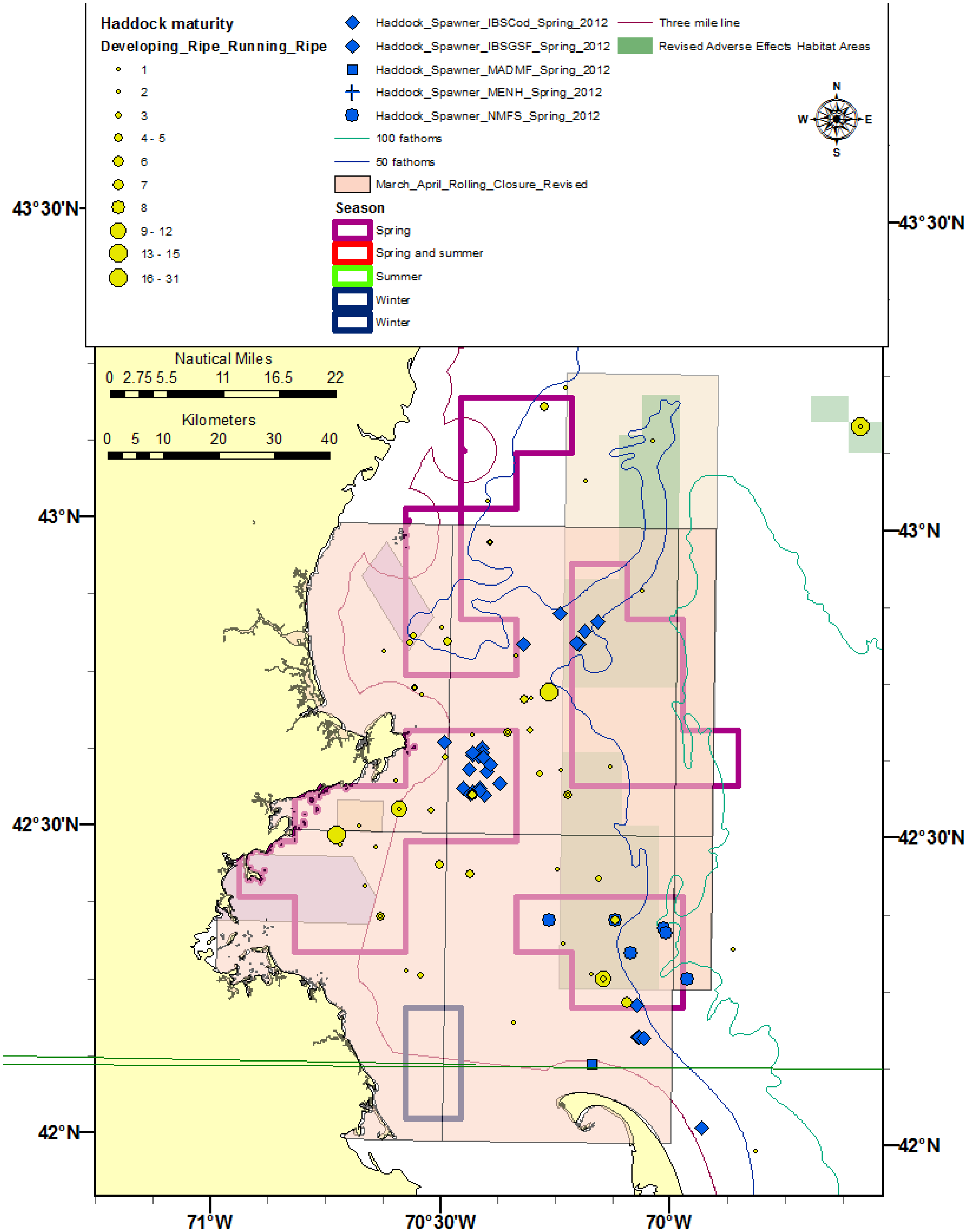


Figure 13. Presence (red)/absence (red) of haddock in spawning condition observed during the 2002-2012 NMFS spring trawl surveys.

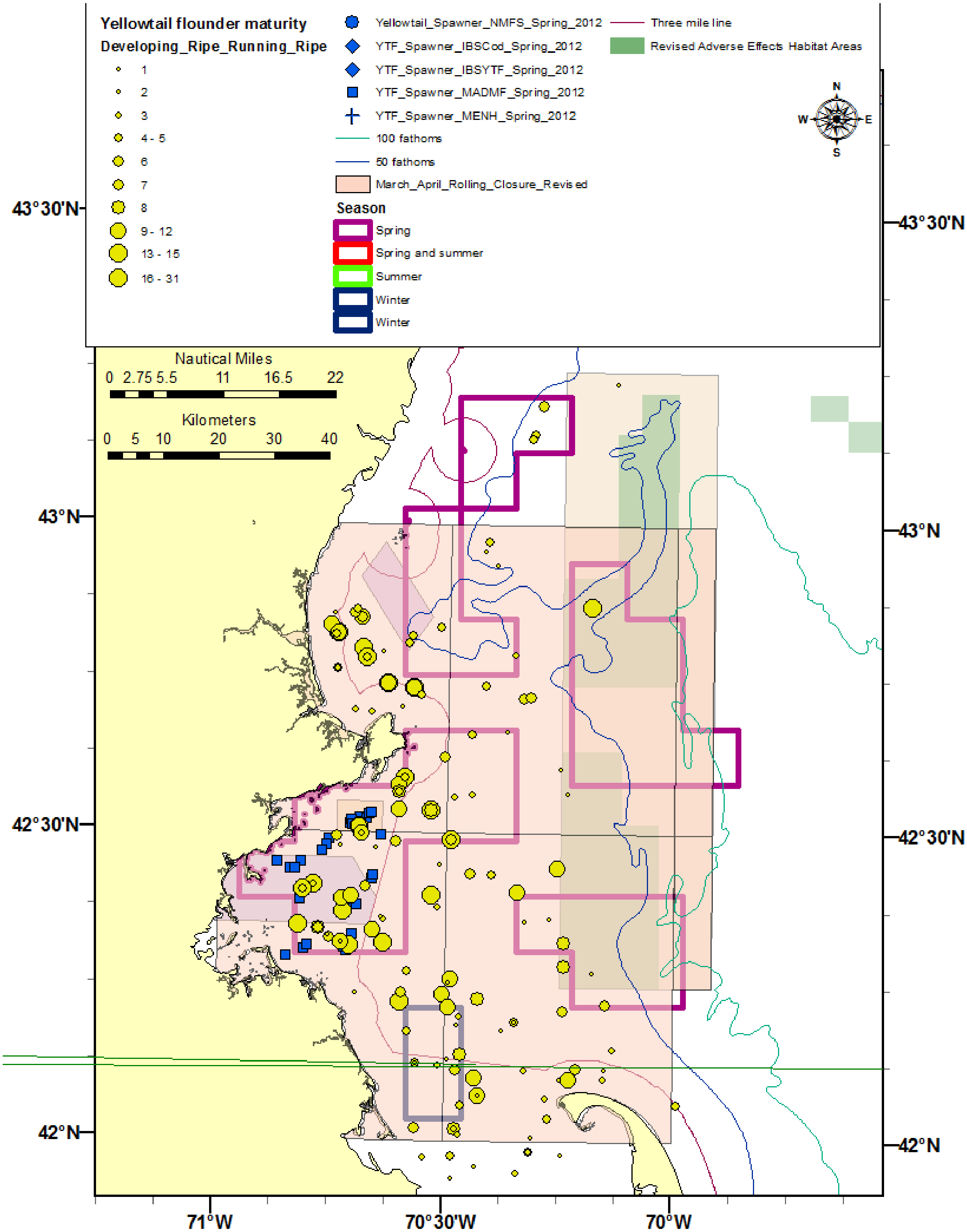


Figure 14. Coastal juvenile groundfish habitat management area option, compared to a summary grid of weighted hotspots (darker shade denotes a higher weighted hotspot value; outlined and unshaded blocks represent areas with hotspots given zero weight).

