Executive Office of Energy and Environmental Affairs
Massachusetts Office of Coastal Zone Management

FISHERIES
Work Group Report

2014 Massachusetts Ocean Management Plan Update

March 31, 2014

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1. Overview

On July 31, 2013, the Massachusetts Division of Marine Fisheries convened a Fisheries Work Group to discuss if and how to update three maps in the Massachusetts Ocean Management Plan: important fish resource areas, high commercial fisheries effort and value, and concentrated recreational fisheries activity. The work recommended by the working group was discussed by CZM staff and the Science Advisory Council on October 30, 2013. The working group met again to discuss results and finalize the conclusions on December 10, 2013. In January, February, and March 2014 the workgroup results were discussed by the Science Advisory Council, the Ocean Advisory Commission, and at two public meetings. This report represents the workgroup recommendations for SSU and existing use layers in the 2014 Ocean Plan Update. Drafts of this report were improved by the comments identified in the advisory and public meetings.

2. Introduction

The primary charge of the Fisheries Work Group (as well as the other five work groups) was to identify changes to the Special, Sensitive, and Unique (SSU) resource areas and existing water dependent use maps that were developed for the 2009 Ocean Plan. The charge is fully described in the first working group report; it includes other priorities, such as updating the baseline assessment and discussing the science framework, that are being addressed outside of the scope of this report. There is one SSU resource, important fish resource areas, and two existing water dependent uses, high commercial fisheries effort and value and concentrated recreational fisheries, that the working group mapped in 2009 and reassessed this year for the 2014 Ocean Plan Update. This report describes the reassessment work done for each of those maps.

Additionally, the workgroup recommended giving aquaculture more thorough consideration in the Ocean Plan. That work is also presented.

3. High commercial fishing by effort and value

3.1 Methods

In the 2009 Ocean Plan, multiple harvester catch reporting systems, along with dealer reports were combined to generate a map that represented regions where both high effort and value fisheries occurred. The workgroup recommended conducting the same analysis for the 2014 Ocean Plan Update. A major difference between the two assessments is that DMF introduced mandatory, comprehensive trip-level reporting for all commercial permit holders in 2010, but the substance of the analysis did not require any change. All prior methods were followed and the spatial parameters remained the same.

3.1.1 Non-shellfish

The DMF trip-level reporting program is complimentary to the existing National Marine Fisheries Service (NMFS) Vessel Trip Reporting (VTR) program; the implementation of this program was a primary recommendation of the Fisheries Working Group working on the 2009 Ocean Plan. The program eliminates known data gaps in pre-2010 DMF catch report data and minimizes duplication between federal and state data collection programs. DMF trip-level reporting was initially implemented as a pilot program in 2008 with 10% of state-only lobster permit holders enrolled, and expanded to 20% in 2009 (the remaining permit holders continued to report via fishery-specific, annual catch reports during these years). The program was fully implemented in 2010. At that point, since the DMF trip-level reporting program and NMFS VTR program both collect the same type of data at the trip-level, DMF allowed the exemption of federally reporting vessels from the trip-level reporting program and instead collects those data from NMFS VTRs in order to compose a complete data set. The only processing required to fully integrate the two datasets is a spatial routine that translates the latitude and longitude coordinates provided on the NMFS VTR to DMF Statistical Reporting Areas (SRA) (Figure 1). For the 2014 Ocean Plan Update, harvester reported data from 2010-2012 came from DMF trip-level reports and NMFS VTRs. Harvester reported data from prior to 2010 came from a collection of DMF fishery-specific catch reports and NMFS VTRs. Dealer reported data sources or structure did not change.

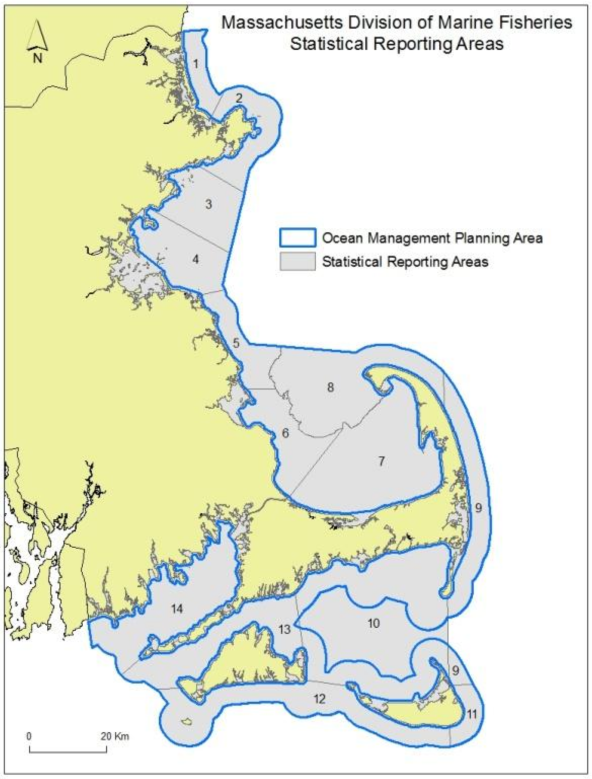


Figure 1. DMF Statistical Reporting Areas. Ocean Planning area is blue boundary line.

For the harvester reported, non-shellfish component of the analysis, integrating DMF trip-level data with the existing data used in the 2009 Ocean Plan required slightly modifying the original methods, but did not materially alter the analysis. Due to the structure of the data, this was done in a two stage process.

(1) 1988-2009 data were collected in a manner consistent with the 2009 Ocean Plan commercial fisheries analysis. Total trips and landings from State Waters were aggregated by SRA from each fishery-specific catch report from all available years. NMFS VTR reported commercial fishing trips occurring in State Waters between 2006 and 2009 were also collected. Any trips that were also reported on DMF catch reports were removed; If a VTR trip recorded landing fluke, striped bass, sea urchins, lobster (by trap only), black sea bass (by pots only) or scup (by pots only) it was removed. Furthermore, the trip was also removed if gillnets or fish weirs were the reported gear type. The remaining trips were then tallied by SRA and treated in the same fashion as DMF catch report data. With the only difference between the two sets of trip counts being that DMF fishery-specific catch reports apportioned monthly trip counts to SRAs according to individual harvest totals, while VTR data counted each distinct SRA/trip combination as a whole trip. Landings from DMF fishery-specific catch reports and NMFS VTRs were converted to ex-vessel value based on the 2012 Massachusetts state-wide landings-weighted average price per pound (by grade). 2008-2009 NMFS VTR and DMF fishery-specific catch report data were cross-referenced with participants in the trip-level reporting pilot program and any duplication between the reporting programs was omitted.

(2) 2008-2012 data were collected from both DMF trip-level reports and NMFS VTRs. Total trips and landings were aggregated by SRA. Trips were calculated in a manner consistent with the method used for the DMF fishery-specific catch reports (1988-2009). This was done because

prior to trip-level reporting, trips were reported by month and assigned to SRA based on the proportion of catch from each SRA. Trip-level data can accommodate multiple areas *per trip,* thus simply summing trips by SRA from trip-level data could potentially inflate the number of *actual* trips. Landings were converted to live pounds (whole animal, shell on) based on the grade and disposition code reported by the harvester. The live pound values were then converted to values by multiplying them by the 2012 Massachusetts state-wide landings-weighted average price per live pound (Appendix A).

After pulling harvester reported data from all sources and standardizing on trips and 2012 value, the data were merged into a single data set. The merged data set was then truncated to only include data from State Waters (SRA<15). Value and effort information were then aggregated by catch report source, SRA, and year. In order to construct a cohesive data set, data gaps in reporting years between the various catch reports needed to be filled. This was done by standardizing the broad analysis time-series according to the minimum and maximum years available in the catch report data. This resulted in a minimum year of 1988, marking the first year of the Bluefin Tuna Purse Seine Catch Report, and 2012, the most recent full year available of DMF trip-level and NMFS VTR data (Appendix B). Gap filling was only required for the fishery-specific catch reports between 1988 and 2005. Only data from full collection years (1988-2007) of the fishery-specific catch reports were used to generate these averages. Gaps were filled by substituting the average value (and trips) for each SRA by catch report source for the available data. 2008-2012 DMF trip-level and NMFS VTR data were added to these data. This resulted in an estimate of trips and value by year for each SRA that could then be summed across all catch report sources to obtain an annual estimate of value and trips by SRA between 1988 and 2012. These annual totals by SRA were then averaged across the time-series and divided by the square kilometers of their corresponding SRA to arrive at a measure of fishing effort and value per unit of area. These estimates were used for the non-shellfish component of 2014 Ocean Plan Update commercial fisheries analysis.

3.1.2 Shellfish

The shellfish component of the analysis used Massachusetts dealer reported shellfish transactions from the Standard Atlantic Fisheries Information System (SAFIS) between 2006 and 2012. Each transaction was considered to represent one fisherman trip. Total number of trips and landings value were tallied by Designated Shellfish Growing Area (DSGA) (Figure 2) and averaged over the available years. When no price or value information was provided by the dealer, values were derived by multiplying the live pound landings by the state-wide landings-weighted average price per live pound. The values were then divided by the square kilometers of each DSGA to obtain average trips and landings value per square kilometer.

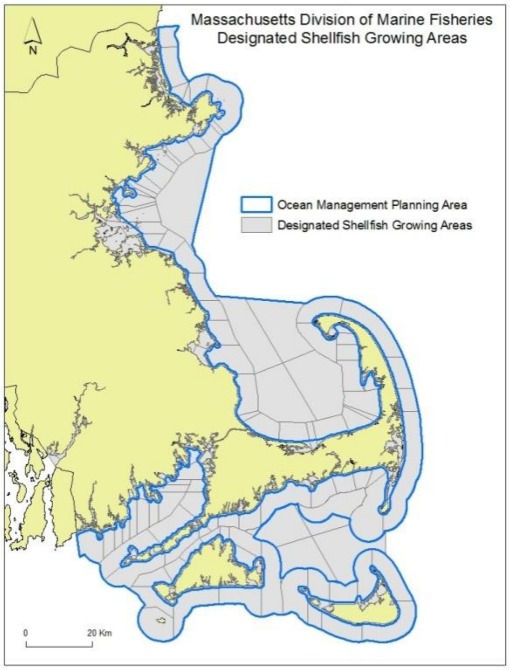


Figure 2. Designated Shellfish Growing Areas updated 1/10/2014. Ocean Planning area is blue boundary line.

3.1.3 Geoprocessing

Spatial analysis utilized ArcGIS 9.3 software for all geoprocessing. All geoprocessing analysis steps remained consistent with the 2009 Ocean Plan and are outlined in Appendix C.

All sources of commercial fishing effort and landings value data were converted to a 250 m^2 raster grid and condensed into two layers representing the combined fishing effort across all commercial fisheries, and the combined value of landings generated by those fisheries for the shellfish and non-shellfish components (DSGA and SRA). To prevent the scale of commercial fisheries in one part of the state overshadowing the importance of those in other parts of the state, the planning area was broken into two regions: north of Cape Cod and south of Cape Cod (Figure 3). The two raster layers (combined fishing effort and total landings value) were then re-classified into 10-percentile bins, *within* each of those regions. With the two layers now on the same relative scale, they were added together (i.e. given equal weight). The resulting combination was re-classified into high (top 25%), medium (middle 50%) and low (bottom 25%) categories within each region. These geoprocessing steps were applied to the entire time-series (1988-2012). This map (Figure 4B) was compared to the 2009 Ocean Plan map (Figure 4A) by subtracting the original 2009 Ocean Plan activity raster map from the 2014 Ocean Plan Update raster map to create a residual map (Figure 4C). The same geoprocessing steps were also applied to a truncated time-series (2010-2012) that only included DMF trip-level reports and NMFS VTRs (Figure 5). This was done to assess recent commercial fisheries activity in relation to historical activity, and also to view the unadulterated trip-level data available between 2010 and 2012.

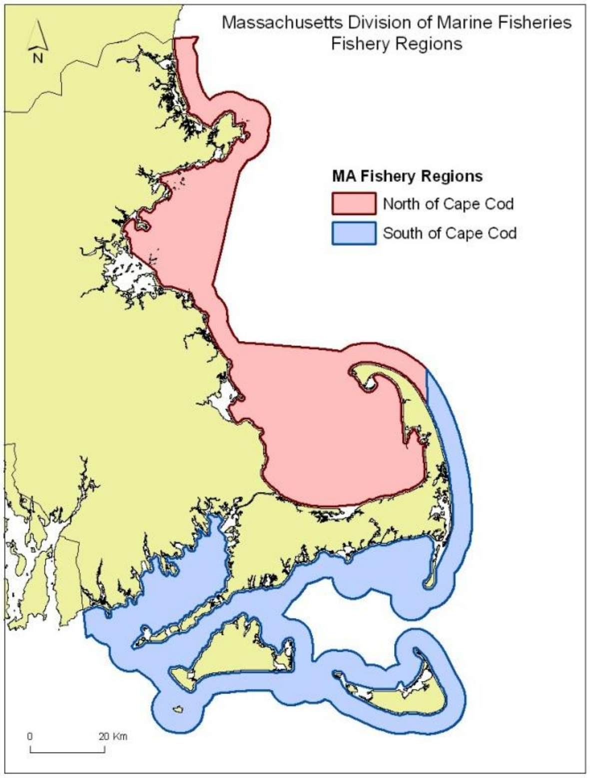
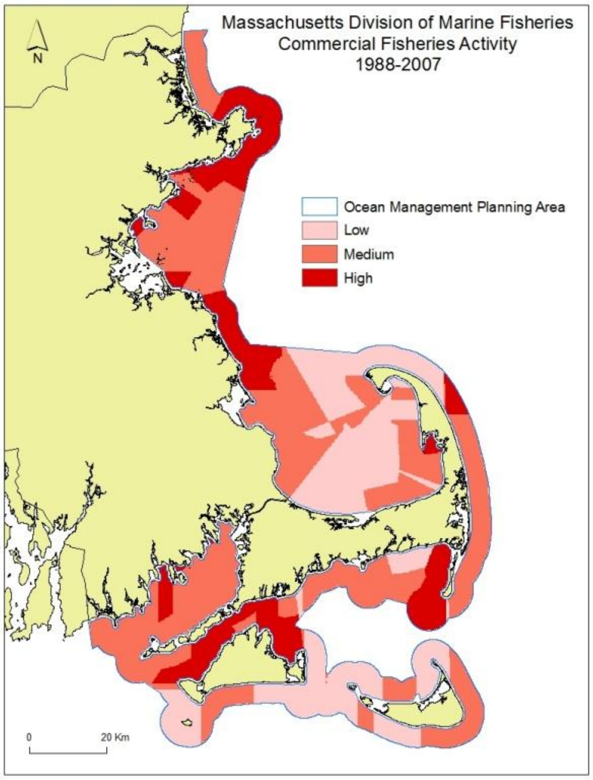
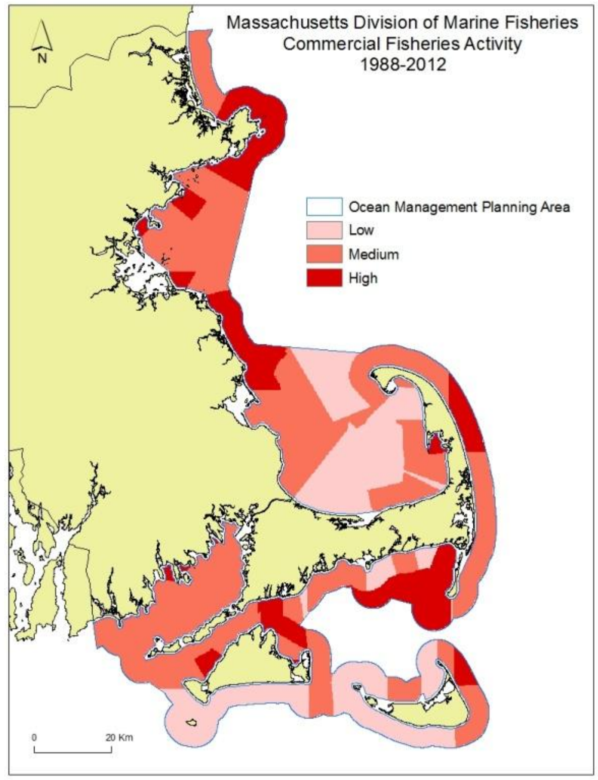


Figure 3. Regions used in commercial fishing analyses.





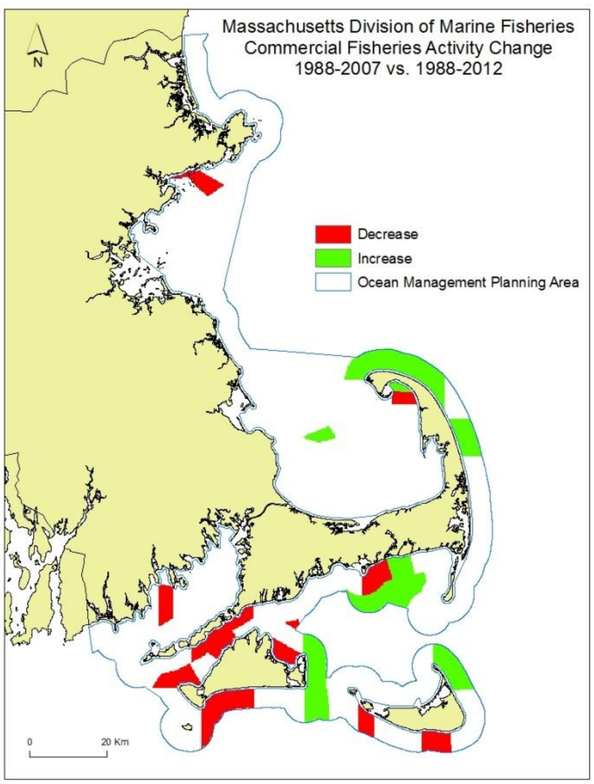


Figure 4. Commercial Fisheries Activity raster maps. (A) 2009 Ocean Plan using 1988-2007 data (top left), (B) 2014 Ocean Plan Update using 1988-2012 data (top right), and (C) residual map comparing difference between 2009 Ocean Plan and 2014 Ocean Plan Update full time-series commercial fishery activity maps (bottom left).

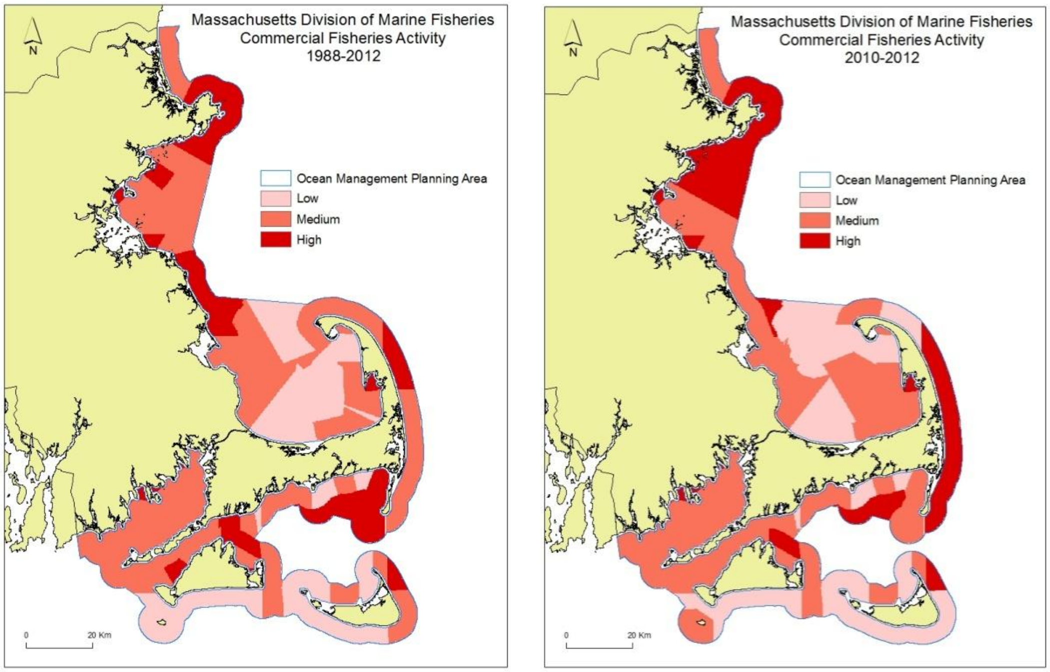


Figure 5. Commercial Fisheries Activity raster maps. (A) 2014 Ocean Plan Update analysis (left), and (B) 2014 Ocean Plan Update using the time series truncated to 2010-2012 data (right).

3.2 Results

The fisheries workgroup recommends using the high values in the updated full time-series (1988-2012) commercial fisheries activity raster map (red polygons in Figure 4B) as the updated "High Commercial Fishing by Effort and Value" map in the 2014 Ocean Plan Update.

3.3 Discussion

In order to include all of the most relevant data, the fisheries workgroup recommends updating the high commercial fishing by effort and value map using the 1988-2012 time series analysis. The residual map, which compares the analysis done for the 2009 Ocean Plan with the more up to date analysis, indicates a relative increase in activity on the backside of Cape Cod near Wellfleet and Provincetown, and increases south of Cape Cod in the Nantucket Sound area. There are decreases in Buzzards Bay, Vineyard Sound, and Massachusetts Bay. The results of the truncated (2010-2012) analysis suggest expansion of high activity areas along the northshore and the backside of Cape Cod in recent years relative to historical data (Figure 5). However, using the truncated time series was not recommended as the ocean plan layer since it represents such a short time series and there is enough variability over time that the approach utilizing a longer time series is more resistant to change.

It is important to remember that the final maps convey relative importance of fisheries activity, and due to north-south stratification, it is possible to have an area of 'high' importance south of Cape Cod that in absolute terms is less than an area of 'low' or 'medium' activity north of Cape Cod. Spatial scales also play a critical role when interpreting these results. The areal units used to report and aggregate these data are coarse. Concentrated commercial fisheries can occur in locations that exist at finer spatial scales than can be accurately detected by these data. Conversely, concentrated fishing in an isolated portion of an areal unit will influence the value for the entire areal unit, which is potentially misleading for locations within that unit where no commercial fishing occurs. These spatial patterns of fishing activity change over time in response to market forces, management actions, abundance, etc.

Therefore it is important to view this analysis as a historical view of important Massachusetts fisheries. Also, it is critical to understand that the accuracy of these data depend upon commercial harvesters and dealers accurately reporting their data, especially the area information.

The shellfish component of the analysis depends on dealers assigning the correct DSGA to shellfish transactions. Dealers are required to report shellfish species by DSGA. However, if a dealer fails to correctly assign a DSGA to a shellfish transaction, that transaction would be omitted from this analysis. For the most part DSGA information is correctly assigned, however certain shellfish species may disproportionately get assigned incorrect DSGA values. For example, on average 40% of conch landings in MA between 2006 and 2012 were not assigned a DSGA. The reason for this is either the transaction was legitimately reported without a DSGA because it was harvested from offshore waters outside MA State Waters, or dealers may not realize they need to provide a DSGA for these transactions. If the DSGA from legitimate State Waters shellfish harvest is not provided, especially when concentrated within a specific species, there is the potential to under represent that species in this analysis. This issue, specific to conch species, could be rectified by either altering the source of conch data (which may trigger its representation at the SRA areal unit) or improving DSGA reporting.