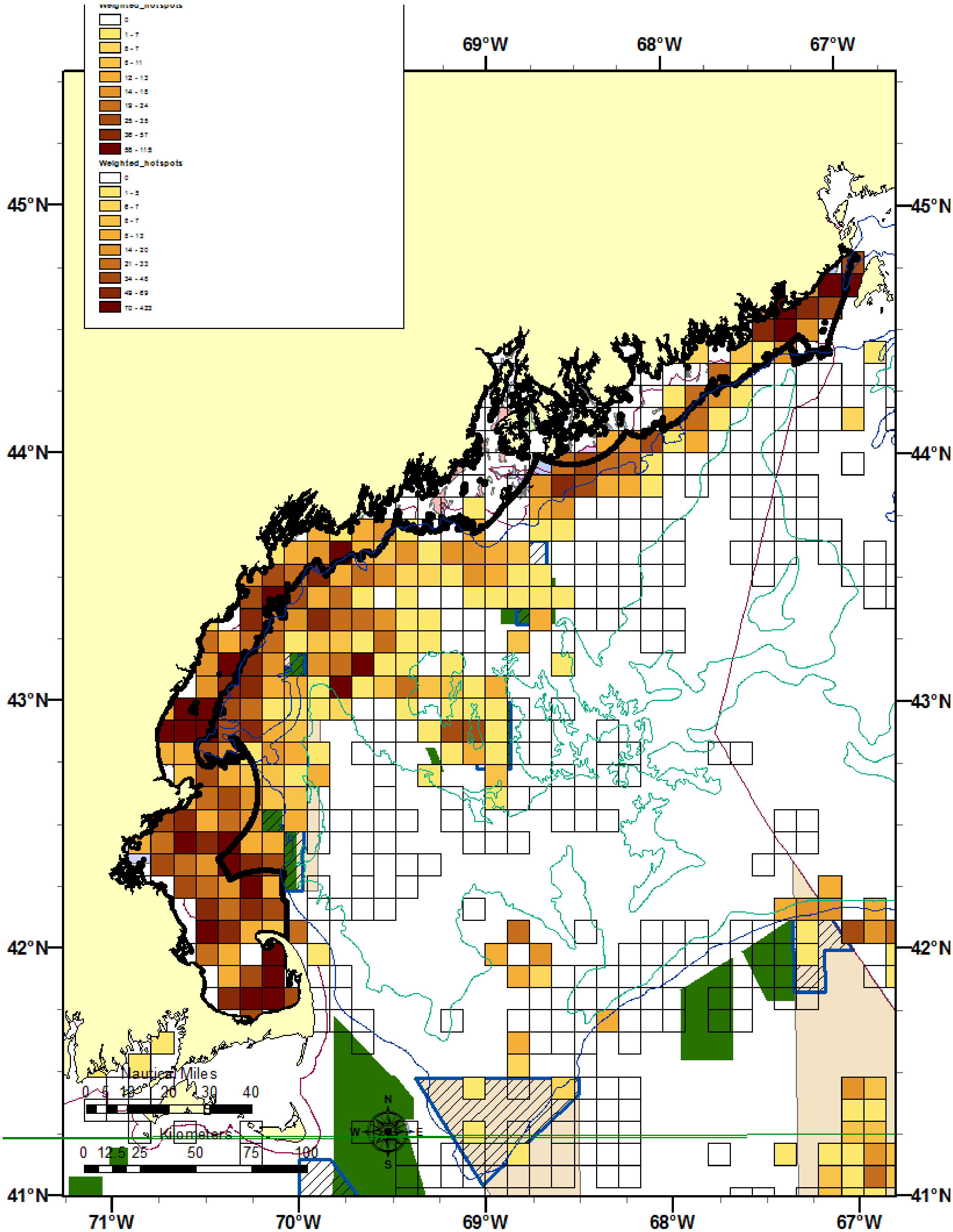


Figure 15. Juvenile groundfish habitat management area option, compared to a summary grid of weighted hotspots (darker shade denotes a higher weighted hotspot value; outlined and unshaded blocks represent areas with hotspots given zero weight).

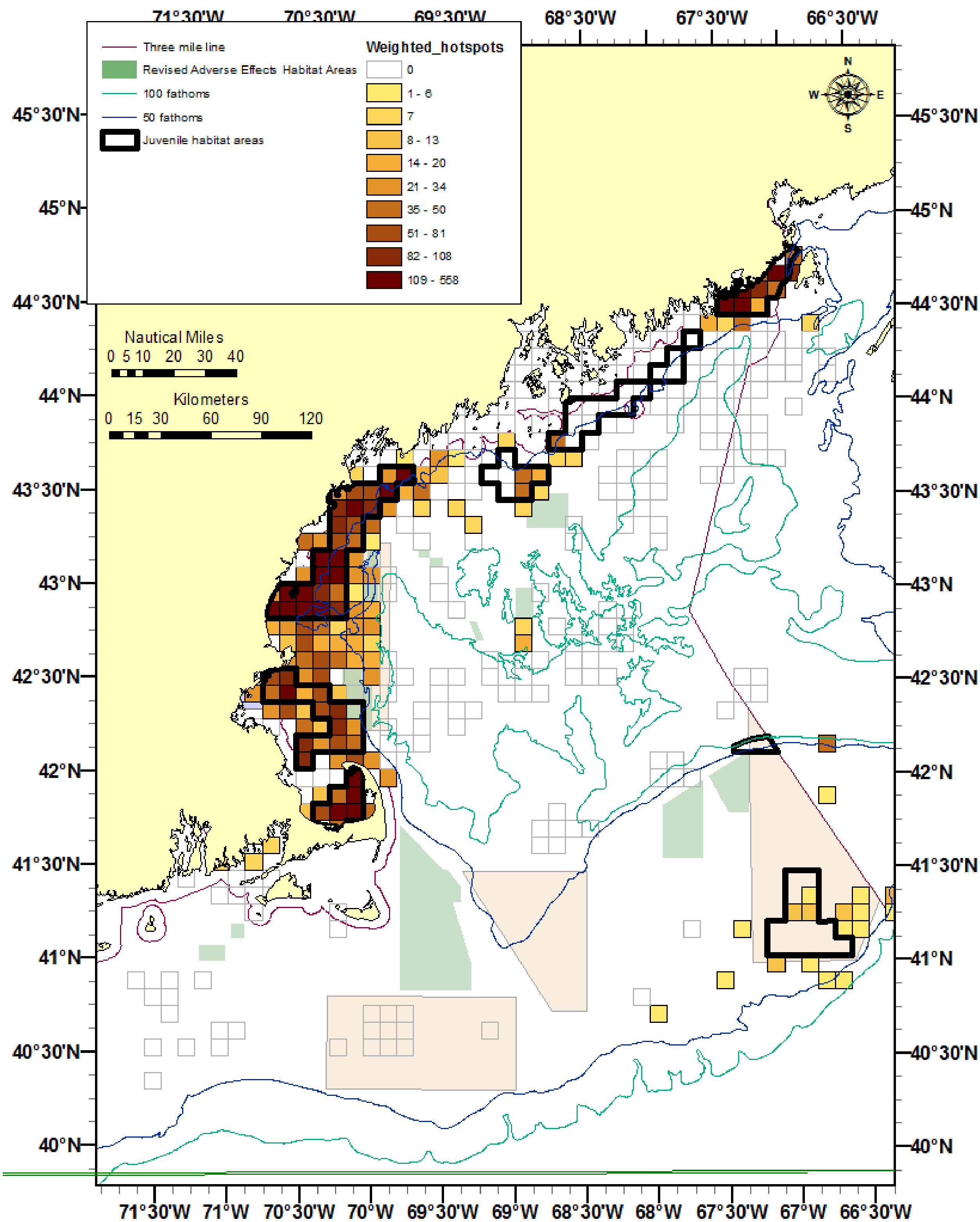


Figure 16. Seasonal groundfish spawning areas derived from hotspot analysis.

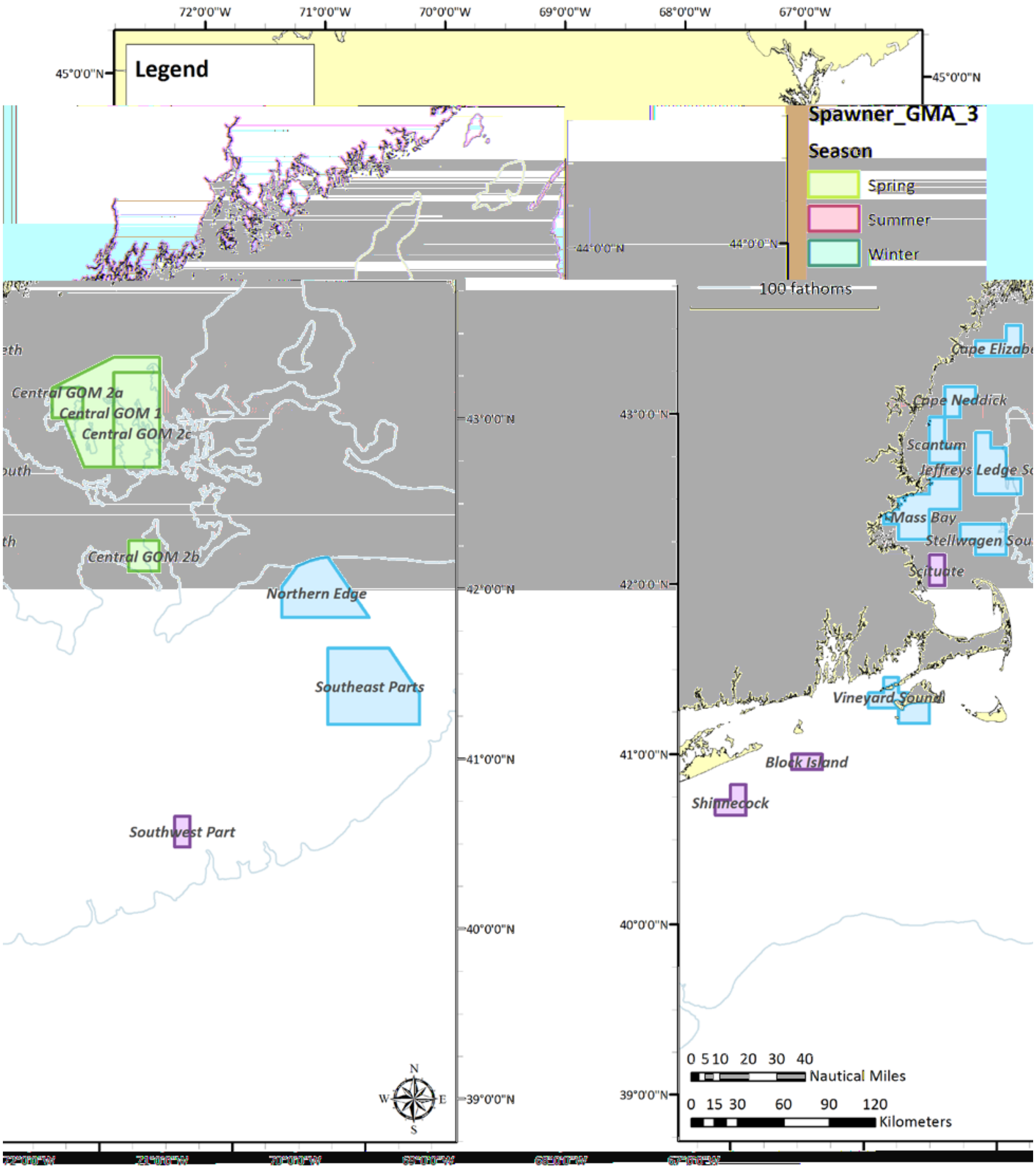


Figure 17. Proposed March-April modified rolling closure option (black outline) compared to existing April sector rolling closure (shaded).

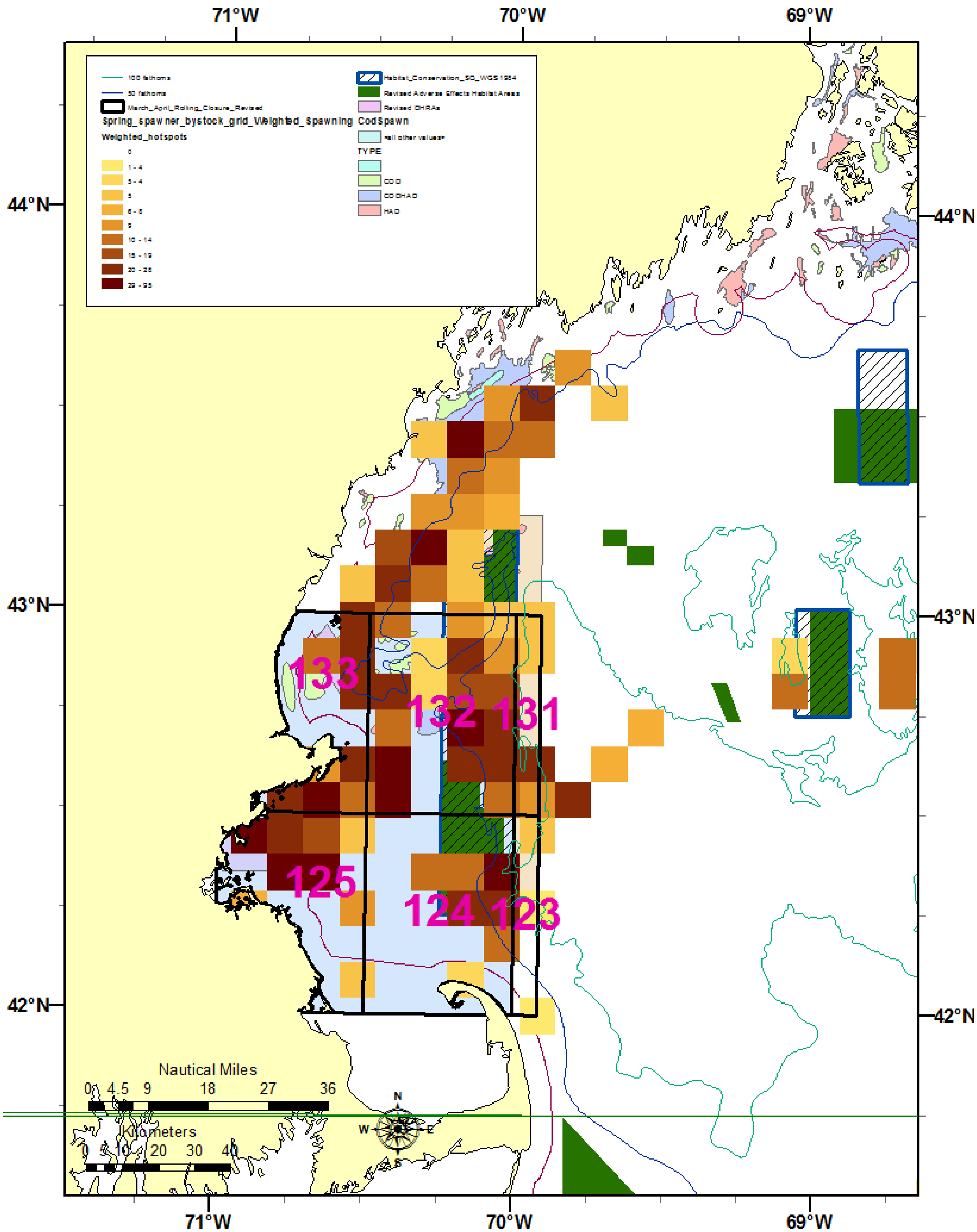


Figure 18. Proposed May modified rolling closure option (black outline) compared to existing May sector rolling closure (shaded).

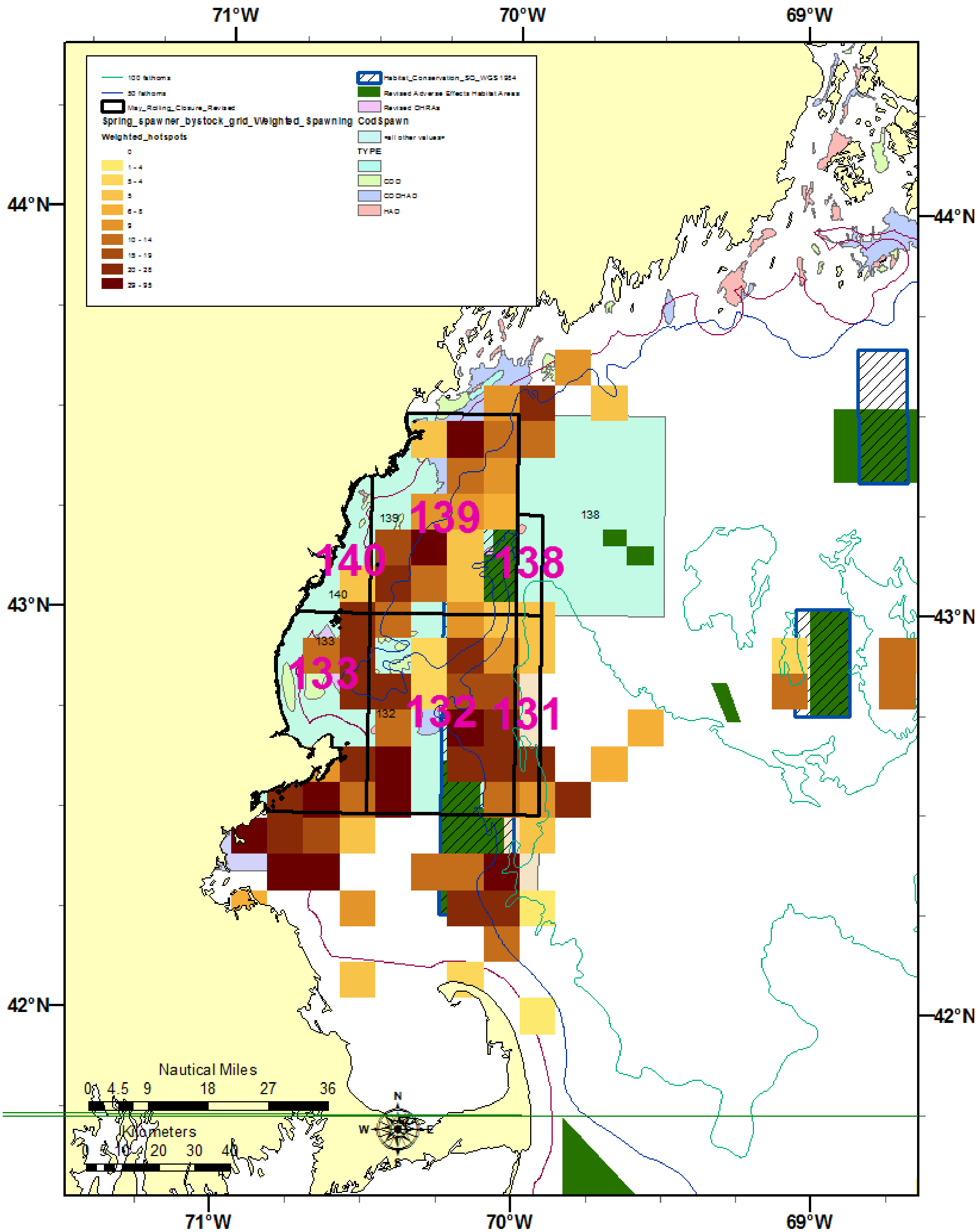
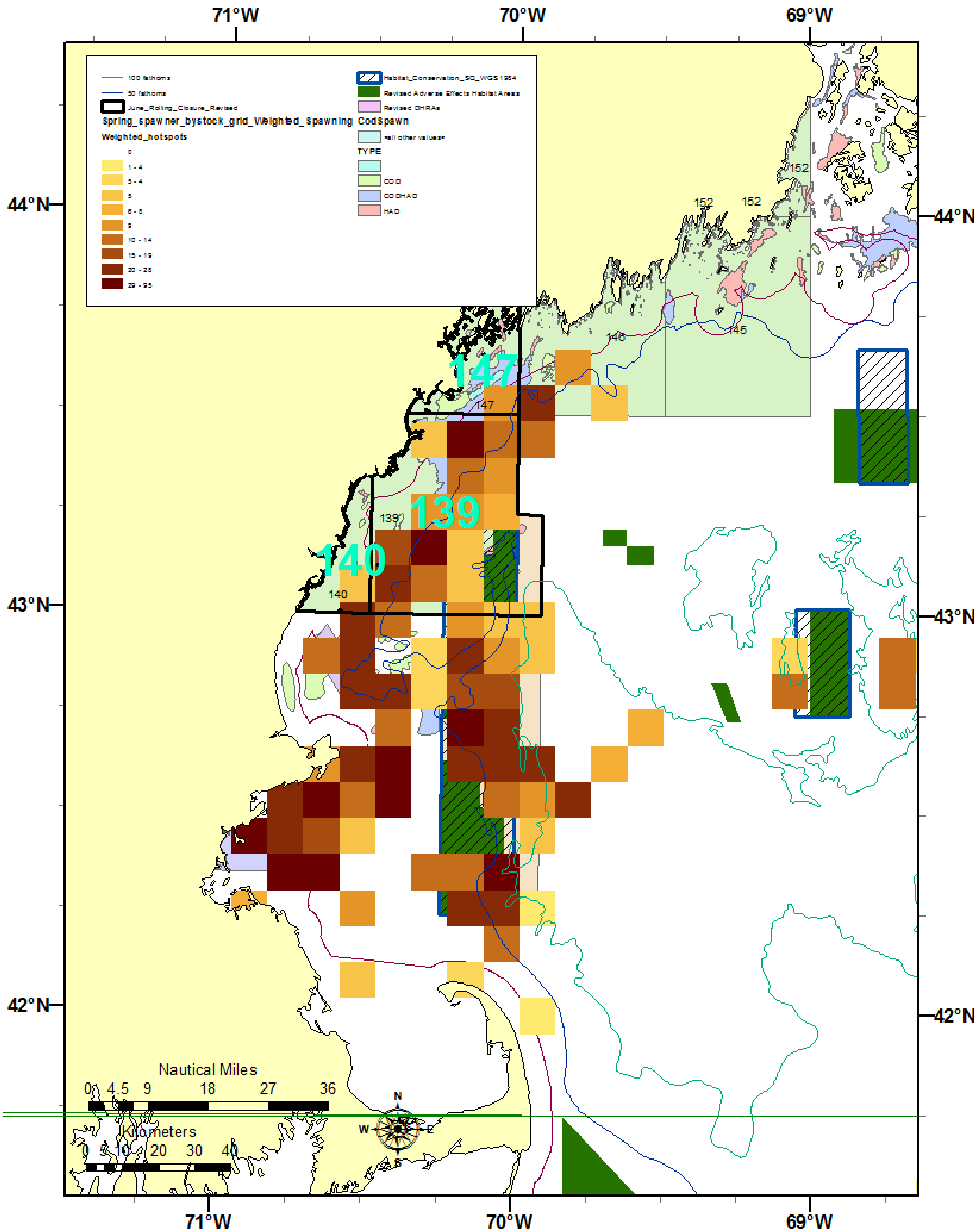