This analysis is sensitive to fluctuations within individual species' state-wide landings-weighted average price per pound. In the 2009 Ocean Plan, all non-shellfish species reported on harvester catch reports were converted to a value based on the 2007 average price. The updated analysis in 2014 followed this same method but standardized value based on the 2012 average price. Thus, any changes in price between 2007 and 2012 at the individual species level could impact the value and subsequent relative weighting of commercial importance in this analysis. In other words, a species with constant landings between 1988 and 2012 that experiences a major price (and subsequent value) increase in 2012 relative to 2007 will have more importance in the 2014 Ocean Plan Update. Major price changes between 2007 and 2012 were seen in the commercial lobster fishery, where the price declined 27% from $5.05/lb to $3.68/lb (Appendix A). Lobster landings dominate the non-shellfish component of this analysis so this is important to the interpretation of the data.

Due to the array of catch reporting systems spanned by this analysis, maintaining consistency between them was difficult. Specifically, before the full implementation of DMF trip-level reporting in 2010, 1988-2009 data still contained small gaps in data collection coverage (Appendix B). In 2010, these data gaps were eliminated by trip-level reporting. These data sets were merged together for this analysis with the assumption that they were essentially equivalent. However, in reality 2010-2012 data is more complete. Despite being slightly different from one another, including the full comprehensive trip-level data in 2010-2012 benefits the larger analysis by providing more information for the time-series average.

In addition to the commercial fisheries activity analysis, the group discussed the value of including vessel monitoring system (VMS) data in the assessment. Many of the Massachusetts fisheries are not covered by VMS due to size or activity in fisheries that are not federally managed (Appendix D), which is the primary reason the working group did not recommend focusing on VMS data. However, there are significant efforts underway by regional ocean planning interests to interpret VMS data at the regional scale, including differentiating between transit routes and fishing activity. This work may influence future updates, but is outside of the timeline for the 2014 Ocean Plan Update.

In the course of reviewing the data products from this report, several commenters identified the need to identify individual fisheries and fishing methods since some fisheries will be more vulnerable to various construction impacts than others. For example, a wind farm might have differential impacts on trawl versus fixed gear fisheries. The workgroup as a whole concurs with the value in better spatial assessment of the individual fisheries and fishing practices for both screening purposes and the determination of potential impacts from a given project. Caution is also warranted in relying too heavily on aggregated data when reviewing specific construction projects, since it can be hard to predict how future construction activities might affect future fishing activities. Furthermore, the various stages of construction projects all have unique potential impacts and timing can heavily influence the amount of impact anticipated.

4. Concentrated recreational fishing

4.1 Methods

For the 2009 Ocean Plan, a survey was sent to thirty expert fishermen with maps of four different regions of the state. The survey provided maps of the state and requested information regarding concentrations of recreational fishing activity (where fishermen fish). Seventeen fishermen responded by drawing polygons on the maps; their maps were georeferenced and digitized. The resulting polygons were then gridded to the standard 250 m^2 grid used for ocean plan layers. All areas identified were considered "Areas of Concentrated Recreational Fishing" (Figure 6A).

For the 2014 Ocean Plan Update, the first dataset considered was from the Marine Recreational Information Program (MRIP) Access Point Angler Intercept Survey (APAIS), an intercept survey of recreational fishermen done dockside by field interviewers at the completion of the fishing trip. The survey is conducted by DMF under NOAA survey protocols. The survey did not include shoreside anglers and used the subdivisions of the existing commercial statistical reporting areas to record spatial information. The survey included spatial information from March to June 2013, but had to discontinue collecting the information based on NOAA protocols. The number of trips per statistical reporting area were mapped (Figure 6B) and the available data was considered for inclusion, but due to the coarse spatial and temporal resolution, it was not used.

The second data source developed was a repeat of the 2009 survey. In the fall of 2013, the survey was sent to 53 experienced recreational fishermen (including charter boat captains and Division of Marine Fisheries employees) to create maps. Twenty-eight responded; some responded with information for multiple regions (Table 1). The maps were digitized and original polygon boundaries were maintained (i.e. no gridding was done as in 2009). A third dataset was available from the SeaPlan recreational boater survey. From May to October 2012 SeaPlan invited a representative random sample of recreational boaters to provide transects of boating trips. The trips that were coded as fishing trips were overlaid on the expert survey (Figure 6C).

Table 1. Number of recreational fishing survey respondents by region.

Region	Number of Responses
A	12
B	11
C	13
D	12
Total	**48**

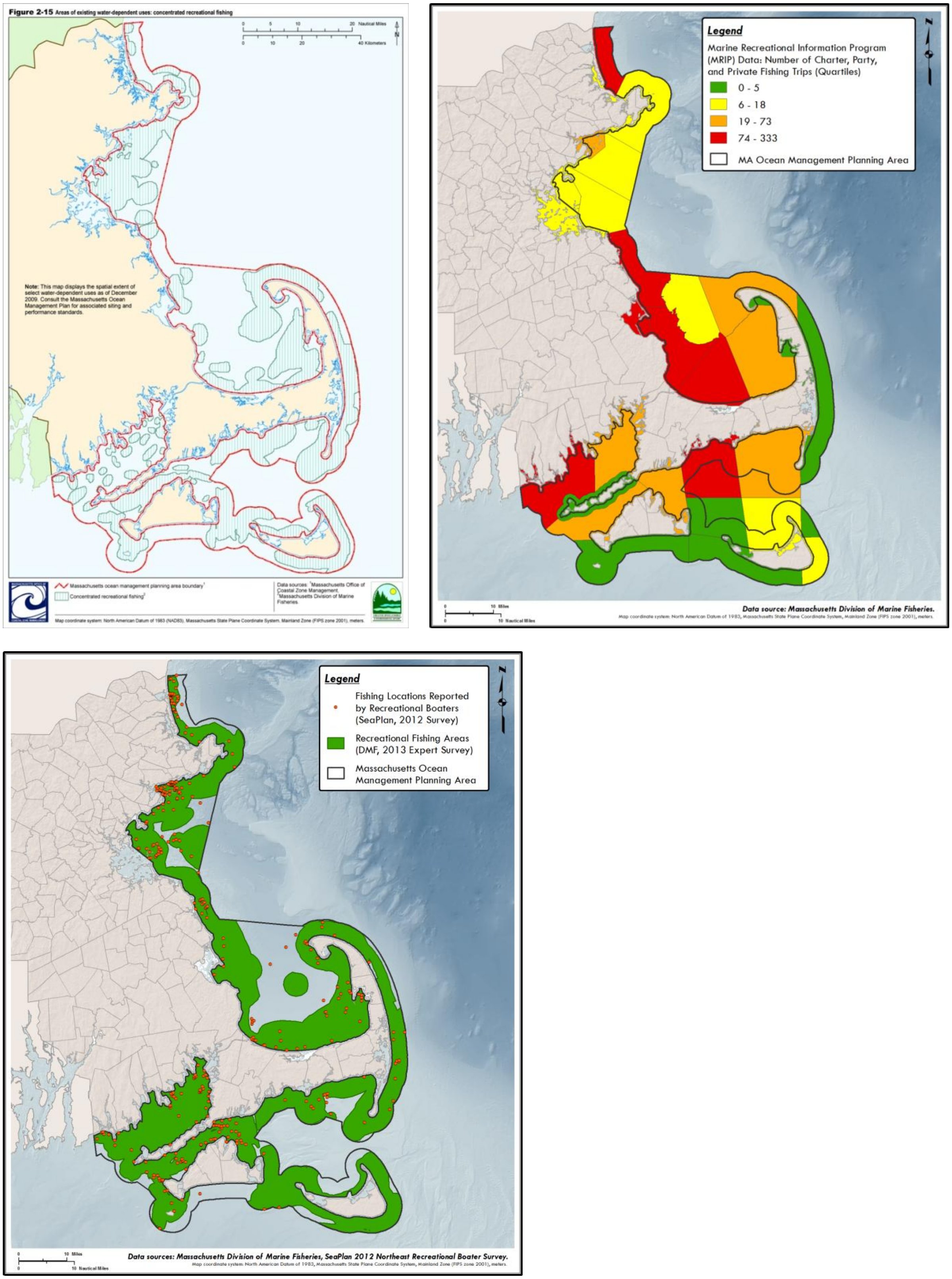


Figure 6. Areas of Concentrated Recreational Fishing maps. (A) 2009 Ocean Plan (top left), (B) MRIP survey data; number of recreational fishing trips by statistical reporting area, March-June 2013 (top right), and (C) Areas of Concentrated Recreational Fishing, 2014, with recreational boater survey data in red dots (bottom left).

In order to delve deeper into the concentrated recreational fishing data results, the individual survey results were gridded into 250m^2 cells. A heat map was generated identifying degree of overlap in the survey results (Figure 7).

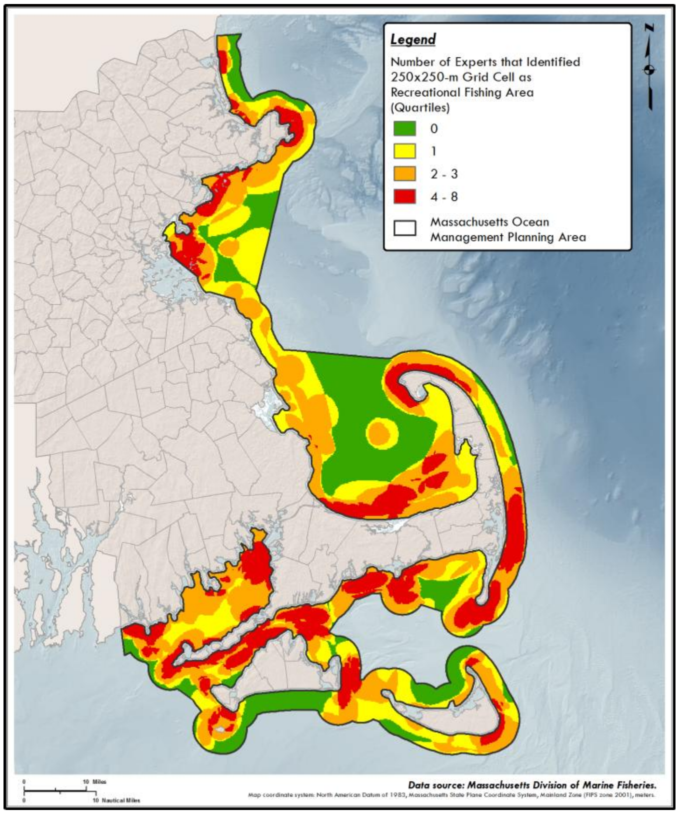


Figure 7. Number of survey respondents identifying a cell as important for recreational fishing.

4.2 Results

The 2014 mapping effort increased the amount of area of concentrated recreational fishing by 1,284 km^2 (Table 2). It is likely that the amount of area increased as a result of a greater number of survey respondents. Therefore, the fisheries workgroup recommends using the expert survey results with more than one respondent identifying an area as important (orange and red polygons in Figure 7) as the updated “Areas of Concentrated Recreational Fishing” map in the 2014 Ocean Plan Update. Using the area of the state identified by more than one respondent increases the amount of area of concentrated recreational fishing by 113 km^2 (Table 2).

Table 2. Comparison of area of concentrated recreational fishing in 2009 and 2014.

	Area (km^2)	Percent of Planning Area
2009 Survey	2,887	52
2013 Survey	4,171	75
2014 Update	3,000	54
Planning Area	5,554	

There were 334 fishing locations reported by recreational boaters in the planning area. Two hundred forty-six (246) points (74%) intersect the fishing areas identified in the 2009 expert survey and 93% of the locations (n=312) intersect the fishing areas identified in the 2013 expert survey.

4.3 Discussion

The MRIP survey had to discontinue including spatial information in 2013, but it is anticipated it will be included in the future. The survey has a robust design and sampling methodology, but the statistical reporting areas may not provide spatial resolution needed for effective ocean planning.

The expert survey was done to attempt to more specifically identify areas of concentrated recreational fishing activity. The 2013 survey resulted in more area than was identified in 2009. This is not necessarily a reflection of the expansion of areas of concentrated recreational fishing. Instead, this is thought to be a byproduct of including additional fishermen and the fishermen's different approaches to the survey maps. The different approaches were apparent in the maps that they submitted; some drew very general polygons covering entire waterbodies and others were more specific. The expert survey could be further refined with additional information (e.g. localized meetings refining the polygons or not using maps that were clearly drawn in a very general manner).

The workgroup recommends improving the survey. The 150,000 person angler database generated from the recreational fishing license may be useful in designing a more accurate survey, and other survey methodologies utilizing cell phones or vessel gps devices may be worthy of consideration. Also of interest for future discussion is including recreational lobster. The reporting standard for recreational lobster changed in 2011 and may provide useful information for ocean planning. The majority of this activity is thought to be outside of the ocean planning area so it wasn't prioritized this year. Shellfishing was also recognized as an important recreational fishing activity that occurs primarily outside of the ocean planning area. The working group did not identify a single source of information that could be used to better understand the spatial distribution of recreational Shellfishing; it is thought that a town-by-town approach will be needed.

5. Important fish resource areas

5.1 Methods

In 2009, the important fish resource area assessment relied exclusively on fisheries-independent otter trawl survey data collected by DMF each year in September and May since this dataset has the most reliable, consistent statewide extent. The survey is conducted for the purpose of measuring changes in the relative abundance of commercially and recreationally important groundfish over time. It is stratified according to depth and region. Some strata are not spatially contiguous due to the need to have enough area in which to randomly assign multiple tows (Figure 8). A primary goal of the 2009 ocean planning process was to create layers with statewide extent for the purpose of site selection screening for wind power and other ocean uses. Therefore, the trawl survey results were compiled according to the survey strata. The assessment was done using survey years 1978-2007. Based on the fisheries workgroup recommendation, the same analysis was done for the 2014 Ocean Plan Update using survey years 1978-2012.

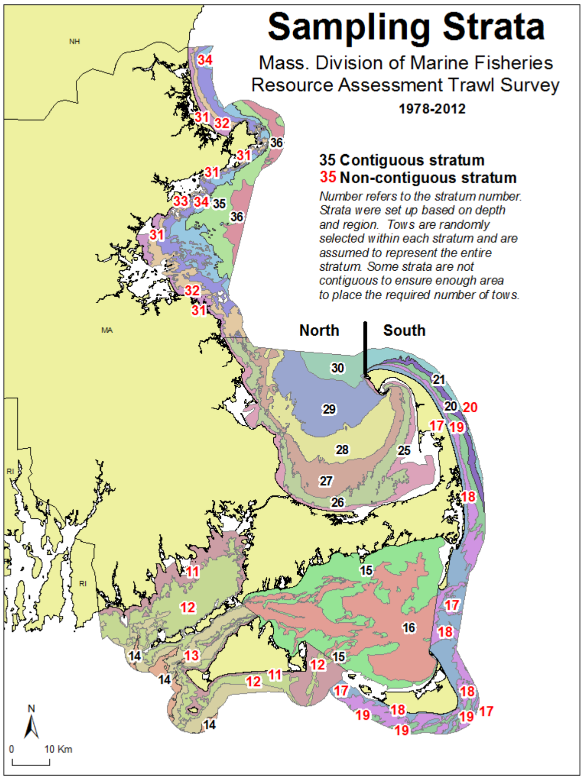


Figure 8. Contiguous and non-contiguous sampling strata. North-south break indicated by black line.

Over time, the survey has collected 181 species. Twenty-two of these species were selected for the ocean plan assessment based on their vulnerability to the trawl (e.g. catchability) and their commercial and recreational importance in the state (Table 3). Atlantic cod and black sea bass young-of-the-year were also included as separate layers in the assessment. Species biomass distributions are strongly tailed with low or zero catches dominating. Therefore, specific analytical decisions were made in order to achieve the following goal: a statewide distribution identifying areas (strata) of relatively high biomass consistently over time for commercially and recreationally important species in the dataset. All statistical and classification work was conducted in R 3.0.1 and Excel 2007; maps were prepared in ArcGIS 10.1.

Table 3. Species selected for consideration in Fisheries Resource analysis

American Lobster	Scup
Atlantic Cod	Sea Scallop
Black Sea Bass	Silver Hake
Channeled Whelk	Spiny Dogfish
Haddock	Summer Flounder
Horseshoe Crab	Tautog
Jonah Crab	Windowpane Flounder
Knobbed Whelk	Winter Flounder
Little Skate	Winter Skate
Loligo	Witch Flounder
Red Hake	Yellowtail Flounder

5.1.1 Individual species maps

For each species, the biomass (abundance for jonah crab, Atlantic cod juveniles, and black sea bass juveniles) was averaged by survey stratum over the survey time series (1978-2012) using the trimean averaging technique ([1st quartile + 2*median+3rd quartile]/4). We selected the trimean to measure the center of the dataset because it is resistant to outlier years (years that have very high or low catches) when compared with the arithmetic mean. The trimeans were calculated in R 3.0.1.

We selected a stratum for inclusion for each species based on the criterion of having at least 7 years of non-zero catches within a season. This selection process allowed us to focus on strata where species were consistently caught in the time series. Sets of strata were analyzed by region (generally north or south of Cape Cod in order to recognize that this boundary is used to delineate different stock units of the same species. Each stratum was classified as high (top 25%), medium (middle 50%), and low (bottom 25%) categories based on distribution of stratum trimean values within the regional stratasets north and south of Cape Cod (a third strata set was included for the backside of the Cape of cod recruitment). Only included strata were used in evaluating quartiles for classification. Excluded strata were classified as NA and should be considered as less than low. Note that the classification of the strata represents a relative ordering of the strata. The quartiles were calculated in ArcGIS 10.1, which treats the data as discrete and creates classes with an equal number of features. For two species in particular, horseshoe crabs and summer flounder, this method placed very similar features (i.e. stratum trimean values) in adjacent classes. So for these two species, the quartile thresholds were manually calculated on the continuous data.

We overlaid the individual species' stratum maps with dots presenting the approximate location and relative biomass of the tow for that species. The choice of classification scheme for binning the biomass data (e.g. the size of the dots) is important for accurately decoding the maps and critical for creating a framework for decision making. For example, a large dot will lead the map user to consider that particular area "very important" regardless of other factors such as frequency of high catches, the particular season, and the actual value of the biomass. The non-zero tows by species were scaled north and south of Cape Cod and by season using the head/tails classification method which is designed for highly-skewed data (Jiang 2013). The thresholds were calculated in Excel. Zero tows were included as Xs on the maps. The dots were further classified with different colors for successive survey time periods. The survey time periods were selected to encompass equivalent numbers of tows. The species- and season-specific dot maps for winter flounder are shown in Figure 9. Maps for all of the species and seasons are provided in Appendix E.

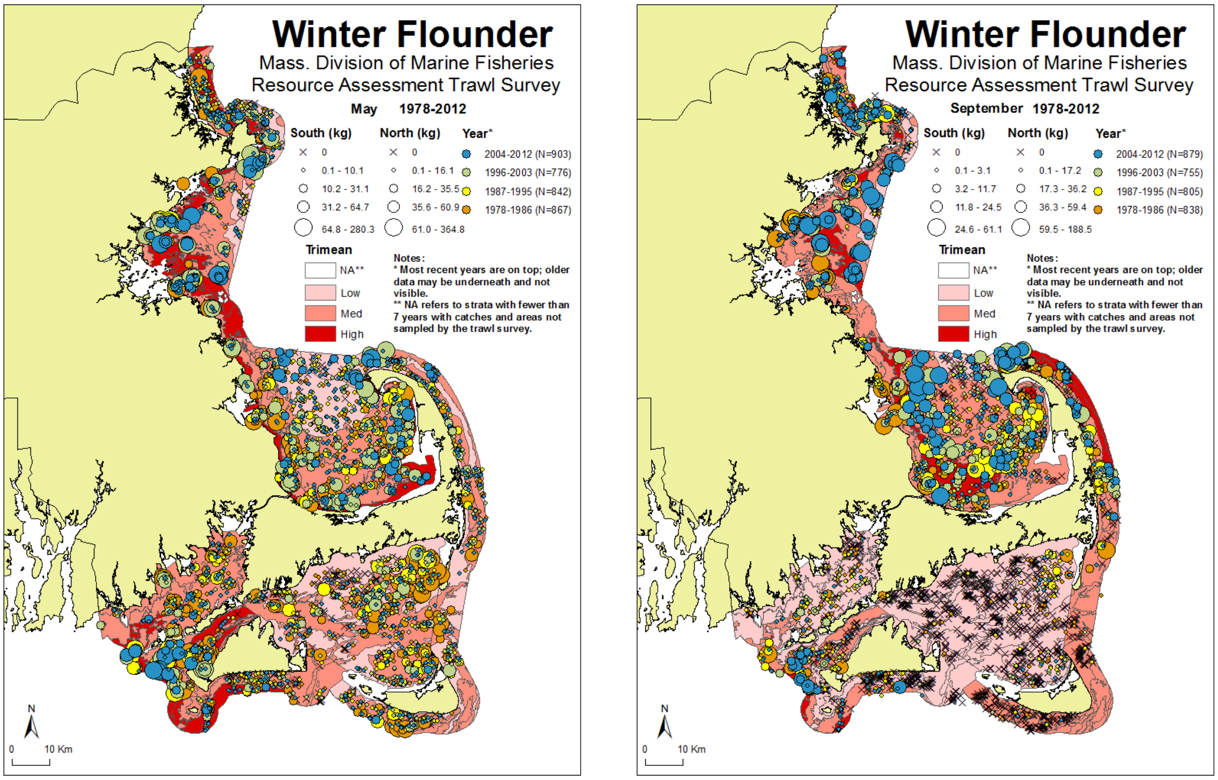


Figure 9. Winter flounder trimean assessment and tow-specific biomass, 1978-2012. A) Fall and B) Spring.

5.1.2 Composite Ocean Plan map

The final ocean plan map is a composite map identifying areas of the state with consistently high biomass for all 22 species. We combined the species and season specific data by normalizing the species stratum trimean by dividing the stratum trimean by the sum of the trimeans for all included strata within a season. Normalizing the stratum trimean gives each species approximately equal influence in the model. The median of the normalized trimean values for all species/seasons was then determined for each stratum. We classified the stratum into high (top 25%), medium (middle 50%), and low categories (bottom 25%) based on quartiles of the distribution of medians of normalized stratum trimean values within regional stratasets (north and south of Cape Cod). The trimeans were calculated in R 3.0.1 and the quartiles were calculated in ArcGIS 10.1. Species/strata/season combinations lacking at least 7 years of positive observations were not included in the analysis.

We compared results from our analysis for the 2014 Ocean Plan Update with the analysis done for the 2009 Ocean Plan, which covered the 1978-2007 time period. There was no change (Figure 10). The results from the 2009 Ocean Plan analysis were slightly modified to produce the final important fish resource area map. Values of the nearest trawl survey stratum were assigned into Salem Harbor and areas outside of the ocean planning area were removed (Figure 11). Making these modifications to be consistent with the 2009 Ocean Plan is recommended.

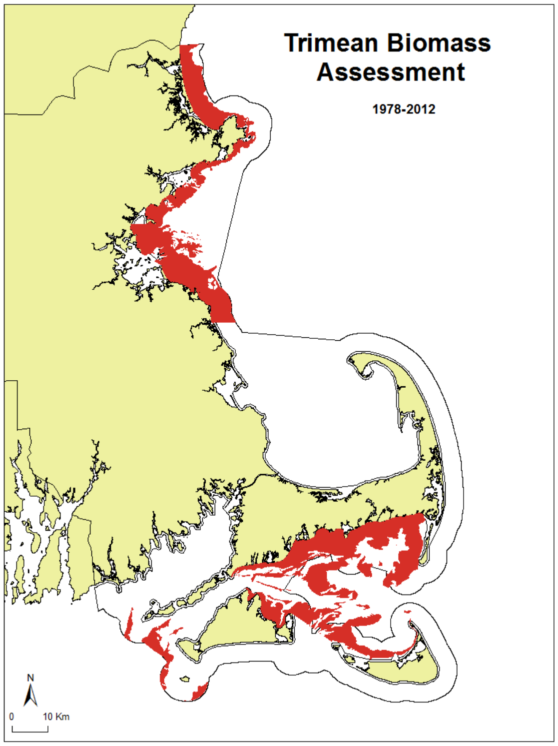
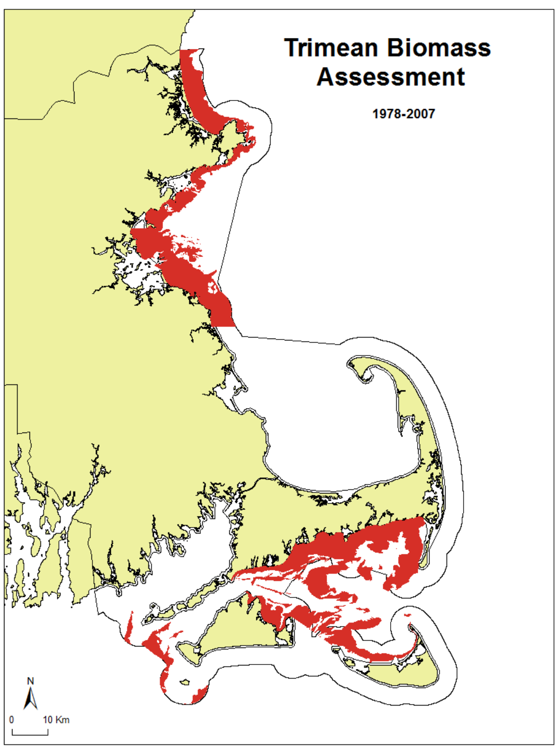


Figure 10. Highest 25% of trimean values are the important fish resource areas A) 1978-2007 and B) 1978-2012. Ocean planning area boundary is in black.



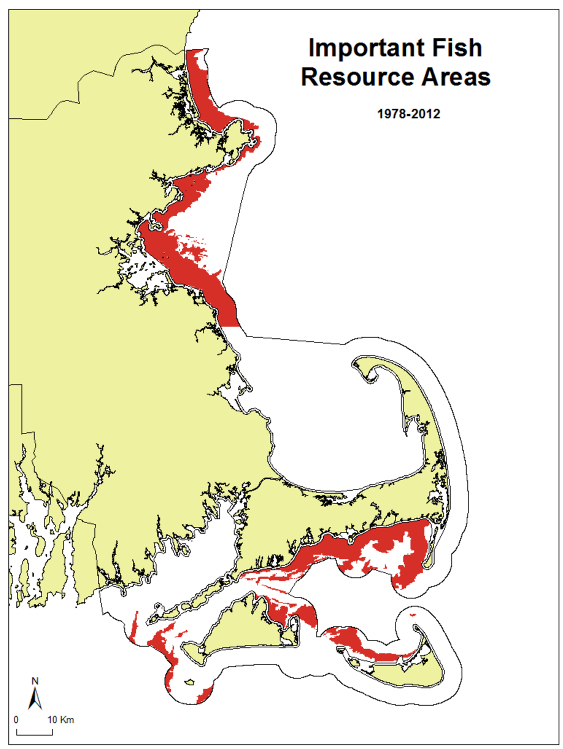


Figure 11. Recommended important fish resource areas for 2014 Ocean Plan Update. No change from 2009 Ocean Plan. Figure 5 is slightly different than Figure 4 since the nearest trawl survey stratum values were assigned shoreward into Salem Harbor and results outside of the ocean planning area were removed consistent with what was done for the 2009 Ocean Plan.

The composite analysis was also done for the time period of 2008-2012 and is different than the 1978-2012 map (Figure 10B). Because of the truncated time period, species/strata/season combinations lacking at least 1 year of positive observations were not included in the analysis. The sample size used to generate this map is much smaller (994) than used in the full 1978-2012 map (6665).

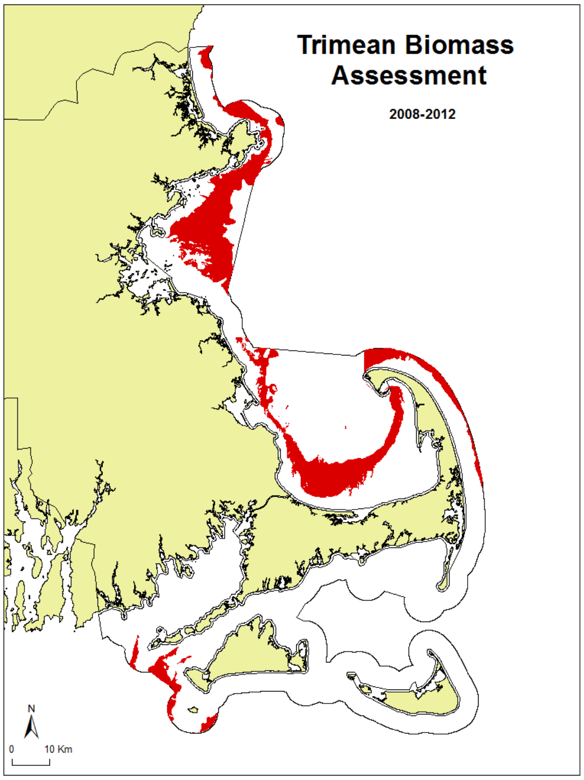


Figure 12. Highest 25% of trimean values 2008-2012.

5.1.3 High biomass tow map

In order to examine spatial distribution of high biomass tows, the location of tows with the top 5% of biomass were provided as a dot map (Figure 13). All species were included in the analysis, not just the 22 used in the composite analysis (except for nine species that are inconsistently recorded: northern shrimp, green crab, sand dollar, sea urchin, hermit crab, Naticidae, northern moonsnail, squid mops, and "trash," which includes algae). For each year, we plotted the location of the top 5% of tows from the cumulative distribution of aggregate biomass by tow for each season within regional stratasets (north and south of Cape Cod). This was done by calculating the percentile ranks in R 3.0.1 and plotting the top five bins for each season in ArcGIS 10.1.

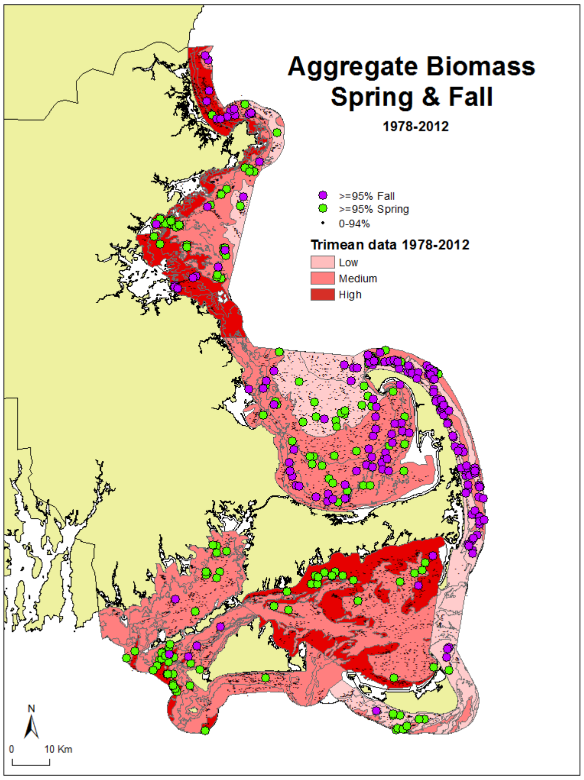


Figure 13. Highest 5% of year-corrected aggregate biomass, 1978-2012.

5.1.4 Habitat closure maps

Also, maps identifying official fisheries closure areas relevant to vulnerable life stages were provided: the Cod Conservation Zones for the protection of aggregations of spawning cod and the inshore net closure for protection of winter flounder spawning (Figure 14). The Winter Cod Conservation Zone prohibits any taking of cod by any means from November 15-January 31 (322 CMR 8.15 (1)). The Spring Cod Conservation Zone prohibits any landing of cod from April 16-July 21 (322 CMR 8.15 (2)). The inshore closure is closed to the commercial fishing for any finfish from February 1 to May 31 (322 CMR 8.09).

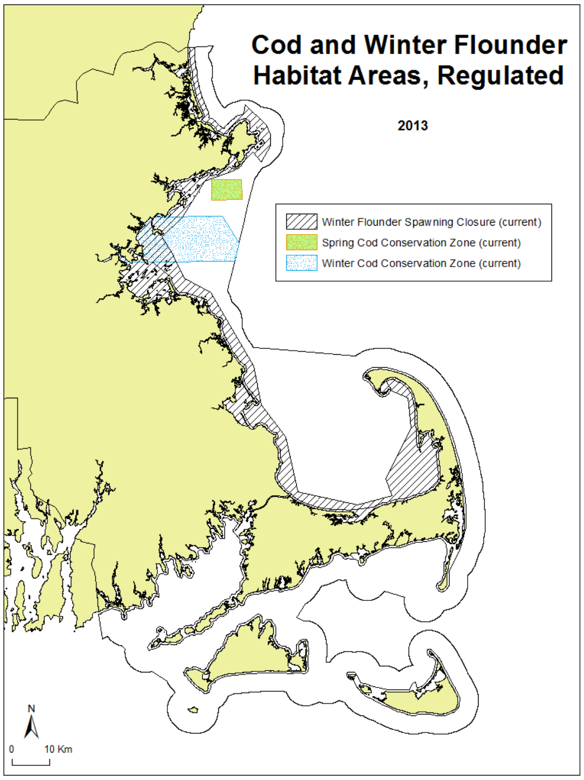


Figure 14. Fisheries regulated areas for the protection of spawning cod and spawning winter flounder.

5.2 Results

The fisheries workgroup recommends using the modified composite trimean stratum assessment map from 1978-2012 (Figure 11) as the updated "Important Fish Resource Areas" map in the 2014 Ocean Plan Update. There is no change in this layer from the 2009 Ocean Plan.

5.3 Discussion

The fisheries working group and the Science Advisory Council have discussed in some detail specifically how to define and map important fish resource areas. The composite mapping method used for the important fish resource area map is a robust method to identify areas that have consistently high biomass over time since it is resistant to outliers. However, the composite map may not accurately reflect shorter-term changes in spatial patterns of biomass. The more recent data identifies deeper waters as having higher average biomass over five years in contrast to the identification of shallower waters with higher average biomass over thirty-four years (Figures 10 and 12). Because the sample size is considerably reduced when smaller time series are examined, differences in the distribution of areas considered "important" may reflect random variation rather than actual change in relative importance of strata. Spatial-temporal variability in distribution of fish may be a function of changes in population size as well as response to changes in abiotic environment such as temperature.

The composite map is not directed toward any specific vulnerability, but combines many species. Identifying areas that have had consistently high biomass is an acceptable approach in developing a single map that represents many species. However, it necessarily condenses a great deal of information. The relative difficulty in determining "biomass hotspots" in Massachusetts is also apparent in the top 5% of aggregate biomass map (Figure 13). In any given year, consistent patterns in location of high biomass are not readily discernible. Also, the biomass is driven by different species in different years. Lastly, if an area has had a high biomass tow sometime in the last thirty years, that one piece of information alone does not suggest the area is important or vulnerable. Being able to explore the underlying data and better understand why certain areas might be considered of "high importance" has been identified as a critical component of working with this dataset.

One effort aimed at improving the availability of species and trawl specific information was the generation of a set of species and season specific stratum assessment maps overlaid with dots at each tow location scaled to represent biomass and shaded to represent decade (Figure 9). This approach enables the user to identify the location of individual trawls have and uncover the spatial distribution of tows with relatively high catches. Furthermore, if a particular species is thought to be uniquely vulnerable to an activity, the spatial distribution of the trawl survey catches of that species can be seen. Another benefit of the dot maps is that they more readily indicate the areas were trawl data is not collected (if the seafloor is too rough, for example) and where the stratum assessment is more reliant on interpolation.

Despite these benefits of the dot maps, we reiterate that the survey is done in only two months of the year, uses a statistical design that is not efficient for determining spatial distribution, and may miss specific activities that may be vulnerable to other ocean uses. A particularly relevant example is the winter and spring cod spawning activities in Massachusetts Bay and off the coast of the South Shore. Therefore, the working group included maps of the cod conservation zones and winter flounder spawning protection zones in this report. These are the two most habitat-related fisheries protected areas that DMF regulates. Making the areas better known and having the maps available was deemed important for informing the review process for construction projects.

Although the static dot maps are useful and easy-to-use information, many more questions could be asked of the dataset that might prove relevant for ocean planning and coastal development. To that end, a subworkgroup has been assembled to discuss various tools that could be optimized to allow for deeper exploration of this dataset and provide the much-needed context for interpreting fisheries data through the lens of ocean planning. The workgroup as a whole encourages the development of such of tool and the necessary training for environmental reviewers.

Further work is also underway to focus more heavily on species anticipated to be vulnerable to certain activities (as is done in the habitat working group). Further work will also explore how to identify SSU areas based on abiotic features (e.g. substrate and tide rips) and incorporate other sources of information such as commercial fisheries data and qualitative information. Some of the critical fish habitats, namely eelgrass, intertidal flats, and hard/complex seafloor, are already recognized as SSUs by the Ocean Plan. Whether or not the important fish resource areas map becomes multiple layers in the Ocean Plan remains to be seen and is not expected to be a part of the 2014 Ocean Plan Update.

6. Aquaculture

In the legislation that established the Ocean Plan, the Oceans Act of 2008, one of the goals outlined was to "identify appropriate locations and performance standards for activities, uses and facilities allowed under the Ocean Sanctuaries Act, including but not limited to renewable energy facilities, aquaculture, sand mining for beach nourishment, cables, and pipelines" (Massachusetts 2008). Municipalities have jurisdiction for the siting of aquaculture activities with the approval of DMF. The existing review process evaluates how proposed aquaculture license sites avoid and minimize impacts to sensitive habitats, existing shellfish beds, and conflicts with other user groups (322 CMR 15.06). In order to better elucidate the Commonwealth's priorities regarding how to site aquaculture, the fisheries working group recommended addressing new offshore aquaculture in a similar manner as sand mining, cables, and pipelines. The Ocean Plan does not alter the existing municipal and state jurisdictions regarding the granting of licenses and permits for aquaculture, but it provides a mechanism to better identify issues that proponents should address in their project development process.

6.1 Methods

In the 2009 ocean planning process, compatibility assessments were the foundation for the development of the siting and performance standards for uses ultimately covered in the Ocean Plan such as sand mining. A compatibility assessment for aquaculture was completed at that time, though it was not used to develop siting and performance standards (Chapter 3 and Appendix 2 of the Draft Ocean Management Plan, EEA 2009). The fisheries workgroup recommended revisiting how to address aquaculture in the 2014 Ocean Plan Update. Therefore, in the fall of 2013 a subworkgroup of the fisheries workgroup reviewed the compatibility assessment that was conducted in 2009 and used it as the basis for recommending siting and performance criteria for consideration in the 2014 Ocean Plan Update.

Through the process of considering how aquaculture should be addressed in the ocean plan, the workgroup also recommended providing maps of fixed fishing facilities including aquaculture license sites and fishing weirs for use by proponents of other projects. These types of facilities may or may not be vulnerable to other uses such as sand mining and cables, so they are provided as informational layers, not as "water-dependent use" layers that should be avoided. The shellfish landings and value from aquaculture license sites are captured in the commercial fishing. The aquaculture and weir maps were made in ArcGIS by delineating the boundaries of existing facilities in the ocean planning area using existing permit documents, information from permit holders, and site visits.

6.2 Results

The compatibility assessment that was conducted in 2009 was determined to be highly relevant today. Using that as a framework, the following siting and performance criteria are proposed for the 2014 Ocean Plan Update:

Allowed Use	**Siting Standard**	**Performance Standards**	**Natural Resource or Water-Dependent Use**
Aquaculture	Presumptively excluded from SSU resource areas; exclusion rebuttable by determinations of LEDPA, no significant alterations, or inaccurate data	Public benefit determination Avoid damage to SSU resources No significant alteration	• North Atlantic Right Whale Core Habitat • Fin and humpback whale core habitat • Areas of hard/complex seafloor • Eelgrass • Important fish resource areas
	Avoid, minimize, and mitigate impacts	Meet all applicable permitting standards	• Areas of concentrated recreational fishing • Areas of high commercial fishing effort and value • Areas of concentrated commerce and commercial fishing traffic

The only difference between the compatibility assessment and the proposed siting and performance standards is the omission of intertidal flats in the Natural Resource presumptive exclusion section in the table above. In the compatibility assessment, Special Aquatic Sites (SAS) were identified as being vulnerable to all of the uses being addressed by the Ocean Plan. SAS include mudflats and eelgrass beds. In the siting and performance criteria tables for each use, the SAS are addressed as individual natural resources, specifically eelgrass beds and intertidal flats. For the purposes of aquaculture, we assumed that eelgrass beds were vulnerable to aquaculture activities, but not intertidal flats. The majority of aquaculture activity in the state is shellfish aquaculture which occurs on intertidal flats.

The fixed fishing facilities map includes existing aquaculture license sites, aquaculture development areas (ADAs), and fish weirs that overlap with the ocean planning area (Figure 15). This map was prepared for informational purposes, and not as a screening layer (SSU or existing use layer) in the 2014 Ocean Plan Update. An ADA is a large aquaculture license site secured by a town under MGL, Chapter 130 which is then subdivided into smaller individual license sites upon application to the town holding the ADA license (individual licensees still need to apply to DMF for a state permit for the possession of seed shellfish). All of the existing license sites are for shellfish aquaculture only. There is one ADA in Provincetown and Truro circled in red; an ADA may not have active aquaculture activity over the whole licensed area. Active aquaculture license sites that overlap the ocean planning area boundary are in the towns of Fairhaven, Mattapoisett, Chilmark, West Tisbury, Orleans, Eastham, and Wellfleet; they are circled in green. All but one of these (Chilmark) are inshore licenses that extend more than 1500 feet from shore so they overlap into the ocean planning area. One offshore site in Cape Cod Bay is linked to an inshore license holder, but it is not currently producing shellfish; this site is circled in purple. Sites where aquaculture licenses were issued previously but no activity occurred (so the license sites are no longer active) are circled in black. There are several hundred additional aquaculture license sites inshore of the ocean planning area boundary which are in the process of being mapped; those sites are not circled. Fish weirs are fish traps that are located in a single location over the fishing season and so are permitted for specific sites. There are 37 weir sites that have permits that are current as of January 2014. Other weir sites were permitted in the past, but the permits have expired; those sites were not mapped. The currently permitted sites are located in the towns of Barnstable, Brewster, Chatham, Dennis, Harwich, Manchester, Marblehead, and Salem.

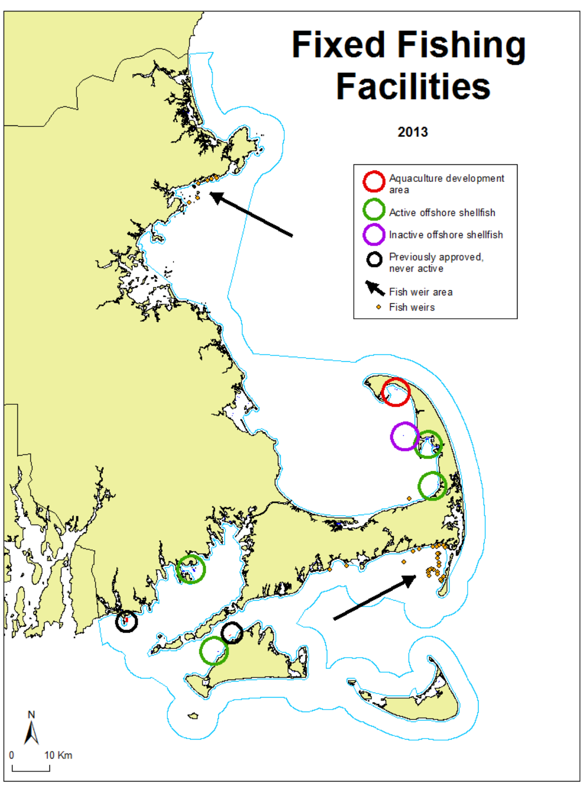


Figure 15. Fish weirs and aquaculture sites within the ocean planning area. Sites circled for visibility; size of circle is not related to size of facility. Aquaculture facilities outside of the ocean planning area are also on the map but not circled. Fish weirs with current permits (as of Jan 2014) are orange dots; the black arrows point to the two main groups of weirs in the ocean planning area.

References

322 CMR 15.06. Code of Massachusetts Regulations. Management of marine aquaculture: Site review. http://www.mass.gov/eea/agencies/dfg/dmf/laws-and-regulations/322-cmr-15-00-management-of-marine-aquaculture.html

Executive Office of Energy and Enviromental Affairs (EEA). 2009. Draft Massachusetts Ocean Management Plan. http://www.mass.gov/eea/ocean-coastal-management/mass-ocean-plan/draft-massachusetts-ocean-management-plan.html

Jiang, Bin. 2013. Head/tail breaks: A new classification scheme for data with a heavy-tailed distribution. The Professional Geographer, 65(3): 482-494.

Massachusetts. 2008. The Oceans Act of 2008. Chapter 114 of the Acts of 2008. https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter114

MGL. Massachusetts General Laws, Chapter 130.