Figure 19. Proposed June modified rolling closure option (black outline) compared to existing June sector rolling closure (shaded).



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Getis-Ord Gi* statistic in ArcGIS

The Hot Spot Analysis tool calculates the Getis-Ord Gi* statistic (pronounced G-i-star) for each feature in a dataset. The resultant z-scores and p-values tell you where features with either high or low values cluster spatially. This tool works by looking at each feature within the context of neighboring features. A feature with a high value is interesting but may not be a statistically significant hot spot. To be a statistically significant hot spot, a feature will have a high value and be surrounded by other features with high values as well. The local sum for a feature and its neighbors is compared proportionally to the sum of all features; when the local sum is very different from the expected local sum, and that difference is too large to be the result of random chance, a statistically significant z-score results.

Calculations

The Getis-Ord local statistic is given as:

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j} x_j - \bar{X} \sum_{j=1}^{n} w_{i,j}}{S \sqrt{\frac{\left[n \sum_{j=1}^{n} w_{i,j}^2 - \left(\sum_{j=1}^{n} w_{i,j} \right)^2 \right]}{n-1}}} \qquad (1)$$

where x_j is the attribute value for feature j, $w_{i,j}$ is the spatial weight between feature i and j, n is equal to the total number of features and:

$$\bar{X} = \frac{\sum_{j=1}^{n} x_j}{n} \qquad (2)$$

$$S = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n} - (\bar{X})^2} \qquad (3)$$

The G_i^* statistic is a z-score so no further calculations are required.

Interpretation

The Gi* statistic returned for each feature in the dataset is a z-score. For statistically significant positive z-scores, the larger the z-score is, the more intense the clustering of high values (hot spot). For statistically significant negative z-scores, the smaller the z-score is, the more intense the clustering of low values (cold spot). For more information about determining statistical significance, see What is a z-score? What is a p-value?

Output

This tool creates a new **Output Feature Class** with a z-score and p-value for each feature in the **Input Feature Class.** If there is a selection set applied to the Input Feature Class, only selected features will be analyzed, and only selected features will appear in the Output Feature Class. This tool also returns the z-score and p-value field names as derived output values for potential use in custom models and scripts.

When this tool runs in ArcMap, the **Output Feature Class** is automatically added to the table of contents with default rendering applied to the z-score field. The hot to cold rendering applied is defined by a layer file in <ArcGIS>/ArcToolbox/Templates/Layers. You can reapply the default rendering, if needed, by importing the template layer symbology.

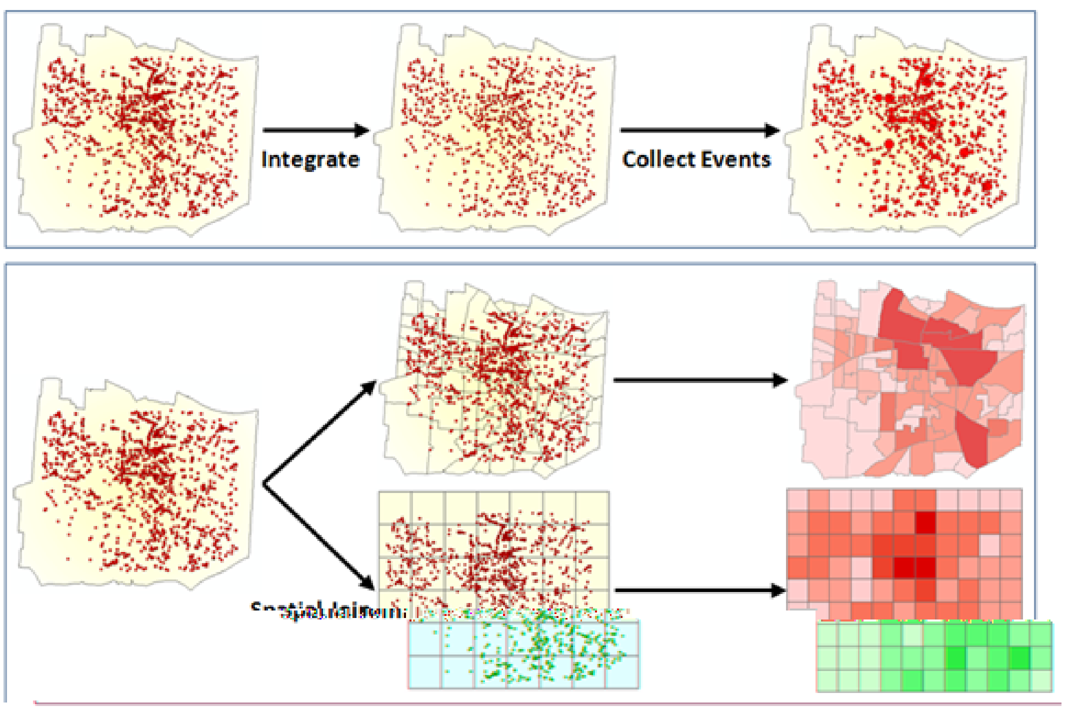
Hot spot analysis considerations

There are three things to consider when undertaking any hot spot analysis:

1. What is the Analysis Field (**Input Field**)? The hot spot analysis tool assesses whether high or low values (the number of crimes, accident severity, or dollars spent on sporting goods, for example) cluster spatially. The field containing those values is your Analysis Field. For point incident data, however, you may be more interested in assessing incident intensity than in analyzing the spatial clustering of any particular value associated with the incidents. In that case, you will need to aggregate your incident data prior to analysis. There are several ways to do this:
    - If you have polygon features for your study area, you can use the Spatial Join tool to count the number of events in each polygon. The resultant field containing the number of events in each polygon becomes the **Input Field** for analysis.
    - Use the Create Fishnet tool to construct a polygon grid over your point features. Then use the Spatial Join tool to count the number of events falling within each grid polygon. Remove any grid polygons that fall outside your study area. Also, in cases where many of the grid polygons within the study area contain zeros for the number of events, increase the polygon grid size, if appropriate, or remove those zero-count grid polygons prior to analysis.
    - Alternatively, if you have a number of coincident points or points within a short distance of one another, you can use Integrate with the Collect Events tool to (1) snap features within a specified distance of each other together, then (2) create a new feature class containing a point at each unique location with an associated count attribute to indicate the number of events/snapped points. Use the resultant ICOUNT field as your **Input Field** for analysis.