Appendix A – Massachusetts 2007 and 2012 Landings-Weighted State-Wide Average Price per Live Pound[1] by Non-Shellfish Species

Species	2007	2012	Species	2007	2012
BLUEFISH	$0.51	$0.78	JOHN DORY	$0.53	$0.81
BONITO,ATLANTIC	$2.29	$3.82	KING WHITING	$1.12	$1.20
BUTTERFISH	$0.64	$0.48	LANCE, AMERICAN SAND	$4.28	$5.37
COD,ATLANTIC	$1.59	$2.07	LOBSTER,AMERICAN	$5.05	$3.68
CRAB,ATLANTIC ROCK	$0.50	$0.56	MACKEREL,ATLANTIC	$0.10	$0.16
CRAB,GREEN	$0.38	$0.30	MENHADEN	$0.09	$0.08
CRAB,HORSESHOE	$0.78	$1.08	PERCH,OCEAN(REDFISH)	$0.55	$0.65
CRAB,JONAH	$0.58	$0.74	POLLOCK,ATLANTIC	$0.45	$0.85
CRAB,RED AT	$0.91	-	SCUP	$0.93	$0.68
CRAB,UNC	$0.55	-	SEA BASS,BLACK	$2.48	$3.20
CUNNER	-	$1.05	SEA TROUT,GRAY(WEAKFISH)	-	$1.76
CUSK	$0.70	$0.76	SEA URCHINS	-	$1.38
DOGFISH,SPINY	$0.23	$0.22	SHARK,MAKO UNC	$1.15	-
DOLPHINFISH	$2.04	$2.86	SHARK,PORBEAGLE	$0.62	$0.74
EEL,AMERICAN	$1.74	-	SHARK,SHORTFIN MAKO	-	$1.72
EEL,CONGER	$0.56	$0.93	SHRIMP,PANDALID	-	$0.93
ESCOLAR	-	$2.03	SKATE,LITTLE	-	$0.12
FISH,UNC	$0.14	-	SKATE,WINTER	$0.22	$0.21
FLOUNDER, PLAICE, AMERICAN	$1.61	$1.54	SKATES	$0.24	$0.26
FLOUNDER,WINDOWPANE	$0.40	-	SQUID,LONG FINNED (LOLIGO)	$0.86	$1.20
FLOUNDER,SUMMER (FLUKE)	$2.41	$2.61	SQUID,SHORT FINNED (ILLEX)	-	$1.05
FLOUNDER,WINTER	$2.12	$1.97	STRIPED BASS	$2.64	$2.88
FLOUNDER,WITCH (GRAY SOLE)	$2.46	$1.88	SWORDFISH	$3.00	$3.17
FLOUNDER,YELLOWTAIL	$1.86	$1.34	TAUTOG	$2.17	$3.13
GOOSEFISH	$1.06	$1.17	TILEFISH (GOLDEN TILEFISH)	$1.42	$2.17
HADDOCK	$1.54	$1.80	TRIGGERFISHES	$0.68	$1.19
HAKE, ATLANTIC, RED	$0.30	$0.44	TUNA,ALBACORE	$1.19	$1.05
HAKE, ATLANTIC, RED & WHITE	$0.66	$1.19	TUNA,BIGEYE	$3.41	$5.50
HAKE, ATLANTIC, WHITE	$1.27	$1.10	TUNA,BLUEFIN	$7.74	$9.31
HAKE,SILVER (WHITING)	$0.53	$0.61	TUNA,YELLOWFIN	$2.66	$4.16
HALIBUT,ATLANTIC	$4.61	$6.78	WAHOO	$2.30	$3.20
HERRING, ATLANTIC, SEA	$0.09	$0.11	WOLFFISH,ATLANTIC	$0.66	-

Source: SAFIS Dealer Reports

[1]Live Pound: whole animal, shell on

Appendix B – Data Sources and Data Gaps

Table 1. Commercial fisheries data sources used in the analysis.

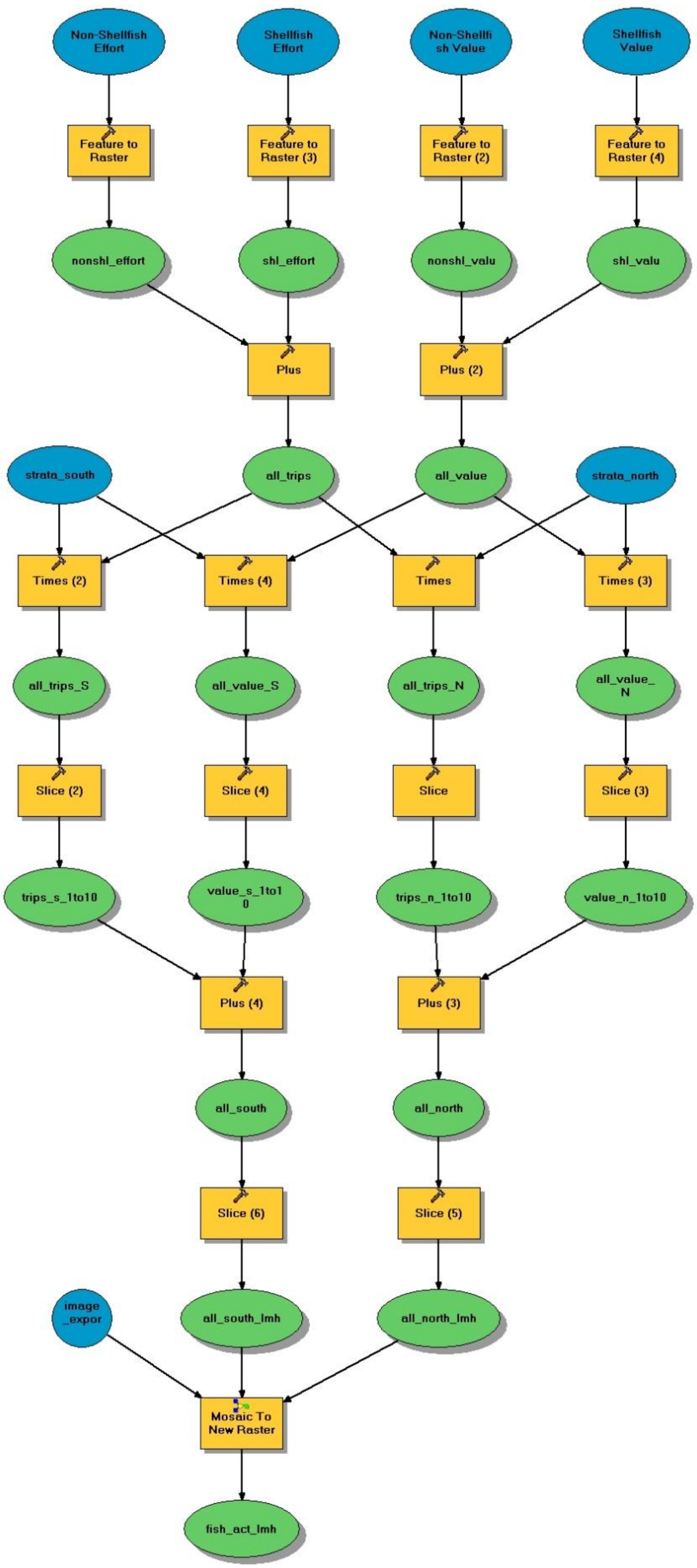
Data Source	Years Used	Spatial Component
DMF Coastal Lobster Catch Report	1994-2009	SRA
DMF Seasonal Lobster Catch Report	1994-2009	SRA
DMF Gillnet Catch Report	2001-2009	SRA
DMF State Waters Groundfish Catch Report	2006-2009	SRA
DMF Sea Urchin Catch Report	2003-2009	SRA
DMF Striped Bass Catch Report	2002-2009	SRA
DMF Fluke Catch Report	2006-2009	SRA
DMF Fish Weir Catch Report	2002-2009	SRA
DMF Scup Pot Catch Report	2001-2009	SRA
DMF Black Sea Bass Catch Report	2001-2009	SRA
DMF Bluefin Tuna Purse Seine Catch Report	1988-2009	Loran or Lat/Lon → SRA
SAFIS Dealer Reports (Shellfish only)	2006-2012	DMF DSGA
NMFS Vessel Trip Reports	2006-2009	Lat/Lon → SRA
DMF Trip-Level Reports	2008-2012[1]	SRA

[1]Pilot program in 2008 and 2009 for 10% and 20% permit holders respectively, 100% implementation in 2010.

Table 2. Commercial fisheries not represented by data sourced between 1988 and 2009.

Species	Description of data gap
Black Sea Bass	Landings of non-Federal vessels, other than fish pots
Bluefish	Landings of non-Federal vessels, other than fish weirs and gillnets
Cod	Landings of non-Federal vessels taking advantage of the <75 lb exemption
Dogfish	Landings of non-Federal vessels, other than gillnets or the SW groundfish fishery
Herring	Landings of non-Federal vessels
Mackerel	Landings of non-Federal vessels
Menhaden	Landings of non-Federal vessels
Sand eels	Landings of non-Federal vessels
Scup	Landings of non-Federal vessels, other than fish weirs and fish pots
Shrimp	Landings of non-Federal vessels
Silver Hake, Red Hake, Cusk & Halibut	Landings of non-Federal vessels, other than gillnets
Skate	Landings of non-Federal vessels, other than gillnets or the SW groundfish fishery
Squid	Landings by non-Federal vessels, other than fish weirs
Tautog	Landings of non-Federal vessels, other than tautog bycatch in fish pots

Appendix C – ArcGIS Model – Commercial Fisheries Activity



Appendix D – Fisheries not covered by the Vessel Monitoring System in Massachusetts

Fisheries that occur in Mass waters	VMS data in state waters?
Sea herring	Federal vessels only
Ocean quahog, surfclam	Federal vessels only
Scallops (dredge and diving)	Federal vessels only
Monkfish	Federal vessels only
Northeast multispecies/coastal access permit (large mesh groundfish; includes trawls, gillnets, hook and line)	Federal vessels only
Highly migratory species (tuna, sharks, swordfish; hook and line and purse seines)	Federal vessels only
Small mesh multispecies	Federal vessels only
Fish weir	Locations are known
Aquaculture	Locations are known
American eel	No VMS (river codes reported)
Pots (conch, lobster, black sea bass)	No VMS
Atlantic mackerel, squid, butterfish	No VMS
Summer flounder, scup, black sea bass	No VMS
Northern shrimp	No VMS*
White perch	No VMS
Smelt	No VMS
Bay scallop	No VMS
Other shellfish (razor clams, oysters, seaworms)	No VMS
Atlantic bluefish	No VMS
Horseshoe crab	No VMS
Inshore net	No VMS
Striped bass	No VMS
Surface gillnet	No VMS
Green crabs	No VMS
Sea urchin (dredge and diving)	No VMS
Menhaden	No VMS
Sand eels	No VMS
Skate	No VMS*
Cusk	No VMS*
Spiny dogfish	No VMS*
Tautog	No VMS
Recreational fishing	No VMS

** A vessel that has a federal permit in a fishery that requires VMS (e.g. Monkfish, northeast multispecies, scallop) can also have state endorsements for other fisheries. In such a case, the vessel reports to the VMS system even when it is fishing under the state endorsement. However, it would be difficult or impossible to discern from the VMS data which fishery the individual was participating in other than what was declared on the VMS as required for the federal permit (the declaration codes can only accommodate the fisheries required to report under VMS). Federally permitted vessels fishing in state waters must comply with their federal permit and/or more restrictive state regulations. The fisheries that this is most problematic for (cusk, skate, dogfish, and shrimp) are indicated with an asterisk. There is also a directed spiny dogfish fishery in state waters in October & November that federal groundfish boats don't participate in. Since fishermen also report VTRs with their catches, theoretically VMS tracks could be linked up to catch information. Since the VTR contains landings from an entire trip, when that trip spans multiple areas, including state and federal waters, it would be impossible to pinpoint where in the VMS track the landings actually occurred. Tilefish excluded since fishery occurs outside of state waters; salmon, river herring, shad excluded since they are not commercial fisheries at this time.*

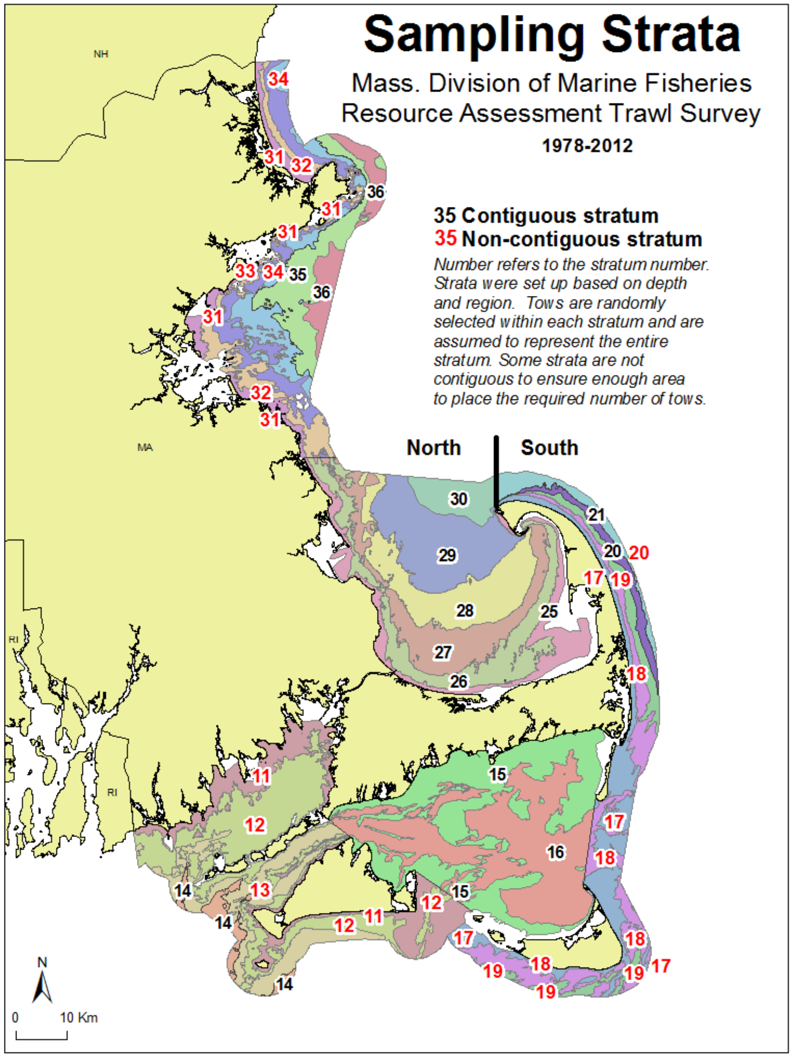
Appendix E – Species and season specific maps of stratum trimean and tow biomass

Methodology from Section 5.1.1 of the Fisheries Workgroup Report, 2014 Ocean Plan:

For each species, the biomass (abundance for Jonah crab, Atlantic cod juveniles, and black sea bass juveniles) was averaged by survey stratum over the survey time series (1978-2012) using the trimean averaging technique ([1st quartile + 2*median+3rd quartile]/4). We selected the trimean to measure the center of the dataset because it is resistant to outlier years (years that have very high or low catches) when compared with the arithmetic mean. The trimeans were calculated in R 3.0.1.

We selected a stratum for inclusion for each species based on the criterion of having at least 7 years of non-zero catches within a season. This selection process allowed us to focus on strata where species were consistently caught in the time series. Sets of strata were analyzed by region (generally north or south of Cape Cod in order to recognize that this boundary is used to delineate different stock units of the same species. Each stratum was classified as high (top 25%), medium (middle 50%), and low (bottom 25%) categories based on distribution of stratum trimean values within the regional strata sets north and south of Cape Cod (a third strata set was included for the backside of the Cape of cod recruitment). Only included strata were used in evaluating quartiles for classification. Excluded strata were classified as NA and should be considered as less than low. Note that the classification of the strata represents a relative ordering of the strata. The quartiles were calculated in ArcGIS 10.1, which treats the data as discrete and creates classes with an equal number of features. For two species in particular, horseshoe crabs and summer flounder, this method placed very similar features (i.e. stratum trimean values) in adjacent classes. So for these two species, the quartile thresholds were manually calculated on the continuous data.

We overlaid the individual species' stratum maps with dots presenting the approximate location and relative biomass of the tow for that species. The choice of classification scheme for binning the biomass data (e.g. the size of the dots) is important for accurately decoding the maps and critical for creating a framework for decision making. For example, a large dot will lead the map user to consider that particular area "very important" regardless of other factors such as frequency of high catches, the particular season, and the actual value of the biomass. The non-zero tows by species were scaled north and south of Cape Cod and by season using the head/tails classification method which is designed for highly-skewed data (Jiang 2013). The thresholds were calculated in Excel. Zero tows were included as Xs on the maps. The dots were further classified with different colors for successive survey time periods. The survey time periods were selected to encompass equivalent numbers of tows. The species- and season-specific dot maps for winter flounder are shown in Figure 4. Maps for all of the species and seasons are provided in this Appendix.

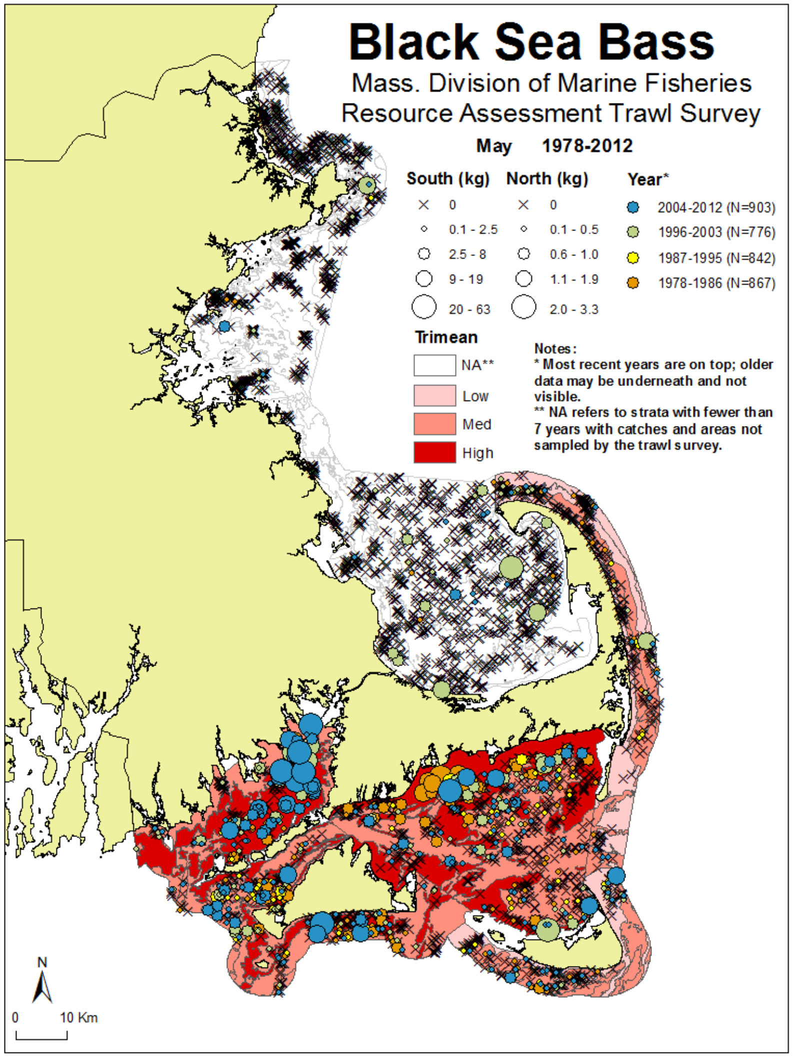


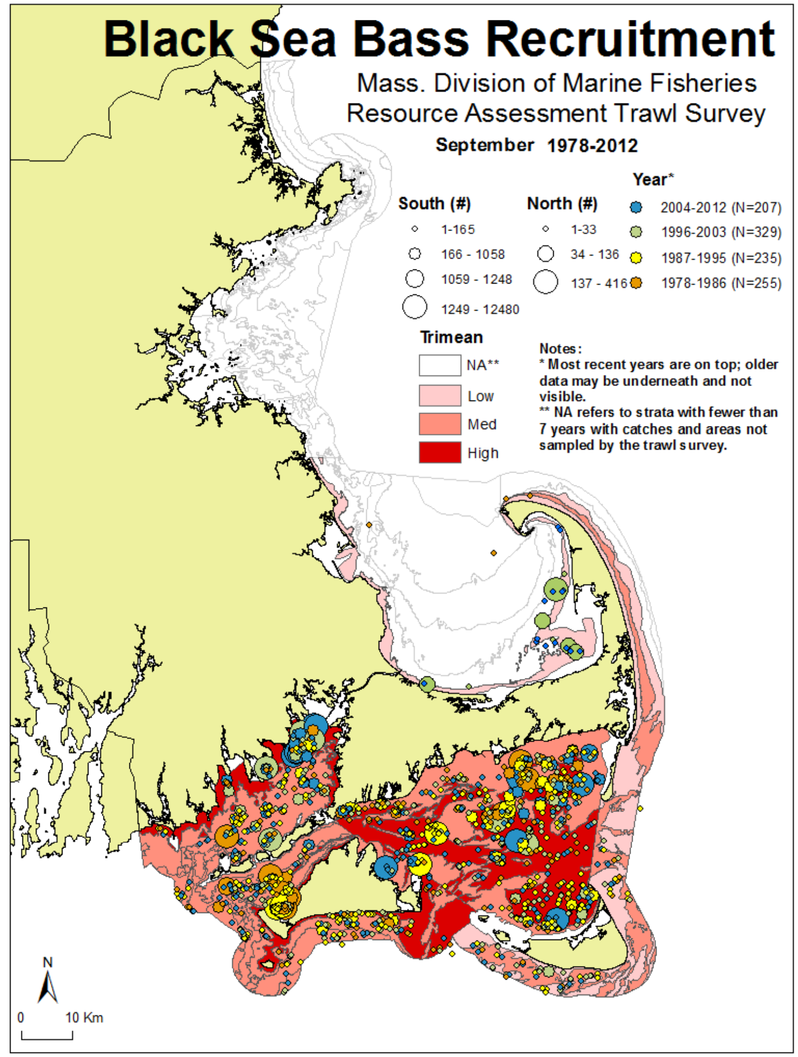
Notes

1. Strata are defined based on depth zones within region and strata may be non-contiguous. Tow locations are randomly selected within a stratum and they are considered a representative sample of towable bottom within a stratum.
2. More recent data is on top, so recent tows represented by large dots may be concealing older tows.
3. Various methods exist for calculating quartiles and they often vary in handling discontinuities in the empirical cumulative distribution. Differences in results among methods can occur more frequently in small datasets. Sample quartiles for strata trimeans distributions were typically calculated by ArcGIS 10.1, which estimates sample quartiles using a method for discontinuous sample quantiles. In cases in which the visual result was confusing or misleading, quartiles were manually calculated by using a method for continuous sample quantiles. We note on the map when sample quartiles were estimated outside of GIS.
4. Cases exist where many big dots (large tows) do not coincide with high trimean values. This is generally attributed to either:
    1. the pattern of larger tows represents a year (s) that are not consistent with the consistent presence of positive or larger tows in the survey time series (they may be considered outliers from the trimean value).