      Note:

      If you are concerned that your coincident points may be redundant records, the Find Identical tool can help you to locate and remove duplicates.



Strategies for aggregating incident data

2. Which **Conceptualization of Spatial Relationships** is appropriate? What **Distance Band or Threshold Distance** value is best?

   The recommended (and default) **Conceptualization of Spatial Relationships** for the Hot Spot Analysis (Getis-Ord Gi*) tool is **Fixed Distance Band**. Space-Time Window, Zone of Indifference, Contiguity, K Nearest Neighbor, and Delaunay Triangulation may also work well. For a discussion of best practices and strategies for determining an analysis distance value, see Selecting a Conceptualization of Spatial Relationships and Selecting a Fixed Distance. For more information about space-time hot spot analysis, see Space-Time Analysis.
3. What is the question?

   This may seem obvious, but how you construct the **Input Field** for analysis determines the types of questions you can ask. Are you most interested in determining where you have lots of incidents, or where high/low values for a particular attribute cluster spatially? If so, run Hot Spot Analysis on the raw values or raw incident counts. This type of analysis is particularly helpful for resource allocation types of problems. Alternatively (or in addition), you may be interested in locating areas with unexpectedly high values in relation to some other variable. If you are analyzing foreclosures, for example, you probably expect more foreclosures in locations with more homes (said another way, at some level, you expect the number of foreclosures to be a function of the number of houses). If you divide the number of foreclosures by the number of homes, then run the Hot Spot Analysis tool on this ratio, you are no longer asking Where are there lots of foreclosures?; instead, you are asking Where are there unexpectedly high numbers of foreclosures, given the number of homes? By creating a rate or ratio prior to analysis, you can control for certain expected relationships (for example, the number of crimes is a function of population; the number of foreclosures is a function of housing stock) and identify unexpected hot/cold spots.

Best practice guidelines

- Does the **Input Feature Class** contain at least 30 features? Results aren't reliable with less than 30 features.
- Is the **Conceptualization of Spatial Relationships** you selected appropriate? For this tool, the **Fixed Distance Band** method is recommended. For space-time hot spot analysis, see Selecting a Conceptualization of Spatial Relationships.
- Is the **Distance Band or Threshold Distance** appropriate? See Selecting a Fixed Distance.
  - All features should have at least one neighbor.
  - No feature should have all other features as neighbors.
  - Especially if the values for the **Input Field** are skewed, you want features to have about eight neighbors each.

Potential applications

Applications can be found in crime analysis, epidemiology, voting pattern analysis, economic geography, retail analysis, traffic incident analysis, and demographics. Some examples include the following:

- Where is the disease outbreak concentrated?
- Where are kitchen fires a larger than expected proportion of all residential fires?
- Where should the evacuation sites be located?
- Where/When do peak intensities occur?
- Which locations and at during what time periods should we allocate more of our resources?

Additional resources

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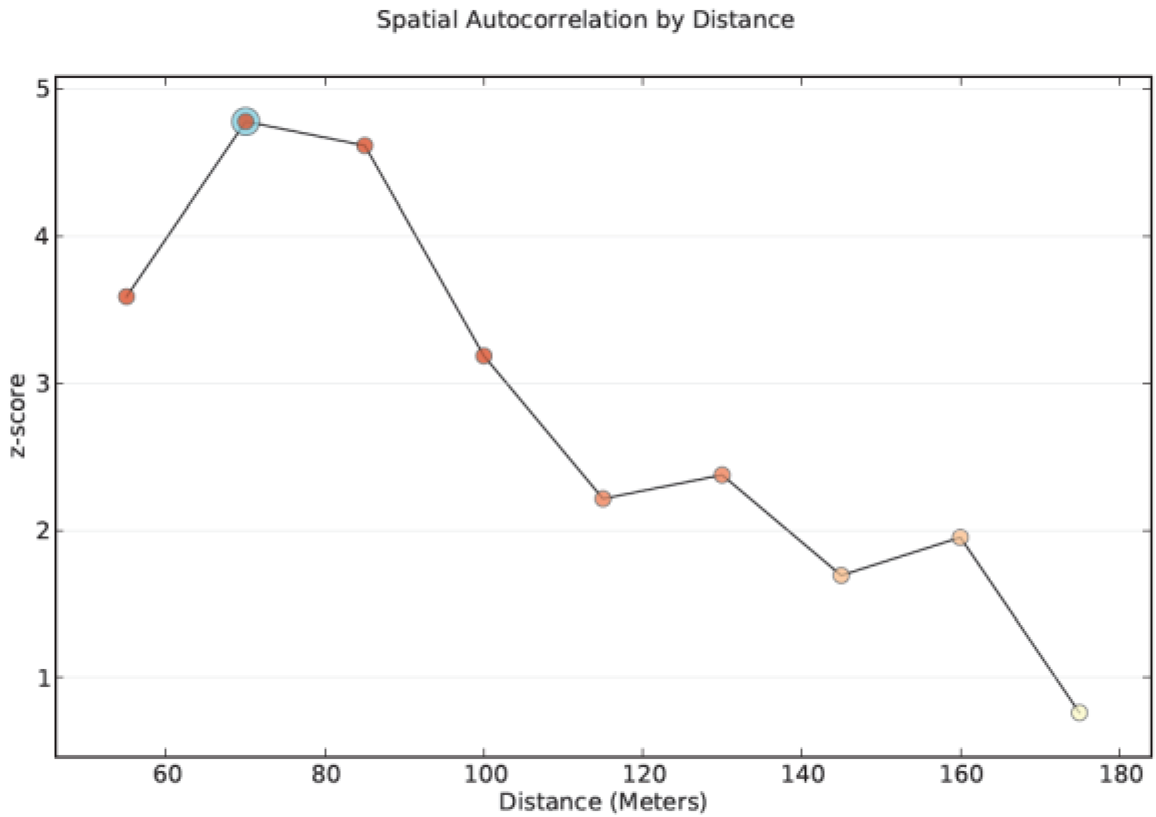
How Incremental Spatial Autocorrelation works in ArcGIS

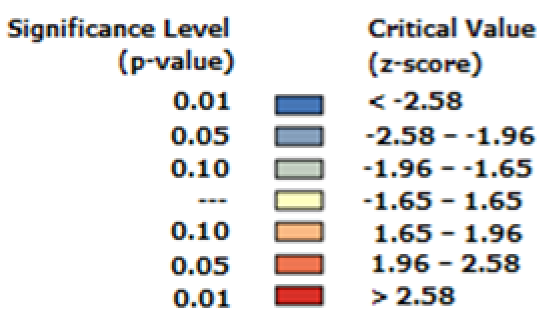
Desktop » Geoprocessing » Tool reference » Spatial Statistics toolbox » Analyzing Patterns toolset

With much of the spatial data analysis you do, the scale of your analysis will be important. The default **Conceptualization of Spatial Relationships** for the Hot Spot Analysis tool, for example, isFIXED_DISTANCE_BAND and requires you to specify a distance value. For many density tools you will be asked to provide a **Radius**. The distance you select should relate to the scale of the question you are trying to answer or to the scale of remediation you are considering. Suppose, for example, you want to understand childhood obesity. What is your scale of analysis? Is it at the individual household or neighborhood level? If so, the distance you use to define your scale of analysis will be small, encompassing the homes within a block or two of each other. Alternatively, what will be the scale of remediation? Perhaps your question involves where to increase after-school fitness programs as a way to potentially reduce childhood obesity. In that case, your distance will likely be reflective of school zones. Sometimes it's fairly easy to determine an appropriate scale of analysis; if you are analyzing commuting patterns and know that the average journey to work is 12 miles, for example, then 12 miles would be an appropriate distance to use for your analysis. Other times it is more difficult to justify any particular analysis distance. This is when the Incremental Spatial Autocorrelation tool is most helpful.

Whenever you see spatial clustering in the landscape, you are seeing evidence of underlying spatial processes at work. Knowing something about the spatial scale at which those underlying processes operate can help you select an appropriate analysis distance. The Incremental Spatial Autocorrelation tool runs the Spatial Autocorrelation (Global Moran's I) tool for a series of increasing distances, measuring the intensity of spatial clustering for each distance. The intensity of clustering is determined by the z-score returned. Typically, as the distance increases, so does the z-score, indicating intensification of clustering. At some particular distance, however, the z-score generally peaks. Sometimes you will see multiple peaks.



Peaks reflect distances where the spatial processes promoting clustering are most pronounced. The color of each point on the graph corresponds to the statistical significance of the z-score values.



One strategy for identifying an appropriate scale of analysis is to select the distance associated with the statistically significant peak that best reflects the scale of your question. Often this is the first statistically significant peak.

How do I select the Beginning Distance and Distance Increment values?