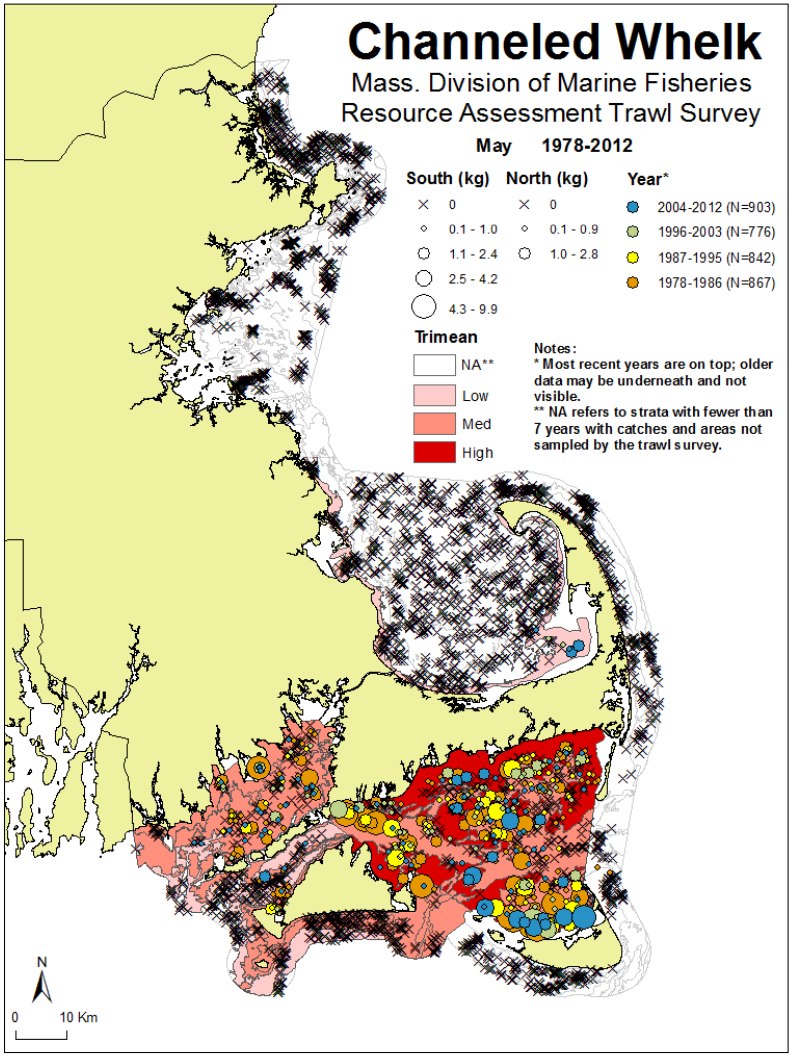
    OR

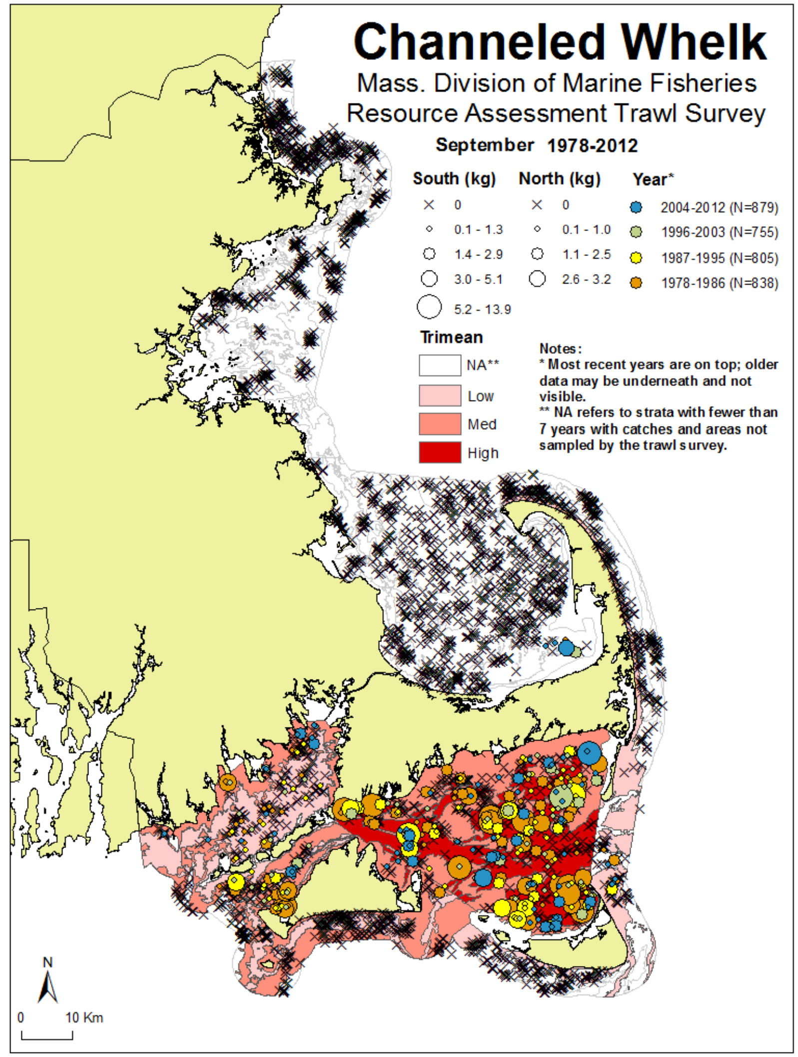
    2. fine distinctions in threshold values in either the dots or the trimean values.

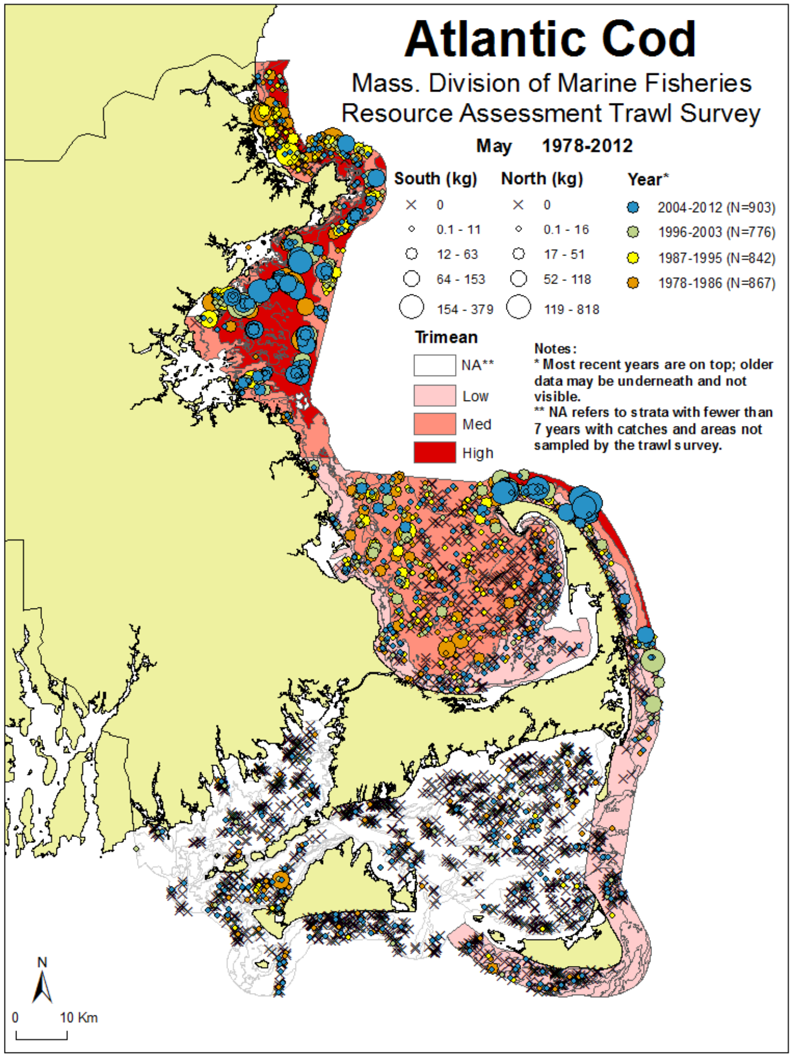


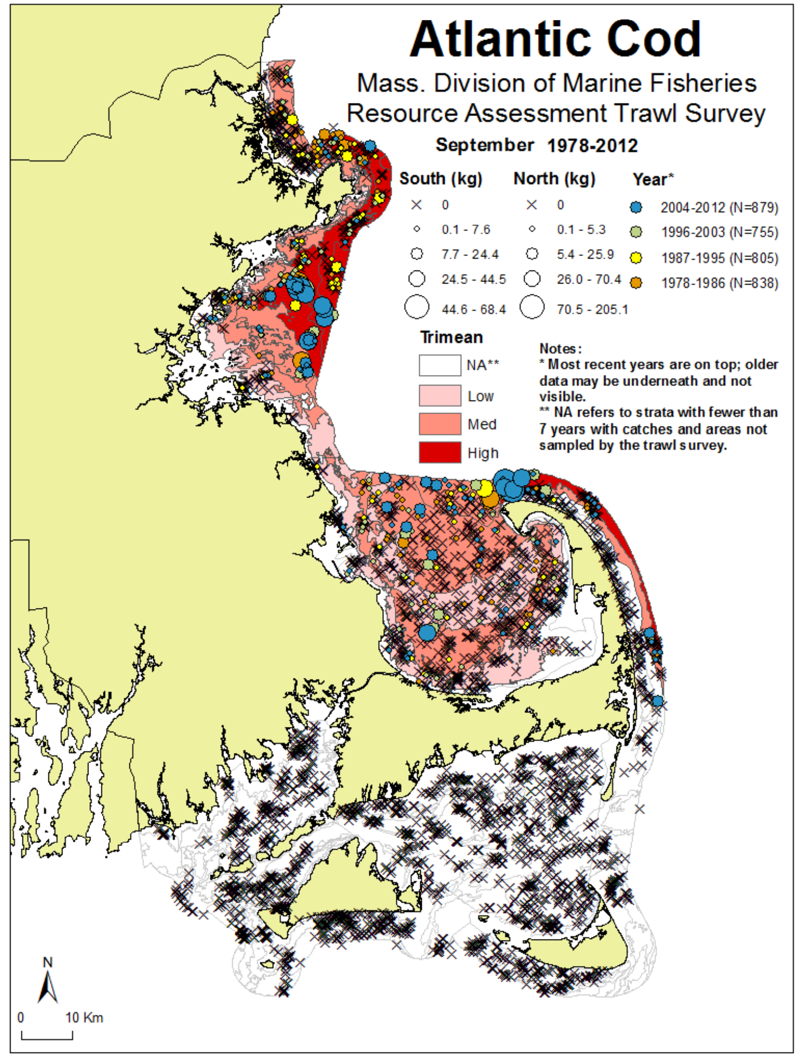


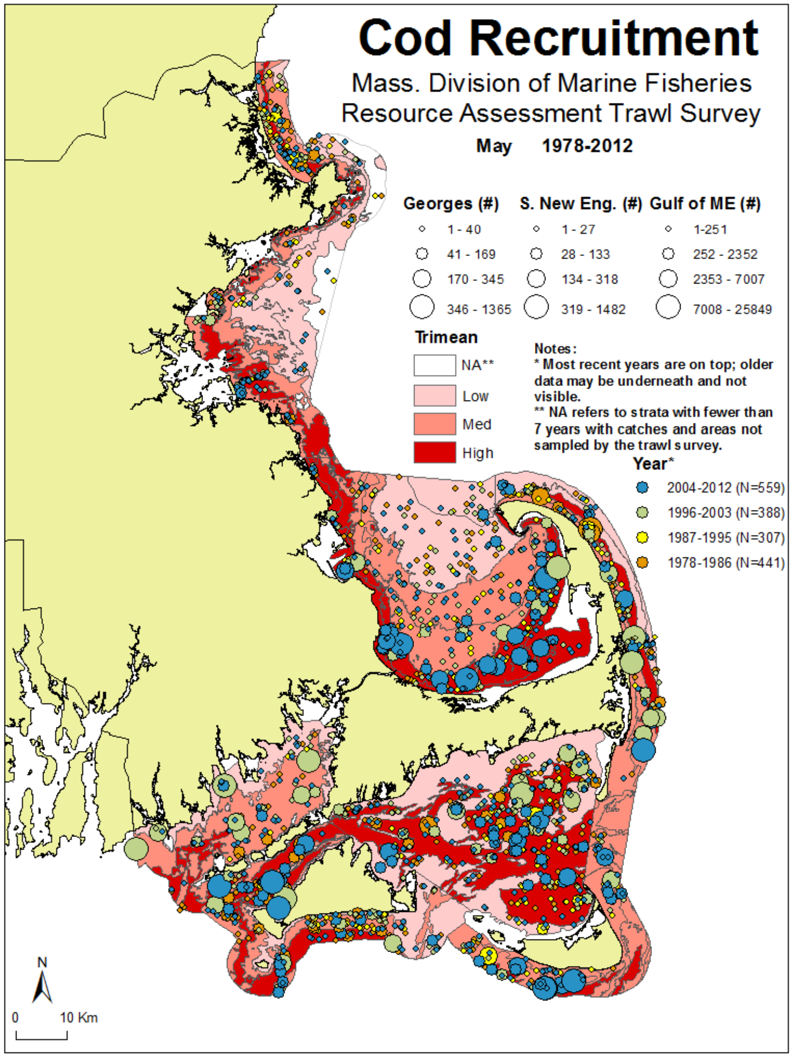
The fall biomass of black sea bass is typically very low compared to spring. We catch relatively few fish larger than young-of-year (yoy) in the fall. The biomass is best covered by the spring survey, and the yoy abundance is the best signal from the fall survey.

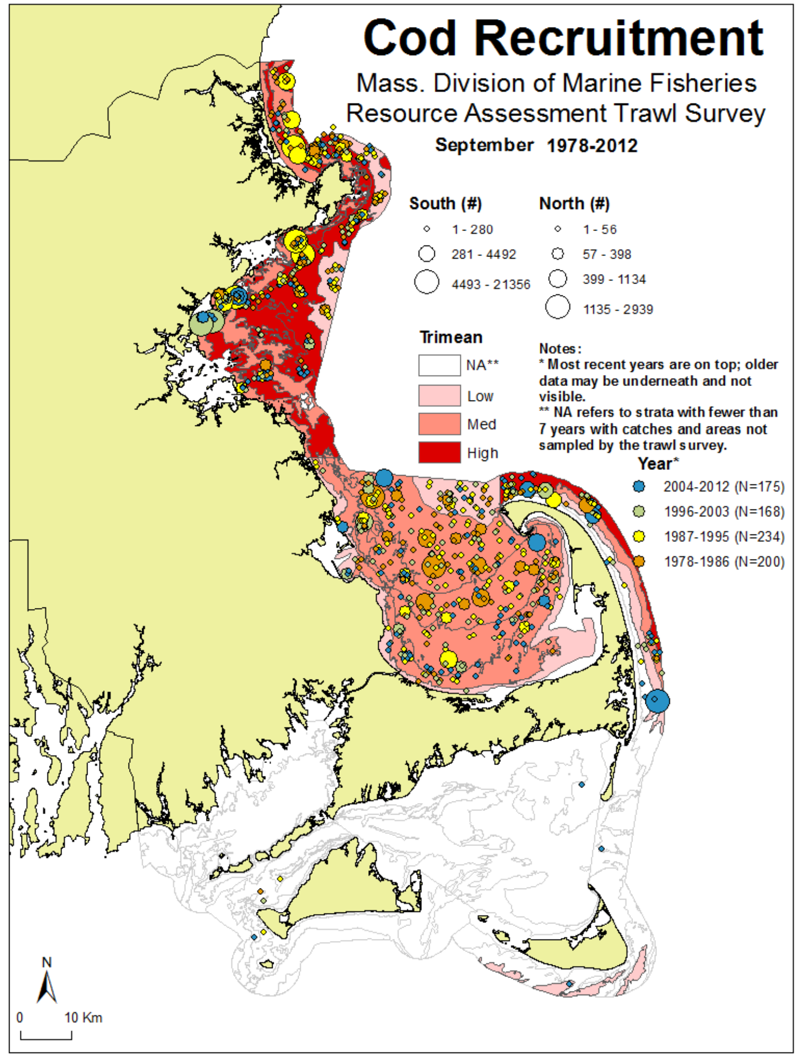

Channeled Whelk
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 1.0
1.1 - 2.4
2.5 - 4.2
4.3 - 9.9
North (kg)
0
0.1 - 0.9
1.0 - 2.8
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

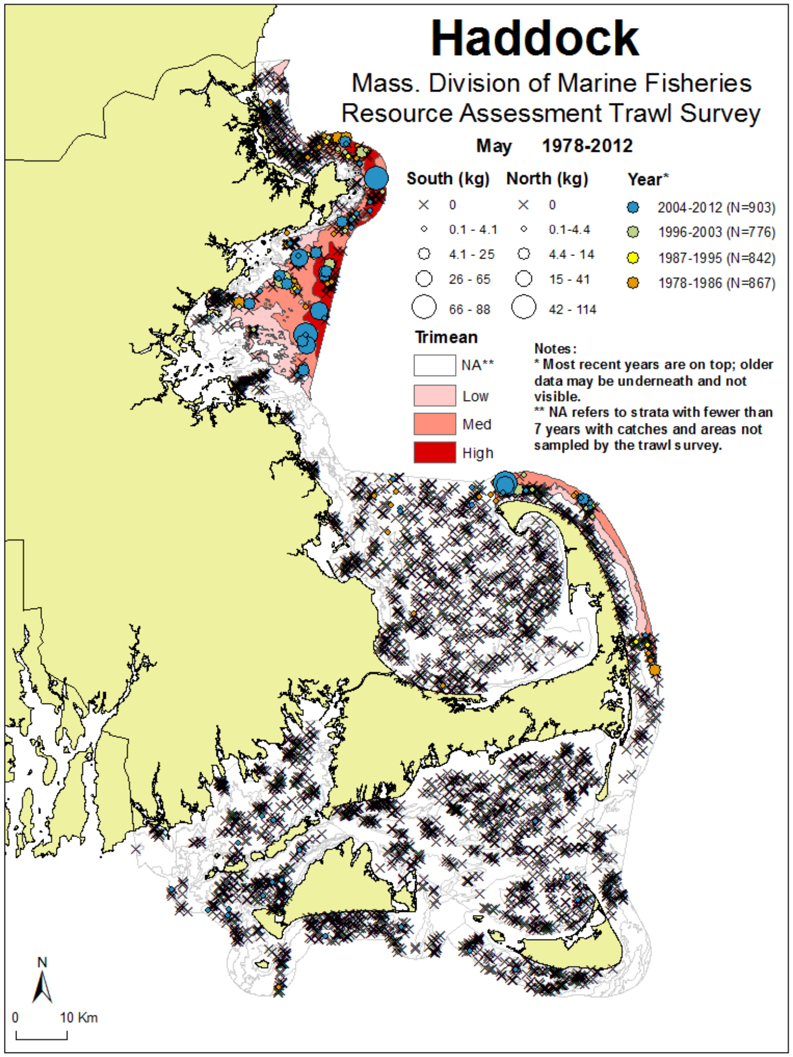

Channeled Whelk
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 1.3
1.4 - 2.9
3.0 - 5.1
5.2 - 13.9
North (kg)
0
0.1 - 1.0
1.1 - 2.5
2.6 - 3.2
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km


Atlantic Cod
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 11
12 - 63
64 - 153
154 - 379
North (kg)
0
0.1 - 16
17 - 51
52 - 118
119 - 818
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

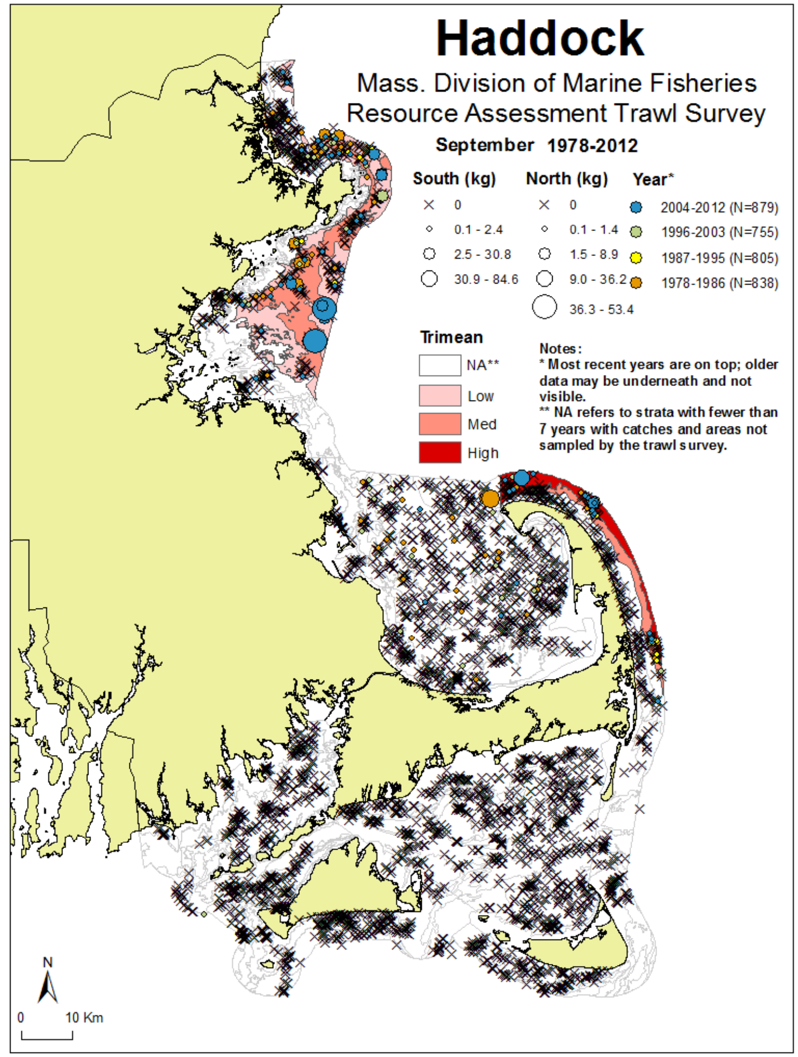

Atlantic Cod
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 7.6
7.7 - 24.4
24.5 - 44.5
44.6 - 68.4
North (kg)
0
0.1 - 5.3
5.4 - 25.9
26.0 - 70.4
70.5 - 205.1
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km


Cod Recruitment
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
Georges (#)
1 - 40
41 - 169
170 - 345
346 - 1365
S. New Eng. (#)
1 - 27
28 - 133
134 - 318
319 - 1482
Gulf of ME (#)
1-251
252 - 2352
2353 - 7007
7008 - 25849
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
Year*
2004-2012 (N=559)
1996-2003 (N=388)
1987-1995 (N=307)
1978-1986 (N=441)
N
0 10 Km