All distance measurements are based on feature centroids and the default **Beginning Distance** is the smallest distance that will ensure every feature has at least one neighboring feature. This is generally a good choice, unless your dataset includes spatial outliers. Determine whether or not you have spatial outliers, then select all but the outlier features and run Incremental Spatial Autocorrelation on just the selected features. If you find a peak distance for the selection set, use that distance to create a spatial weights matrix file based on all of your features (even the outliers). When you run theGenerate_Spatial_Weights_Matrix tool to create the spatial weights matrix file, set the **Number of**

Neighbors parameter to some value so that all features will have at least that many neighboring features.

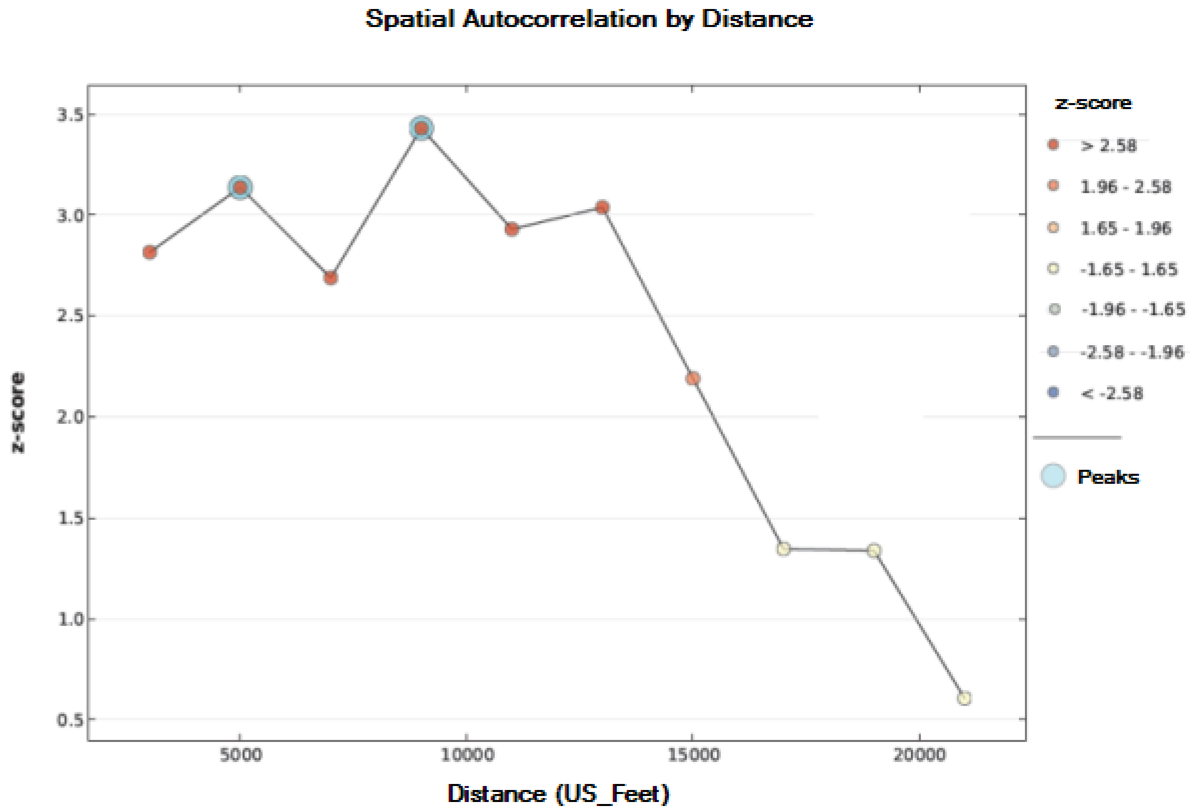
The default **Increment Distance** is the average distance to each feature's nearest neighboring feature. If you've determined an appropriate starting distance using the strategies above and still don't see a peak distance, you may want to experiment with smaller or larger increment distances.

What if the graph never peaks?

In some cases, you will use the Incremental Spatial Autocorrelation tool and get a graph with a z-score that just continues to rise with increasing distances; there is no peak. This most often happens in cases where data has been aggregated and the scale of the processes impacting your **Input Field** variable are smaller than the aggregation scheme. You can try making your Distance Increment smaller to see if this captures more subtle peaks. Sometimes, however, you won't get a peak because there are multiple spatial processes, each operating at a different distance, in your study area. This is often the case with large point datasets that are noisy (no clear spatial pattern to the point data values you're analyzing). In this case, you will need to justify your scale of analysis using some other criteria.

Interpreting results

When you run the Incremental Spatial Autocorrelation tool in the foreground, the z-score results for each distance are written to the ***Progress*** window. This output is also available from the Results window. If you right-click on the Messages entry in the Results window and select **View**, the tool results are displayed in a **Message** dialog box. When you specify a path for the optional **Output Table** parameter, a table is created that includes fields for **Distance**, **MoransI**, **ExpectedI**, **Variance**, **z_score**, and **p_value**. By examining the z-score values in the ***Progress*** window, **Message** dialog box, or **Output Table**, you can determine if there are any peak distances. More typically, however, you would identify peak distances by looking at the graphic in the optional **Output Report** file. The report has three pages. An example of the first page of the report is shown below. Notice that this graph has three peak z-scores associated with distances of 5000, 9000, and 13000 feet. A halo will be drawn to highlight both the first peak distance and the maximum peak distance, but all peaks represent distances where the spatial processes promoting clustering are most pronounced. You can select the peak that best reflects the scale of your analytical question. In some cases, there will only be one halo because the first and the maximum peaks are found at the same distance. If none of the z-score peaks are statistically significant, then none of the peaks will have the light blue halo. Notice that the color of the plotted z-score corresponds to the legend showing the critical values for statistical significance.



On page two of the report, the distances and z-score values are presented in table format. The last page of the report documents the parameter settings used when the tool was run. To get a report file, provide a path for the **Output Report** parameter.

Figure 20. Example of 'good' spatial autocorrelation result: Large spawner silver hake from MADMF fall survey, 2002-2011.

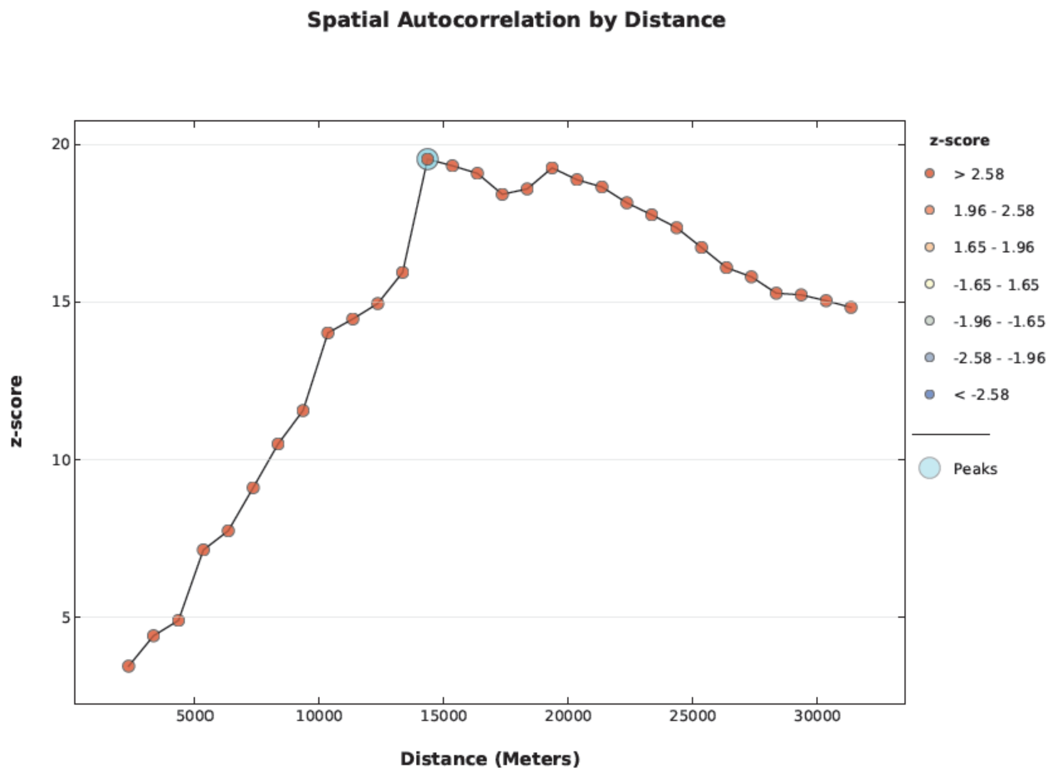


Figure 21. Example of 'satisfactory' spatial autocorrelation result, with secondary peak autocorrelation: Juvenile American plaice from IBS cod fall survey, 2002-2011.

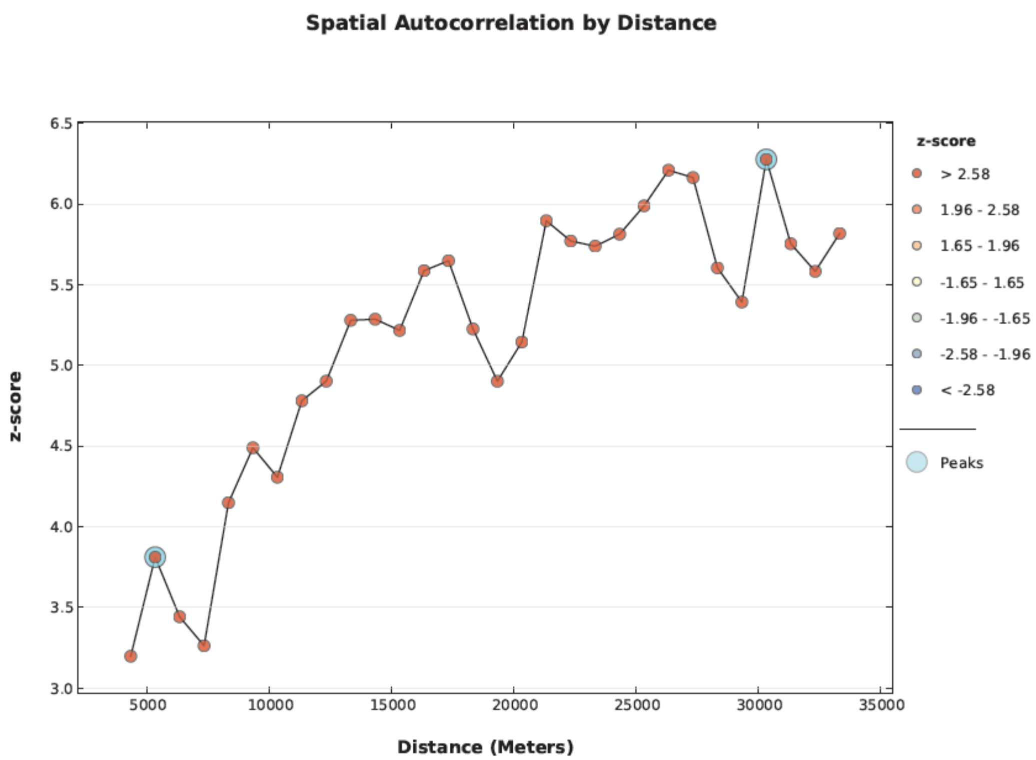


Figure 22. Example of unsatisfactory spatial autocorrelation result, with no significant peak in autocorrelation: Large spawner American plaice from IBS cod fall survey, 2002-2011. In this case, hotspot analysis was re-run with a zone of indifference parameter of 25313 m, corresponding of a secondary non-significant spatial autocorrelation peak, but there were no significant hotspots identified nonetheless.

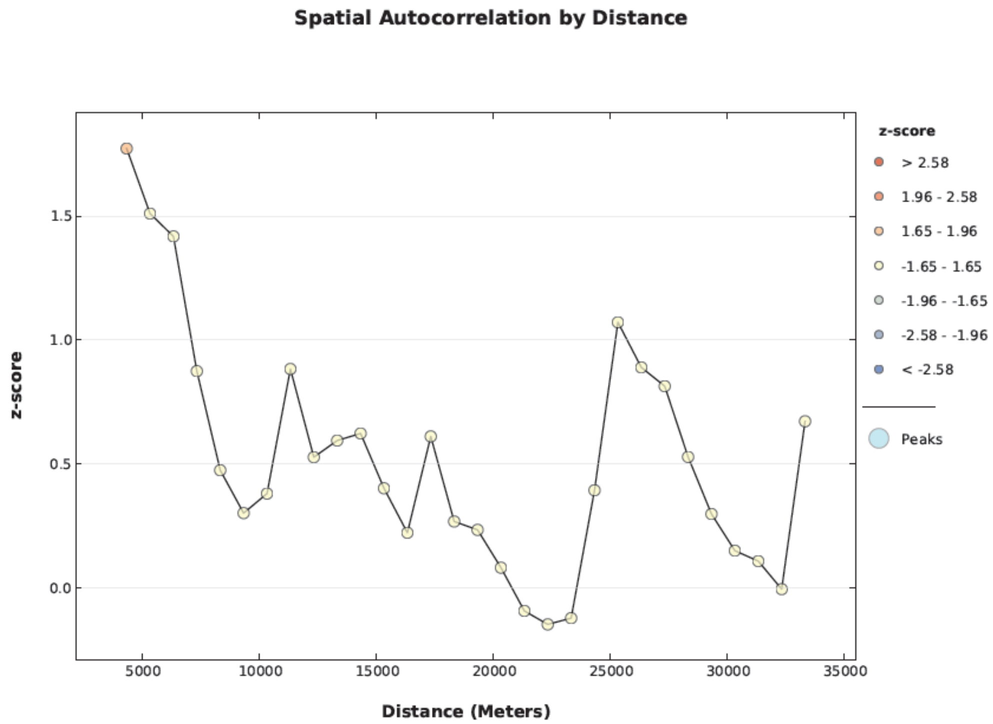


Figure 23. Example of unsatisfactory spatial autocorrelation resulting from insufficient non-zero catches: Large spawner pollock from IBS cod fall survey, 2002-2011. No significant hotspots were identified and no further analysis was attempted.

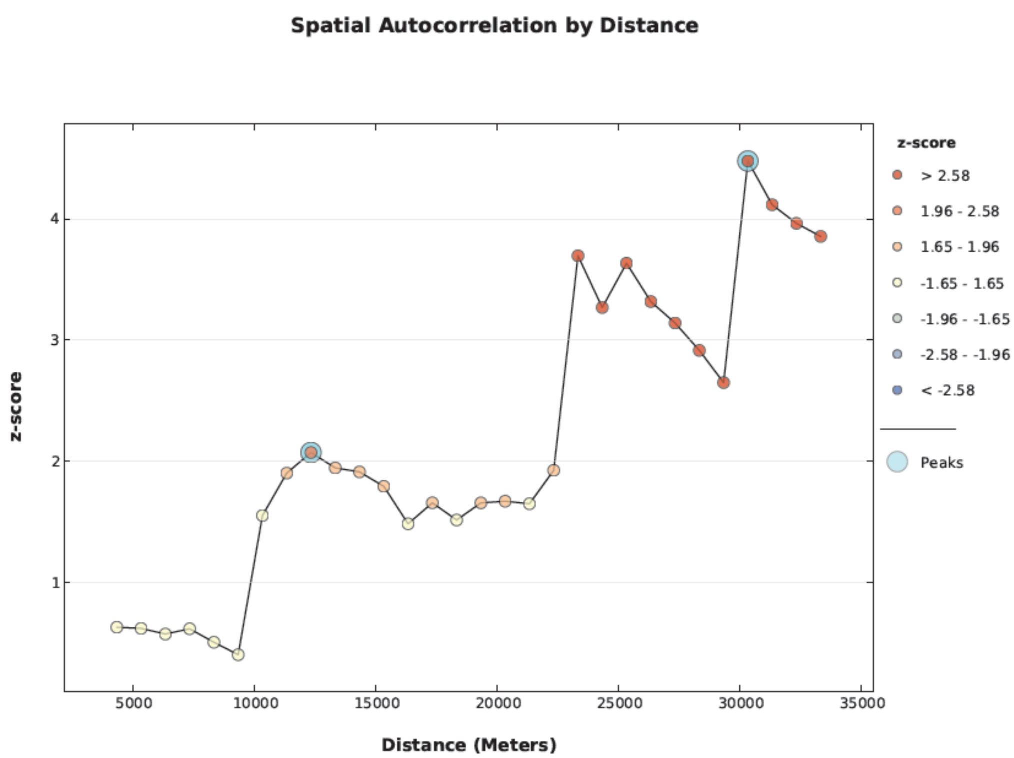


Figure 24. Example of 'good' spatial autocorrelation result, but first autocorrelation peak is probably not meaningful: Juvenile winter flounder from IBS cod fall survey, 2002-2011. The maximum peak of 17,313 m was used as the Zone of Indifference parameter in the hotspot analysis in lieu of the first peak.

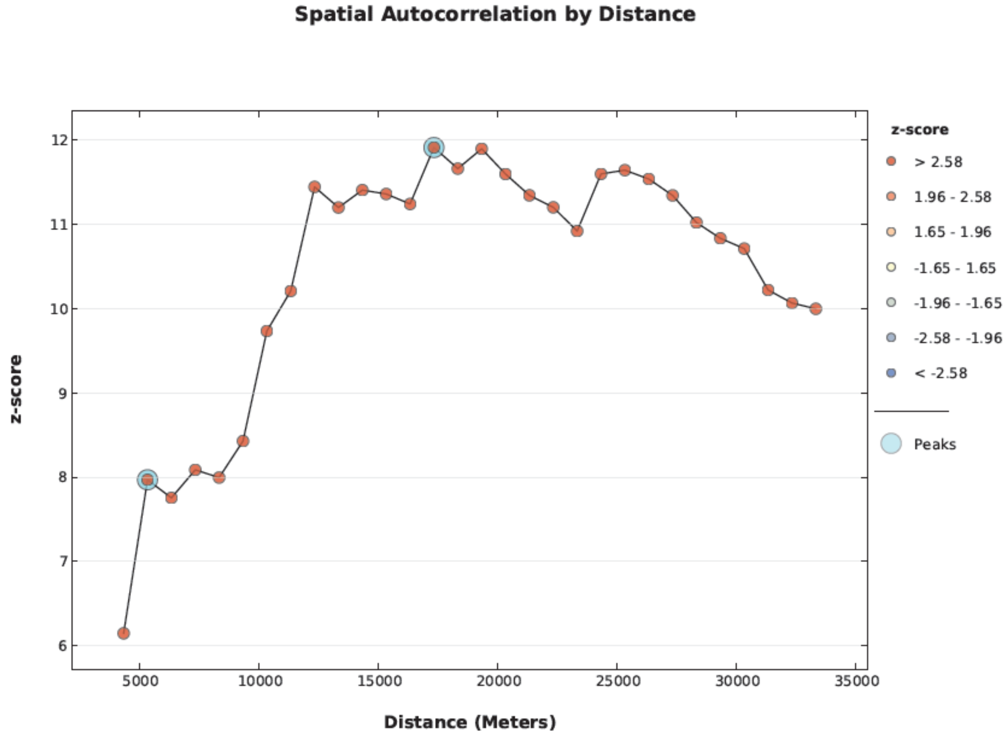


Figure 25. Example of unsatisfactory spatial autocorrelation: Juvenile witch flounder from IBS cod fall survey, 2002-2011. No significant hotspots were identified and no further analysis was attempted.