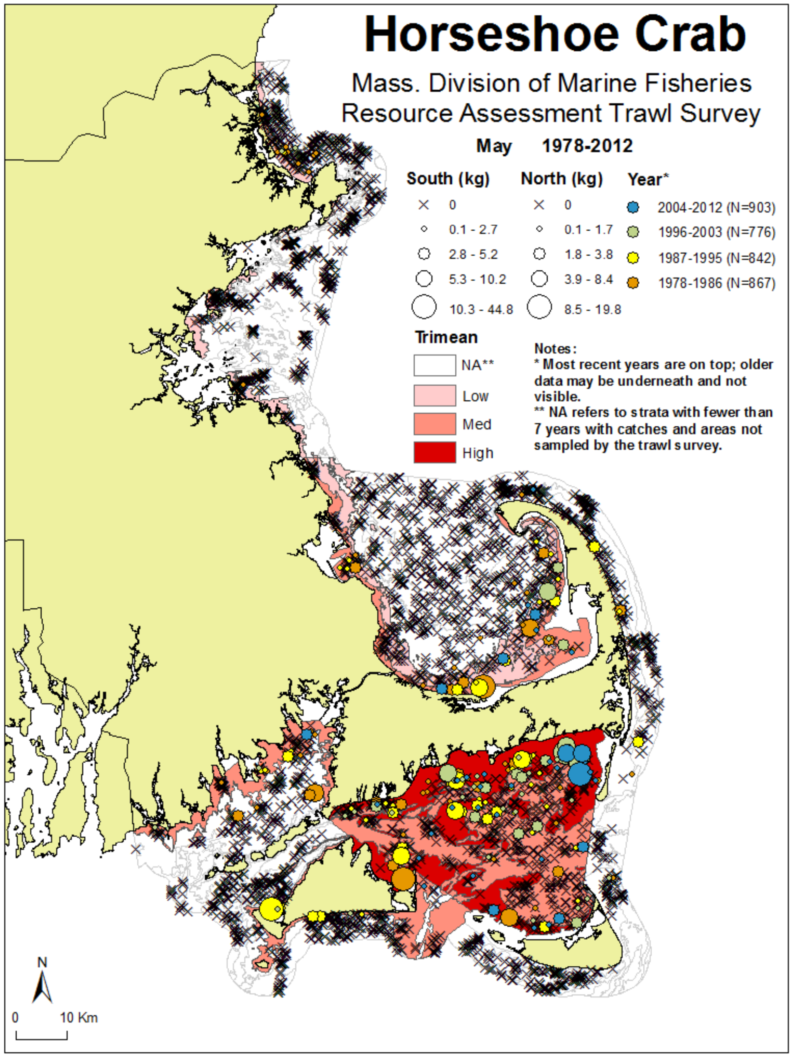

Cod Recruitment
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (#)
1 - 280
281 - 4492
4493 - 21356
North (#)
1 - 56
57 - 398
399 - 1134
1135 - 2939
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
Year*
2004-2012 (N=175)
1996-2003 (N=168)
1987-1995 (N=234)
1978-1986 (N=200)
N
0 10 Km

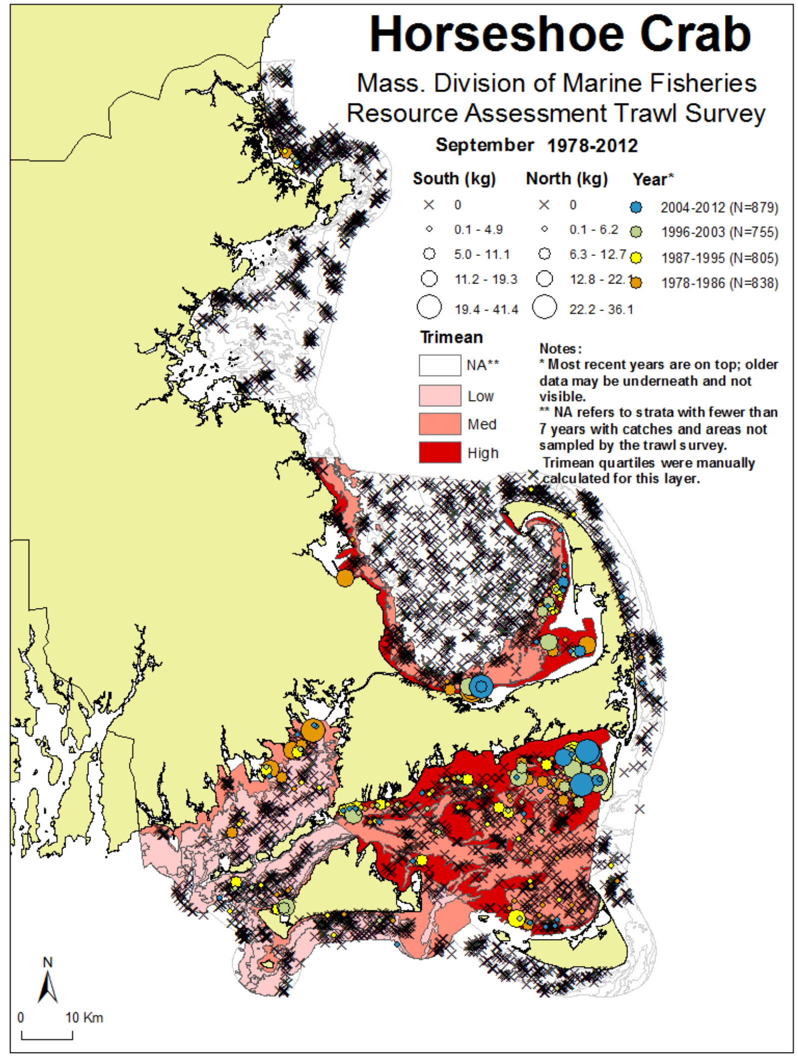


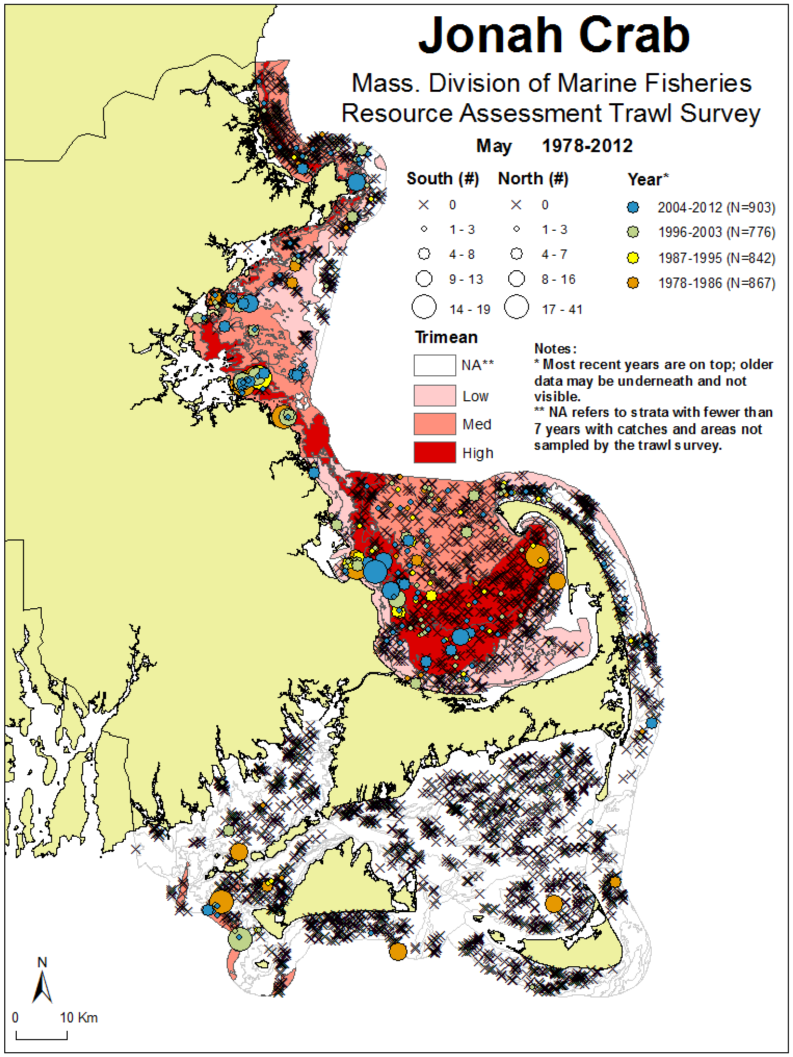
Haddock
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 4.1
4.1 - 25
26 - 65
66 - 88
North (kg)
0
0.1-4.4
4.4 - 14
15 - 41
42 - 114
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

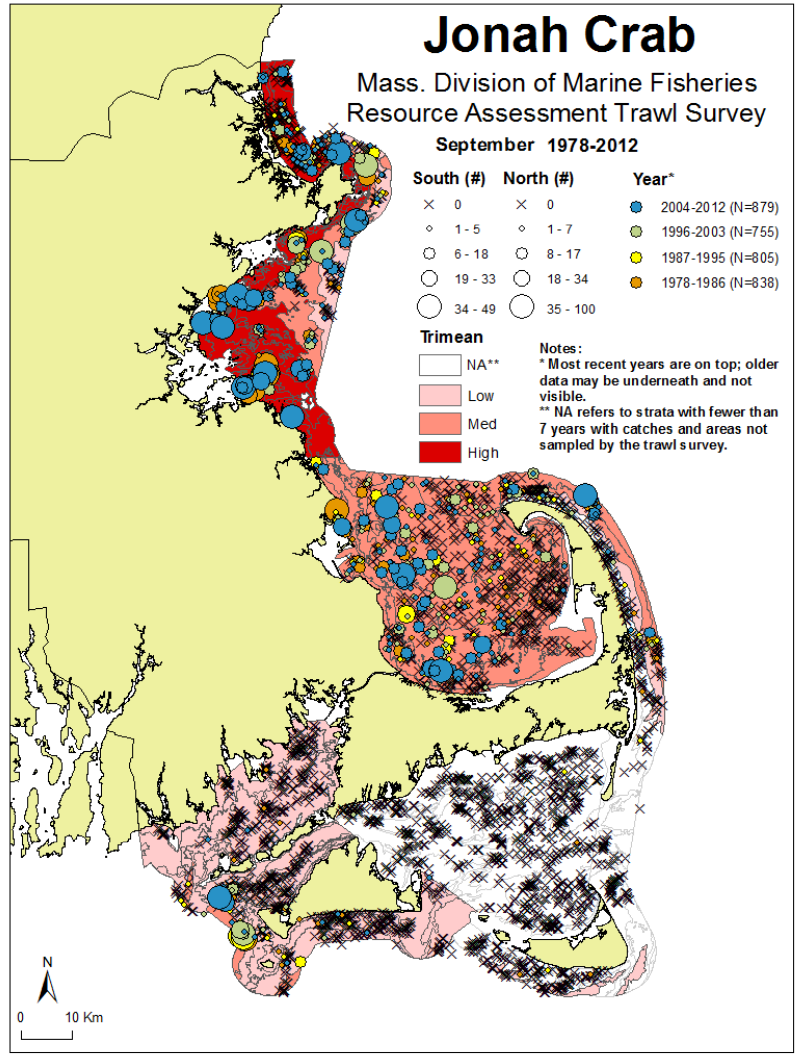


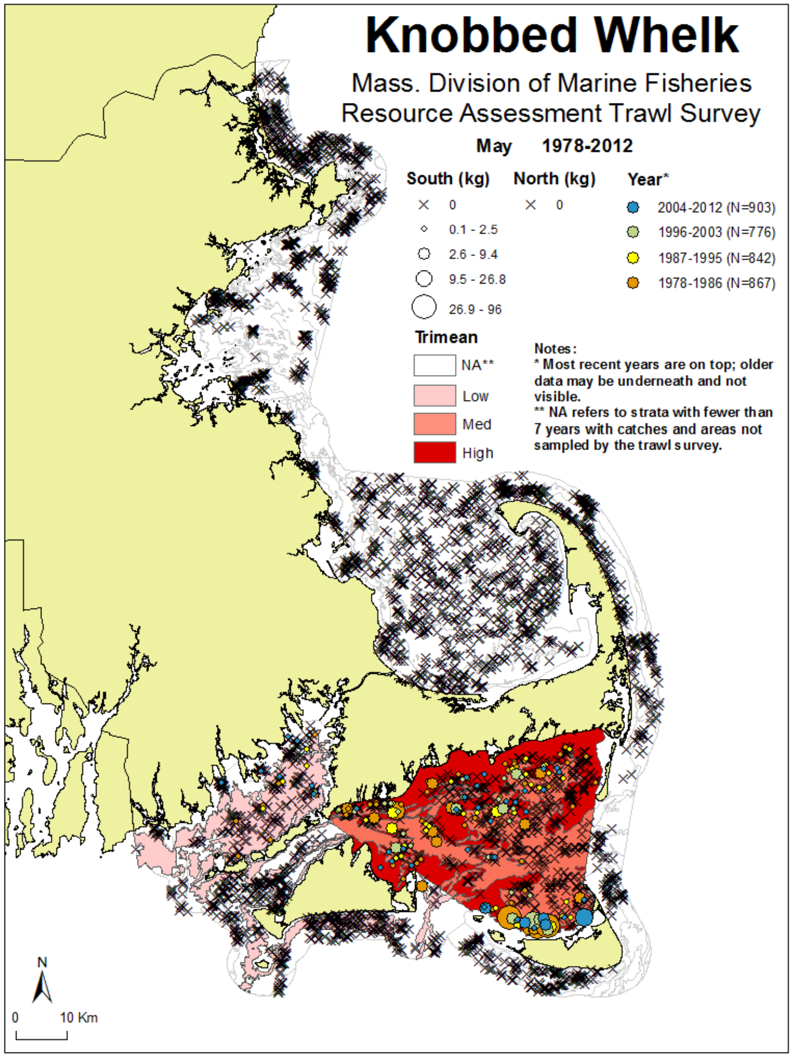
Haddock
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 2.4
2.5 - 30.8
30.9 - 84.6
North (kg)
0
0.1 - 1.4
1.5 - 8.9
9.0 - 36.2
36.3 - 53.4
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

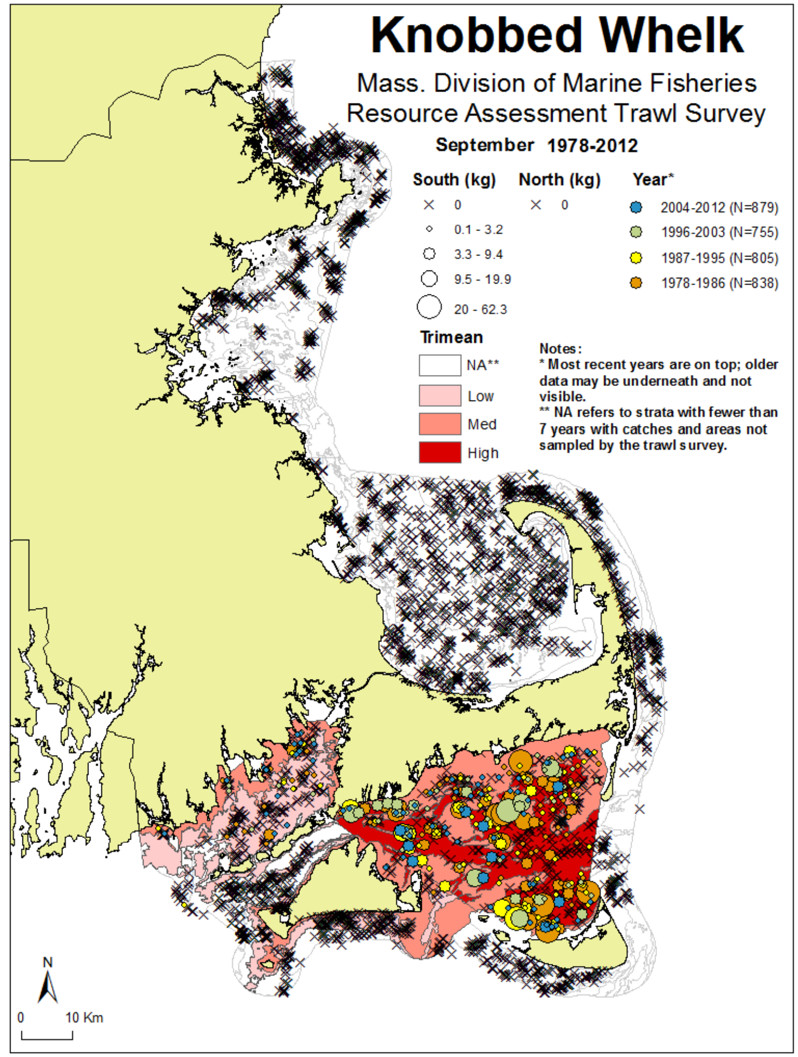

Horseshoe Crab
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 2.7
2.8 - 5.2
5.3 - 10.2
10.3 - 44.8
North (kg)
0
0.1 - 1.7
1.8 - 3.8
3.9 - 8.4
8.5 - 19.8
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

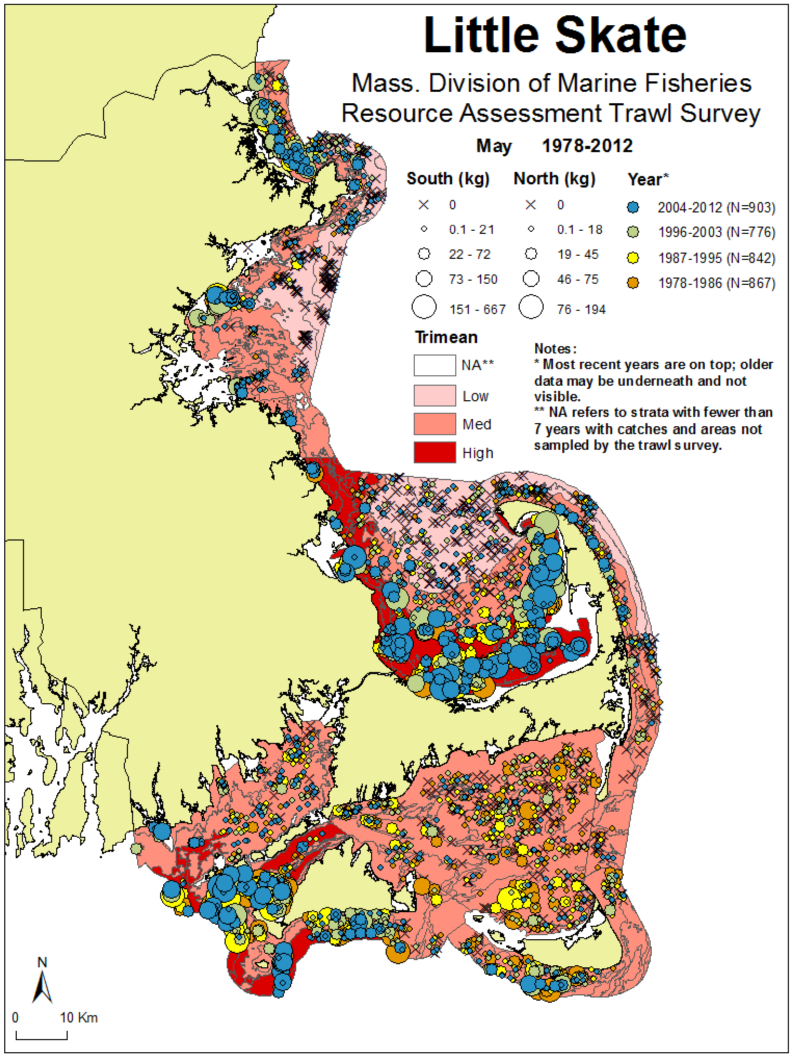

Horseshoe Crab
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 4.9
5.0 - 11.1
11.2 - 19.3
19.4 - 41.4
North (kg)
0
0.1 - 6.2
6.3 - 12.7
12.8 - 22.1
22.2 - 36.1
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
Trimean quartiles were manually calculated for this layer.
N
0
10 Km

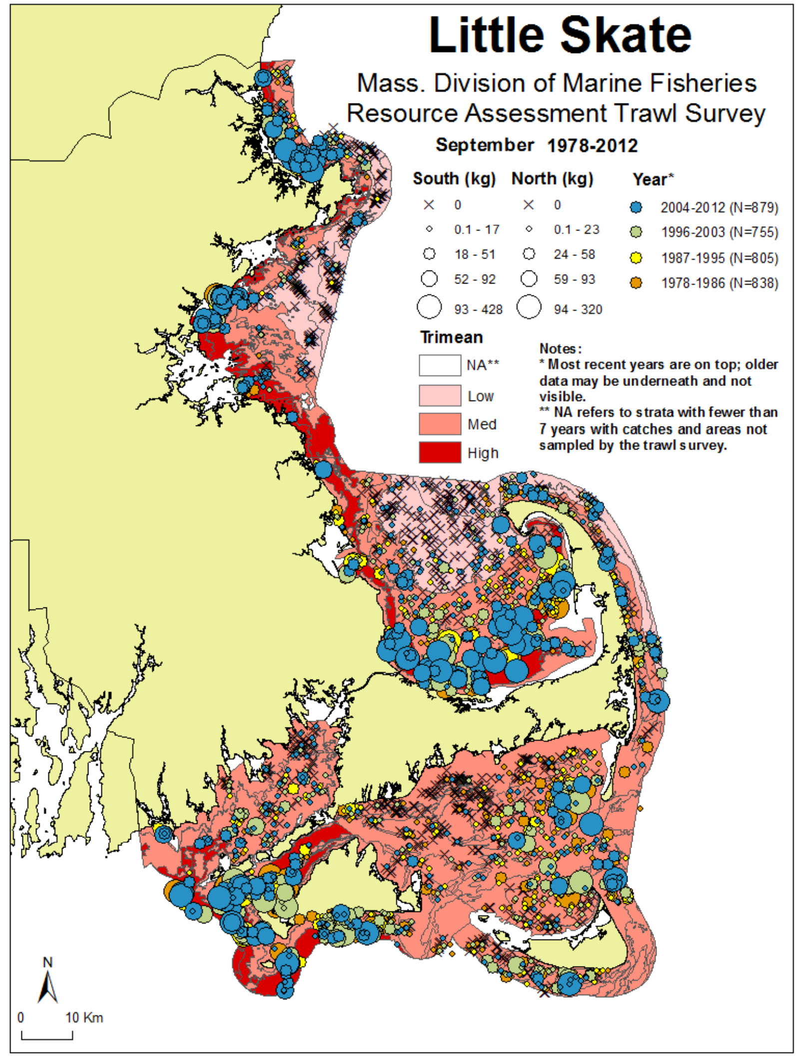

Jonah Crab
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (#)
0
1 - 3
4 - 8
9 - 13
14 - 19
North (#)
0
1 - 3
4 - 7
8 - 16
17 - 41
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