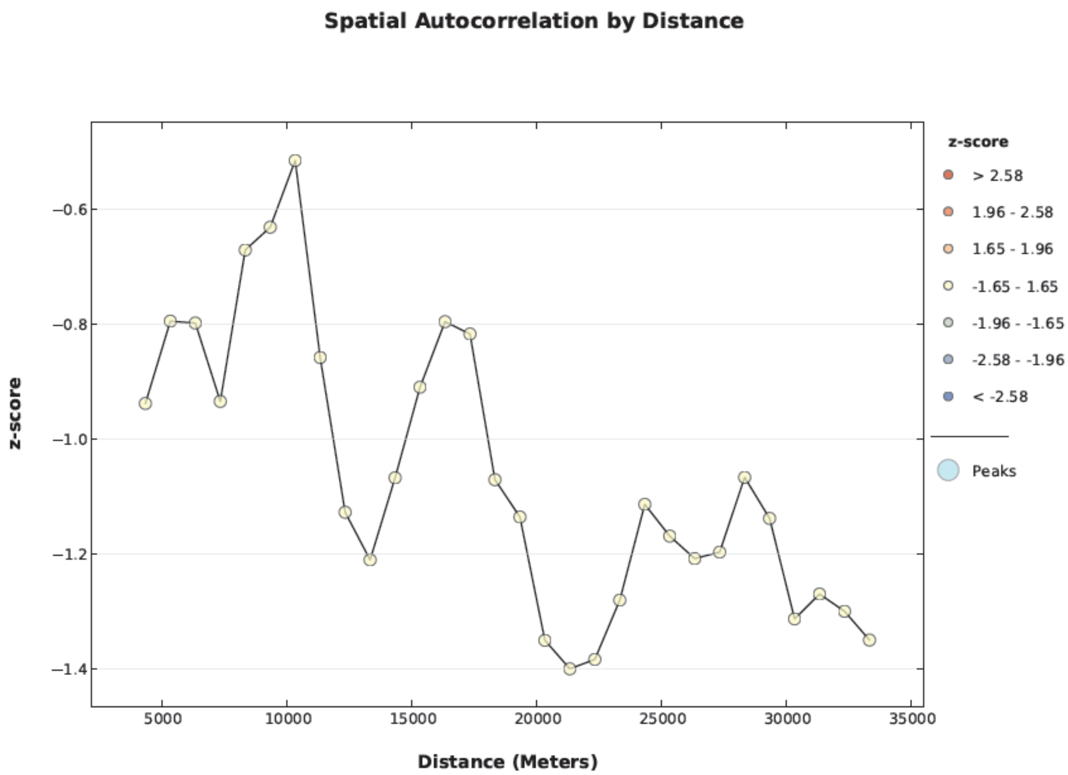


Figure 26. Example of ‘good’ spatial autocorrelation result, with no meaningful first autocorrelation: Large spawner yellowtail flounder from NMFS winter survey, 2002-2007. The maximum peak was applied as a Zone of Indifference parameter in the hotspot analysis.

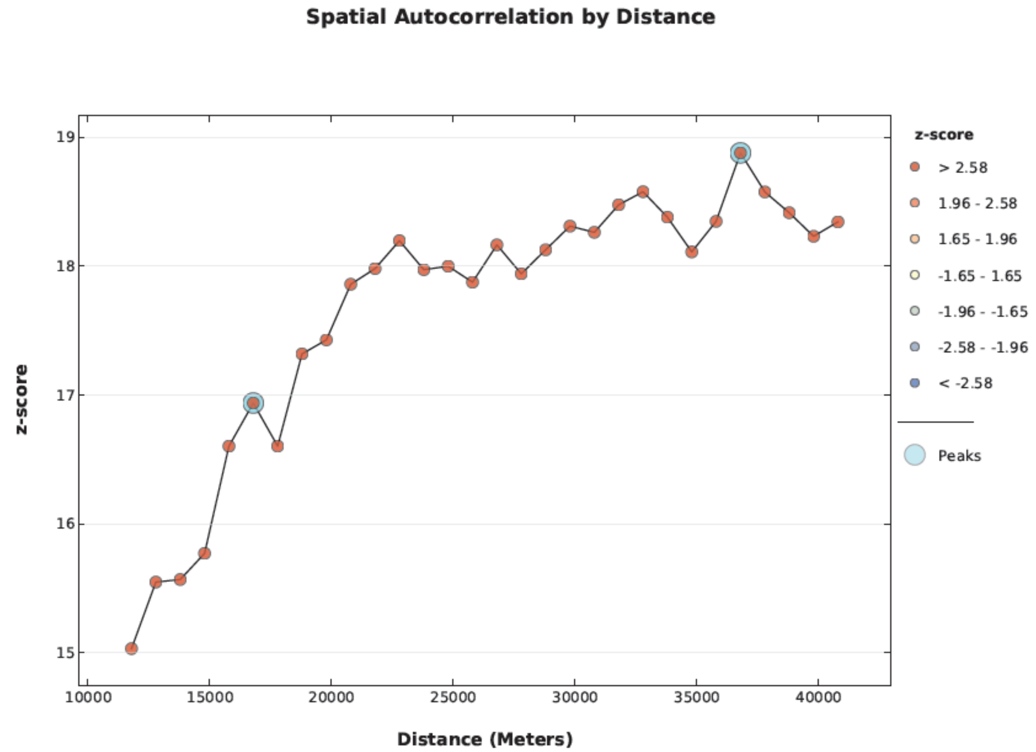


Figure 27. Example of ‘poor’ spatial autocorrelation result. Data are sparse and tend the spatial autocorrelation has a ‘choppy’ appearance: Juvenile cod from NMFS winter survey, 2002-2007. Usually, this pattern is associated with a hotspot analysis that has no significant positive hotspots.

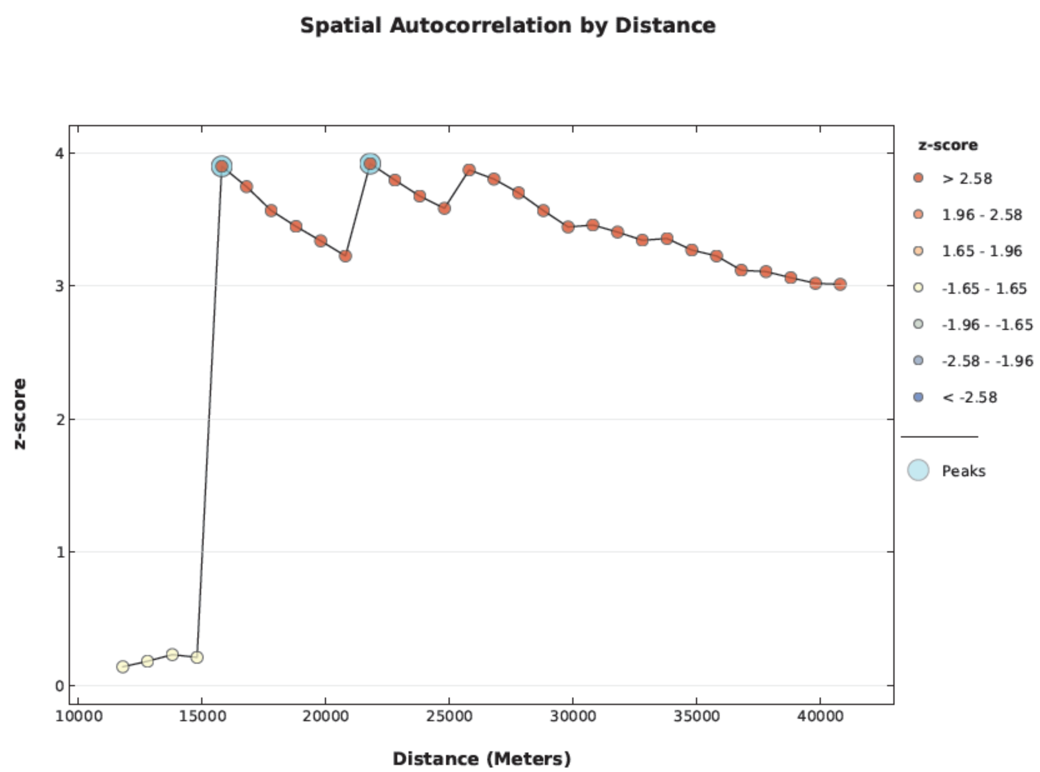


Figure 28. Example of 'strong' spatial autocorrelation result: Large spawner witch flounder from the NMFS winter survey, 2002-2007.