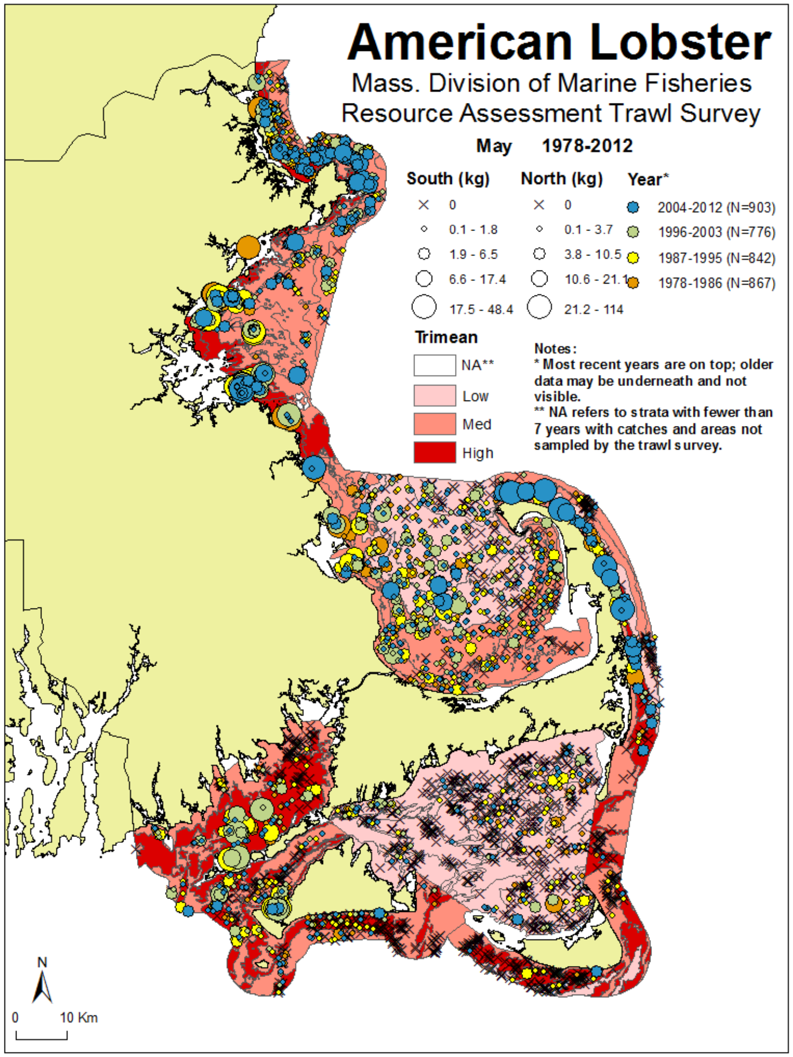

Jonah Crab
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (#)
0
1 - 5
6 - 18
19 - 33
34 - 49
North (#)
0
1 - 7
8 - 17
18 - 34
35 - 100
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

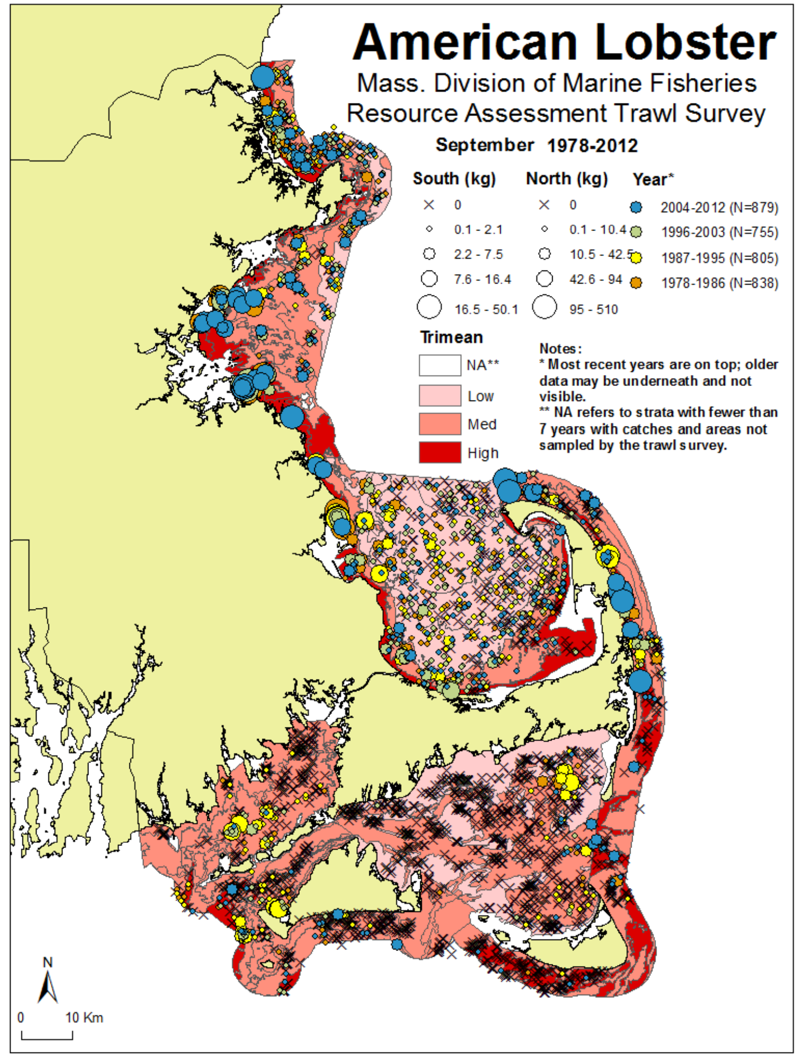

Knobbed Whelk
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 2.5
2.6 - 9.4
9.5 - 26.8
26.9 - 96
North (kg)
0
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

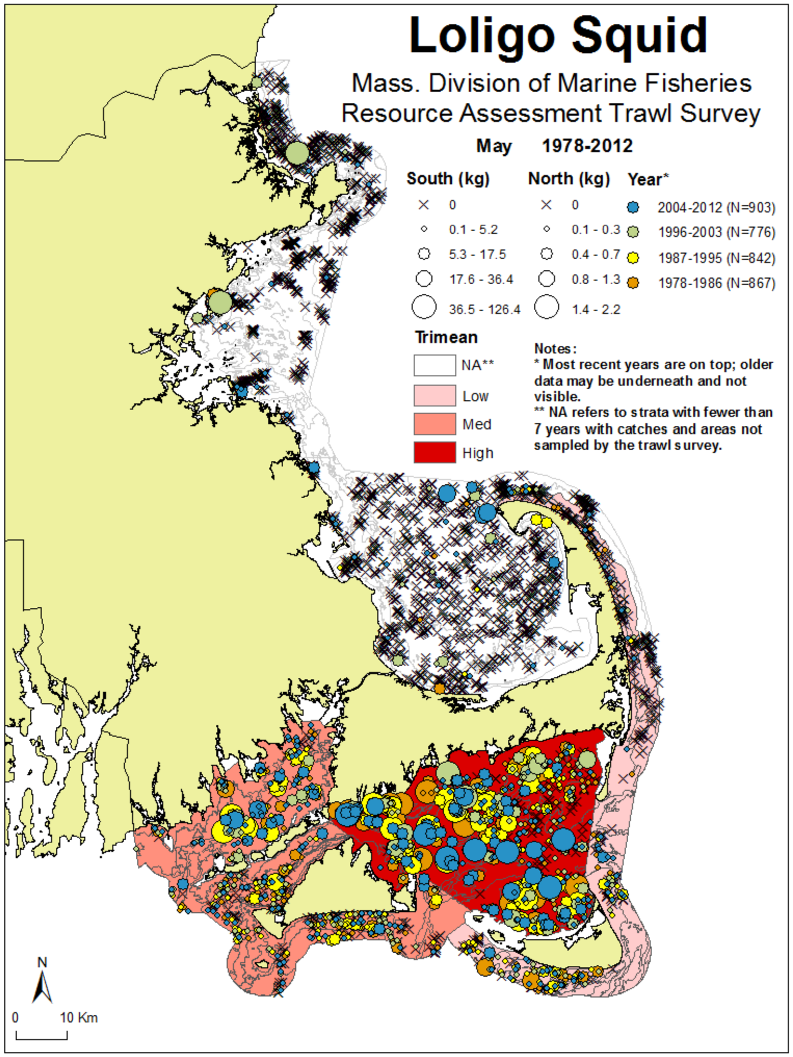

Knobbed Whelk
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 3.2
3.3 - 9.4
9.5 - 19.9
20 - 62.3
North (kg)
0
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

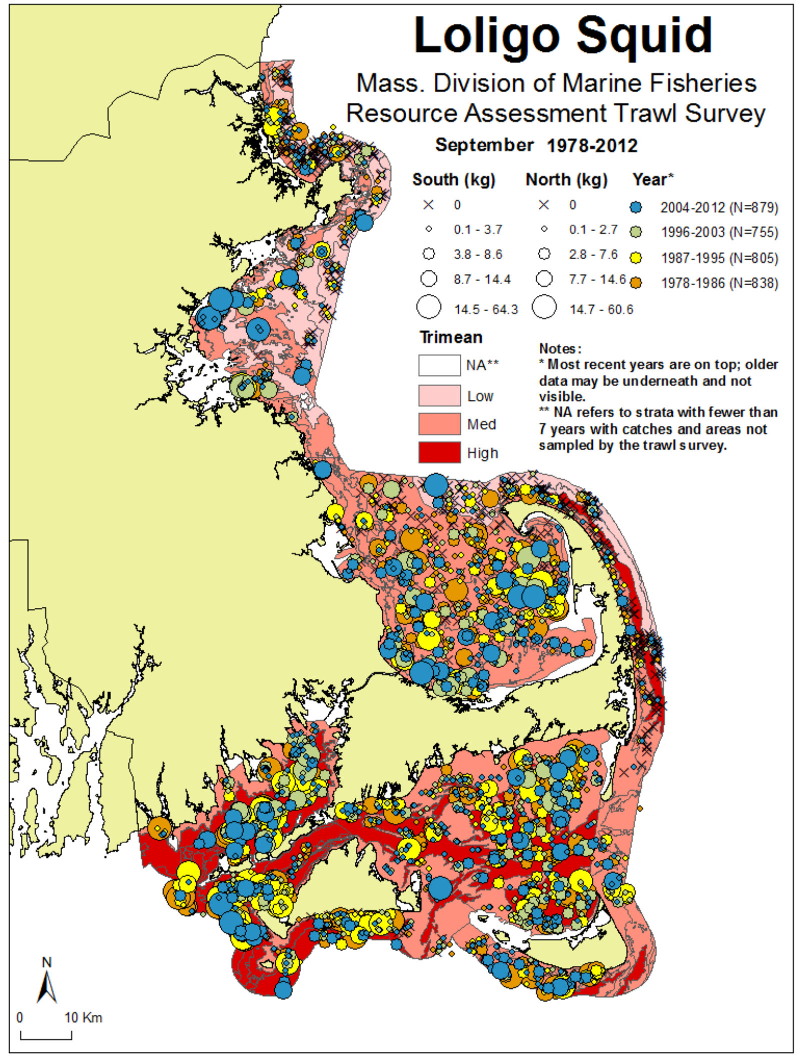

Little Skate
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 21
22 - 72
73 - 150
151 - 667
North (kg)
0
0.1 - 18
19 - 45
46 - 75
76 - 194
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

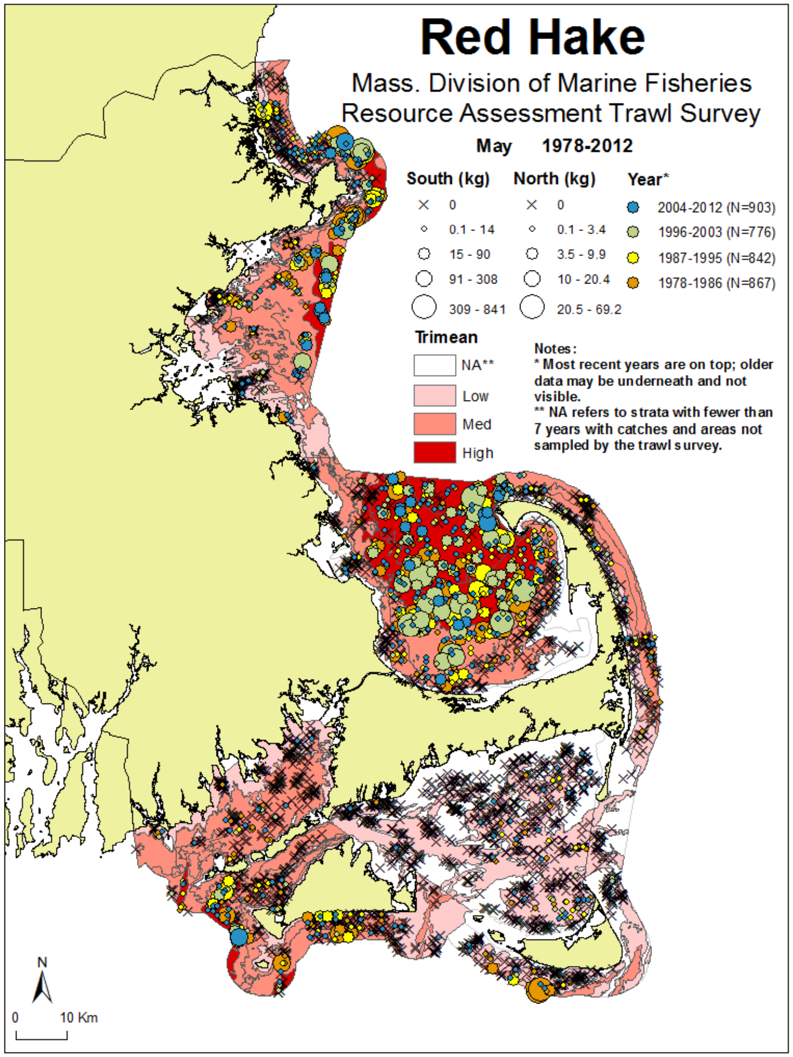

Little Skate
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 17
18 - 51
52 - 92
93 - 428
North (kg)
0
0.1 - 23
24 - 58
59 - 93
94 - 320
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

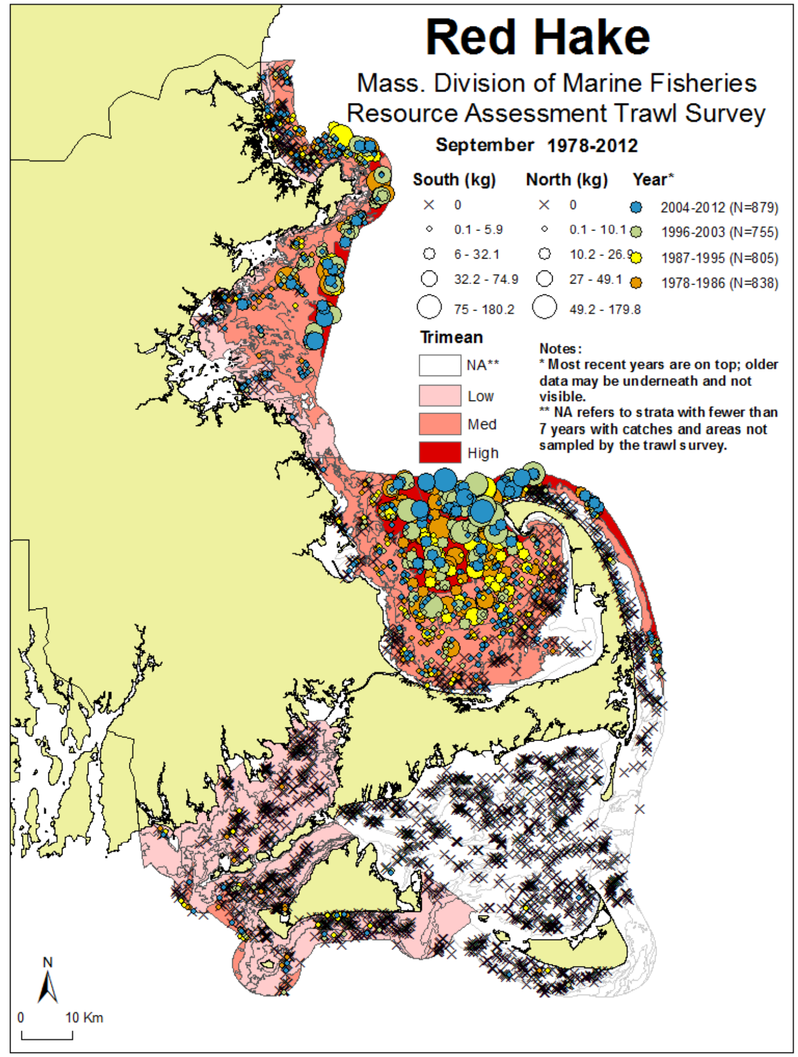

American Lobster
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 1.8
1.9 - 6.5
6.6 - 17.4
17.5 - 48.4
North (kg)
0
0.1 - 3.7
3.8 - 10.5
10.6 - 21.1
21.2 - 114
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

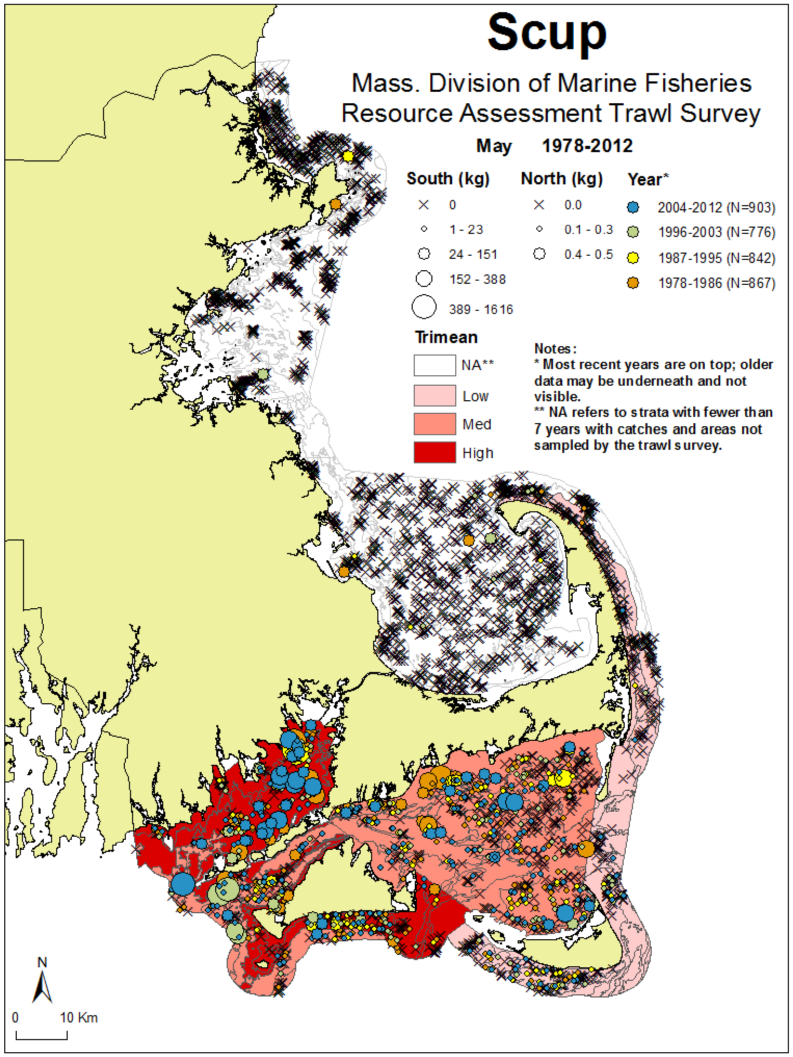

American Lobster
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 2.1
2.2 - 7.5
7.6 - 16.4
16.5 - 50.1
North (kg)
0
0.1 - 10.4
10.5 - 42.5
42.6 - 94
95 - 510
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

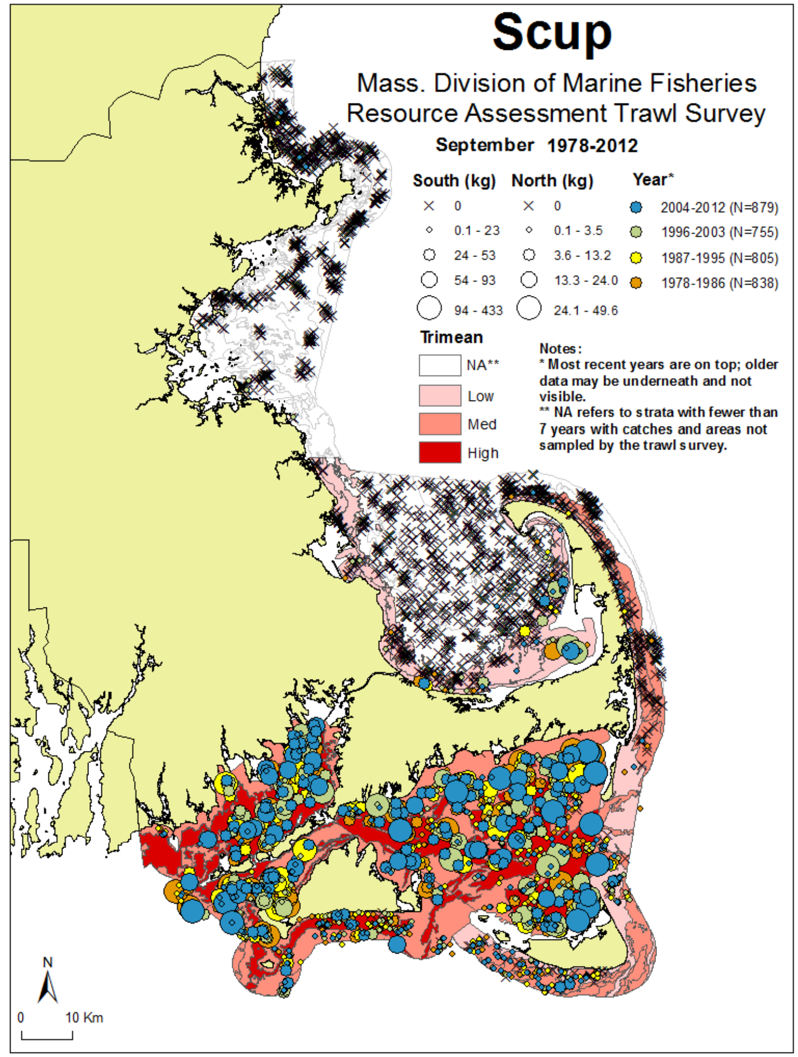

Loligo Squid
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 5.2
5.3 - 17.5
17.6 - 36.4
36.5 - 126.4
North (kg)
0
0.1 - 0.3
0.4 - 0.7
0.8 - 1.3
1.4 - 2.2
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0 10 Km

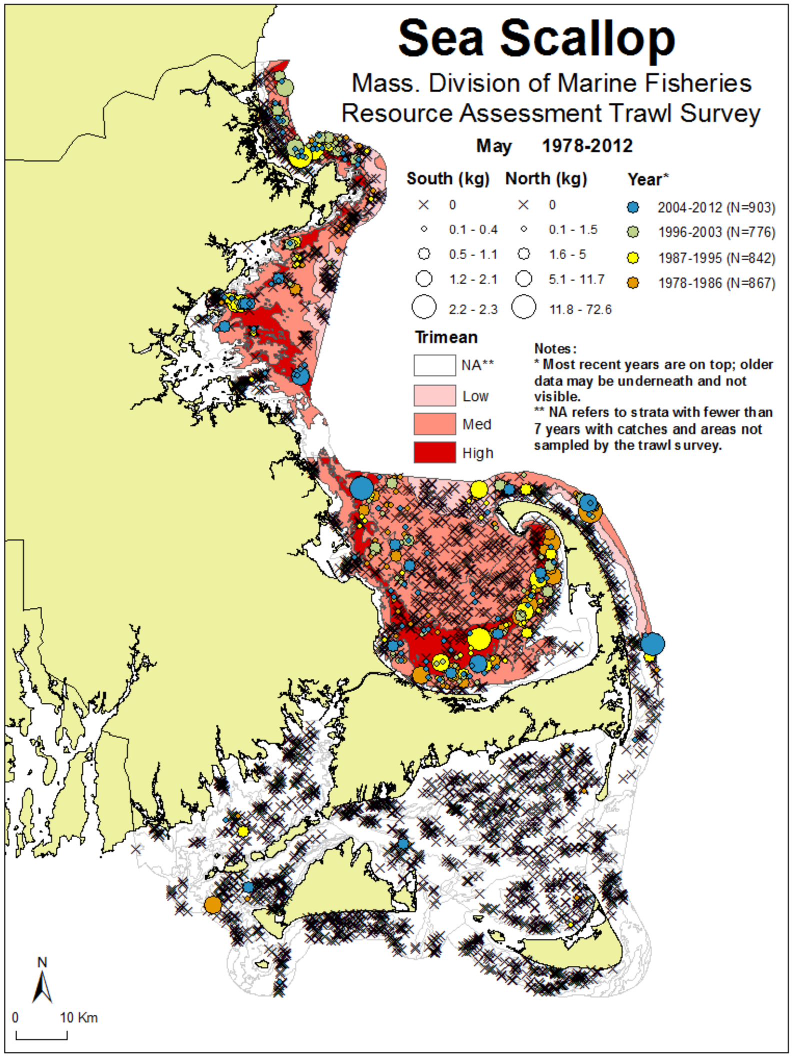

Loligo Squid
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 3.7
3.8 - 8.6
8.7 - 14.4
14.5 - 64.3
North (kg)
0
0.1 - 2.7
2.8 - 7.6
7.7 - 14.6
14.7 - 60.6
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0 10 Km


Red Hake
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 14
15 - 90
91 - 308
309 - 841
North (kg)
0
0.1 - 3.4
3.5 - 9.9
10 - 20.4
20.5 - 69.2
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

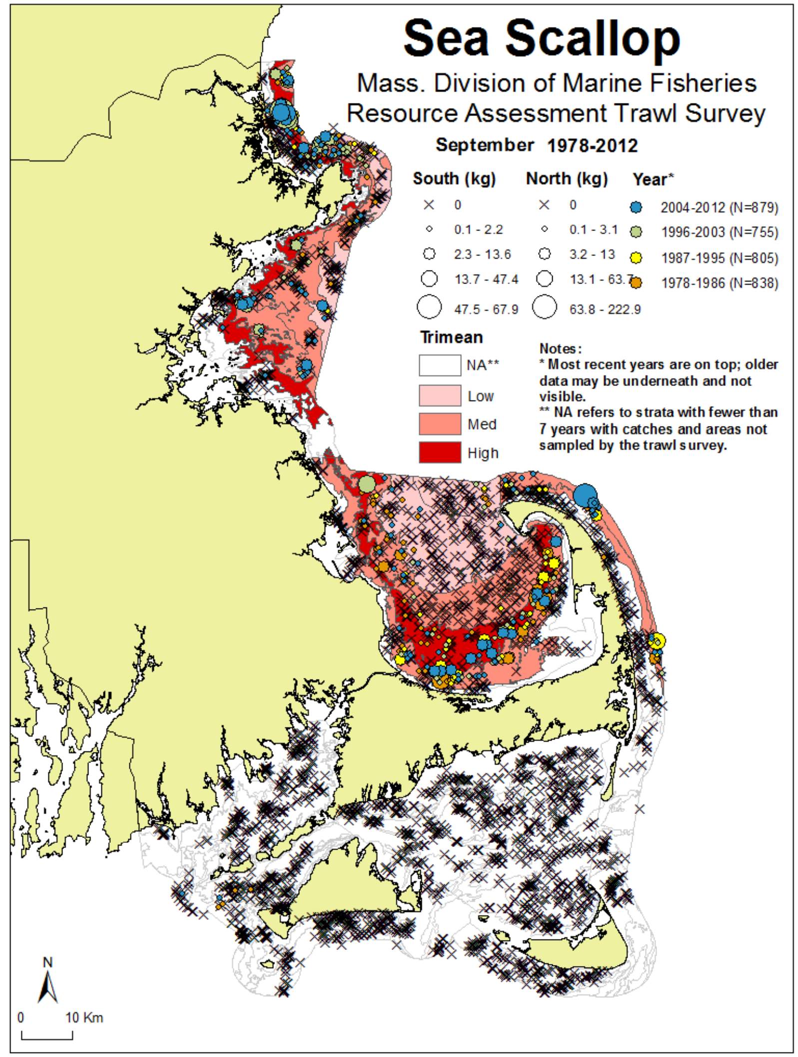

Red Hake
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 5.9
6 - 32.1
32.2 - 74.9
75 - 180.2
North (kg)
0
0.1 - 10.1
10.2 - 26.9
27 - 49.1
49.2 - 179.8
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km


Scup
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
1 - 23
24 - 151
152 - 388
389 - 1616
North (kg)
0.0
0.1 - 0.3
0.4 - 0.5
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

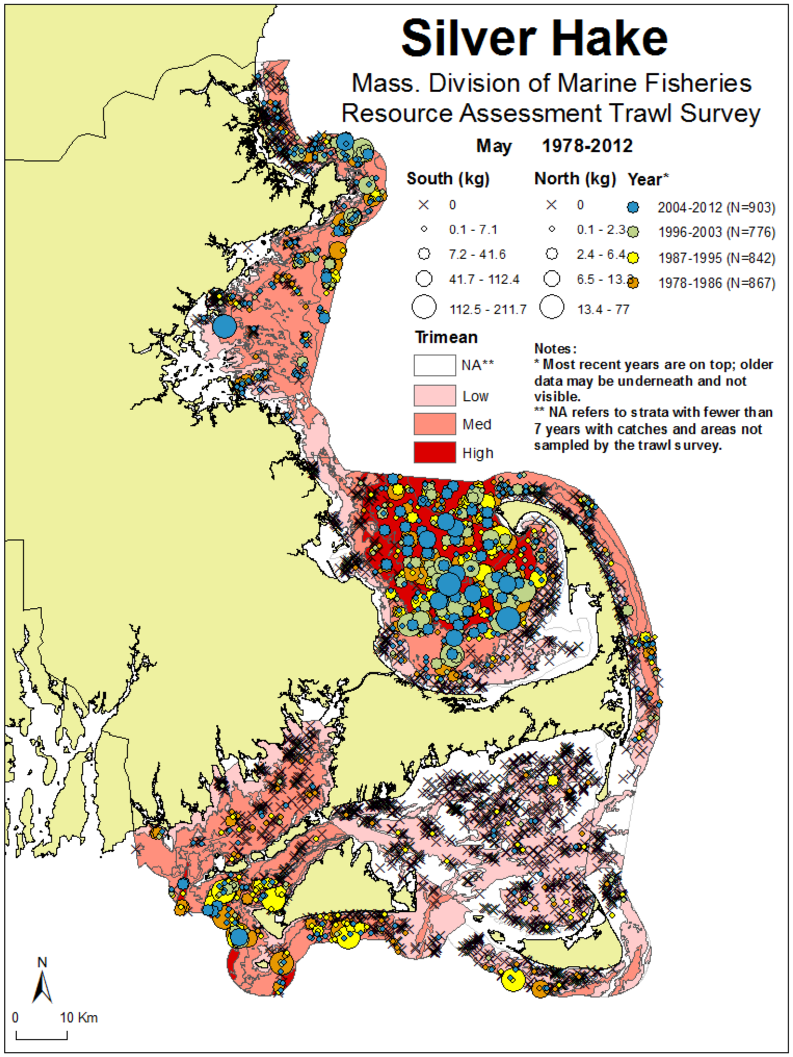

Scup
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 23
24 - 53
54 - 93
94 - 433
North (kg)
0
0.1 - 3.5
3.6 - 13.2
13.3 - 24.0
24.1 - 49.6
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

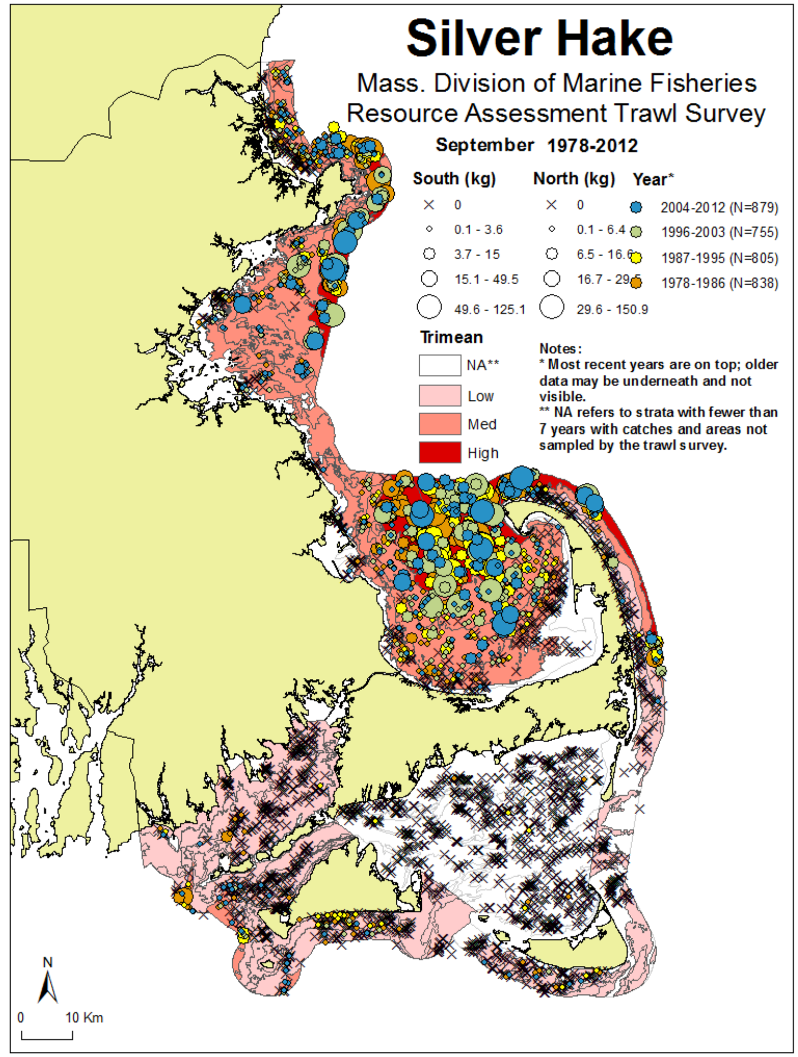


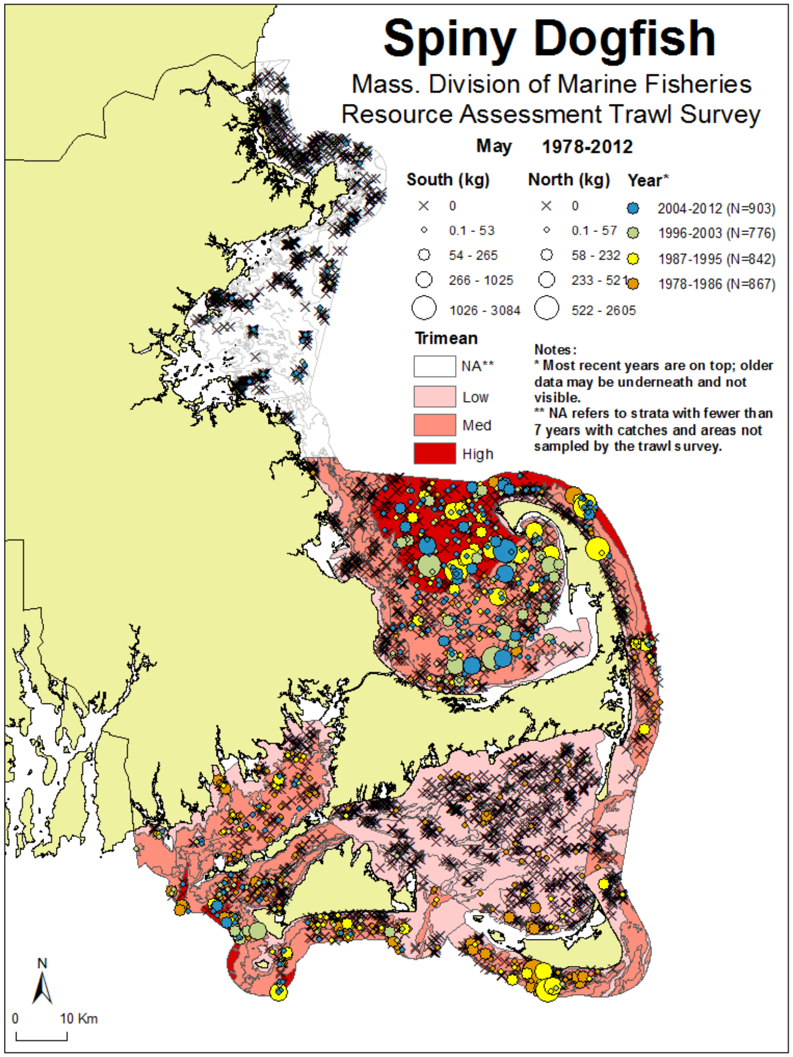
Sea Scallop
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 0.4
0.5 - 1.1
1.2 - 2.1
2.2 - 2.3
North (kg)
0
0.1 - 1.5
1.6 - 5
5.1 - 11.7
11.8 - 72.6
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

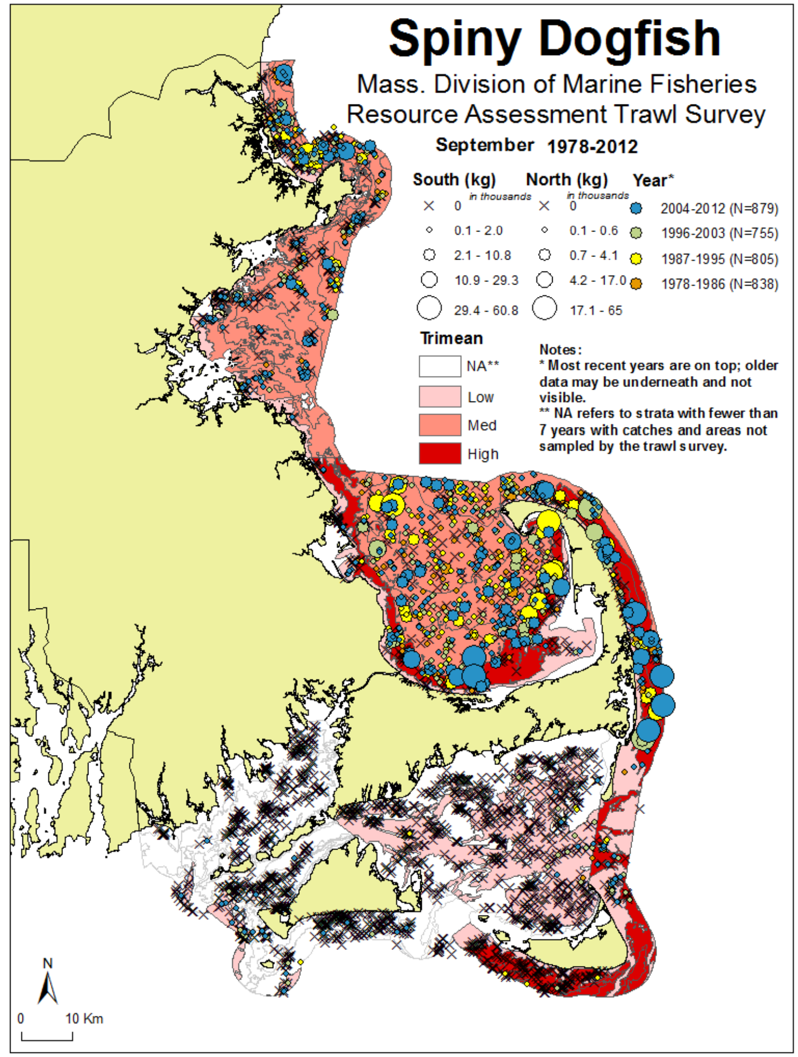


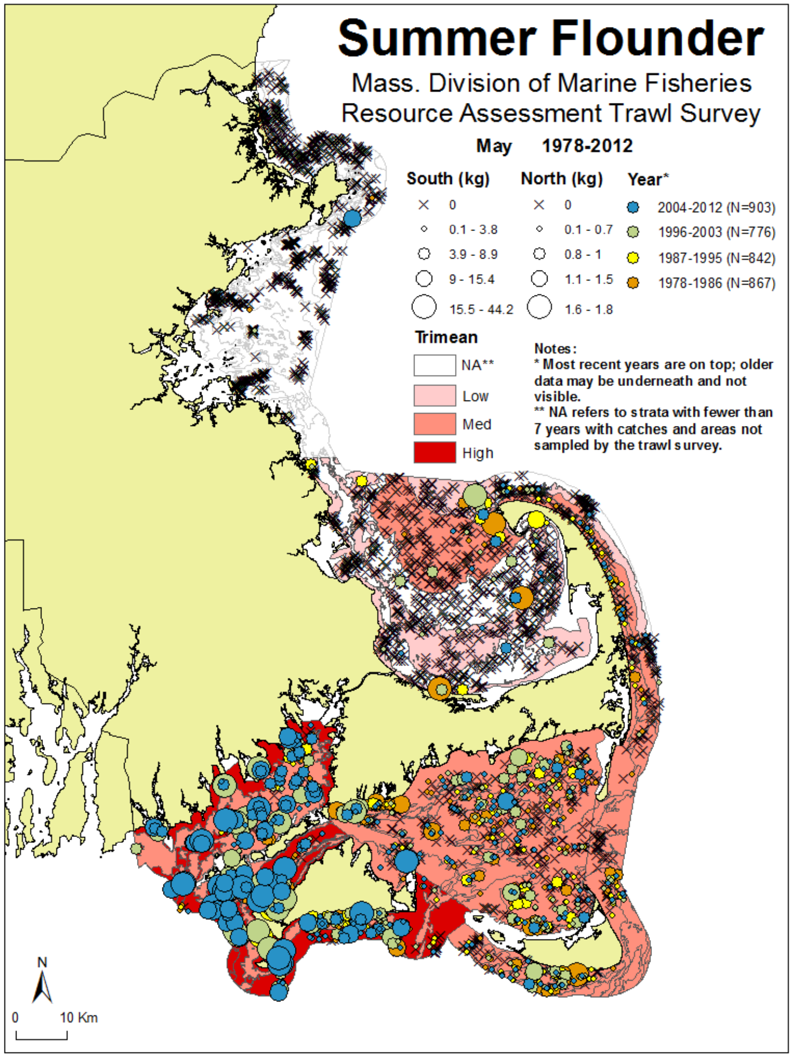
Sea Scallop
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 2.2
2.3 - 13.6
13.7 - 47.4
47.5 - 67.9
North (kg)
0
0.1 - 3.1
3.2 - 13
13.1 - 63.7
63.8 - 222.9
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

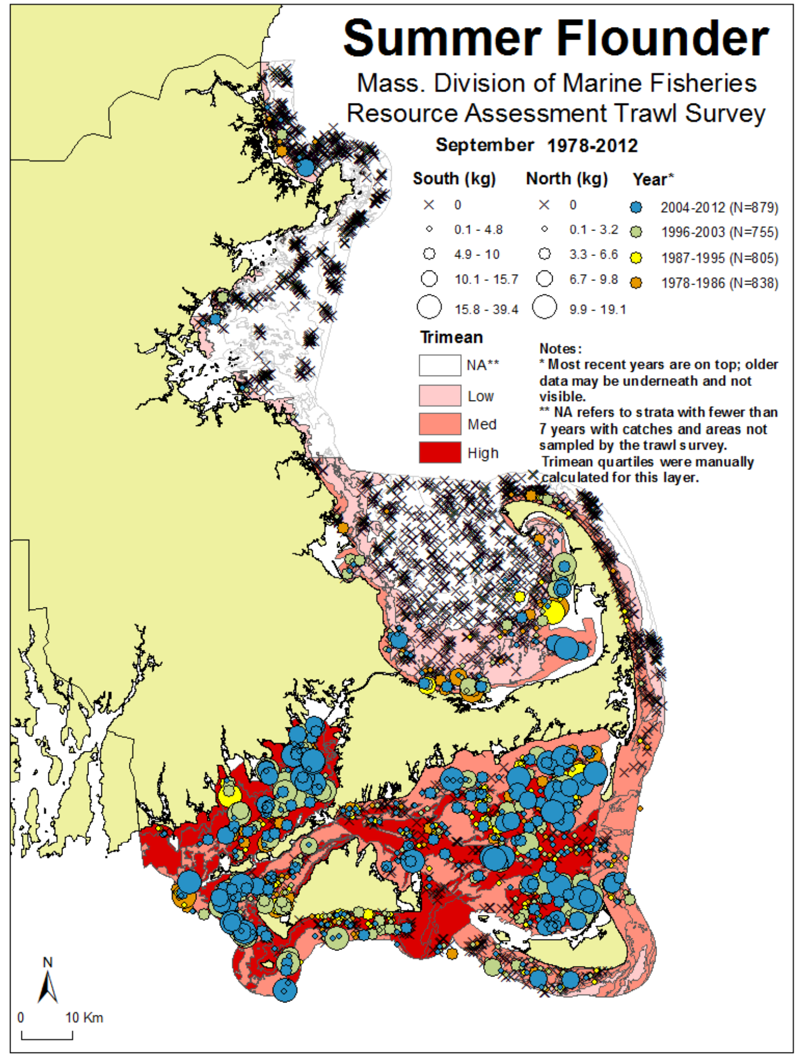

Silver Hake
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 7.1
7.2 - 41.6
41.7 - 112.4
112.5 - 211.7
North (kg)
0
0.1 - 2.3
2.4 - 6.4
6.5 - 13.3
13.4 - 77
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0 10 Km

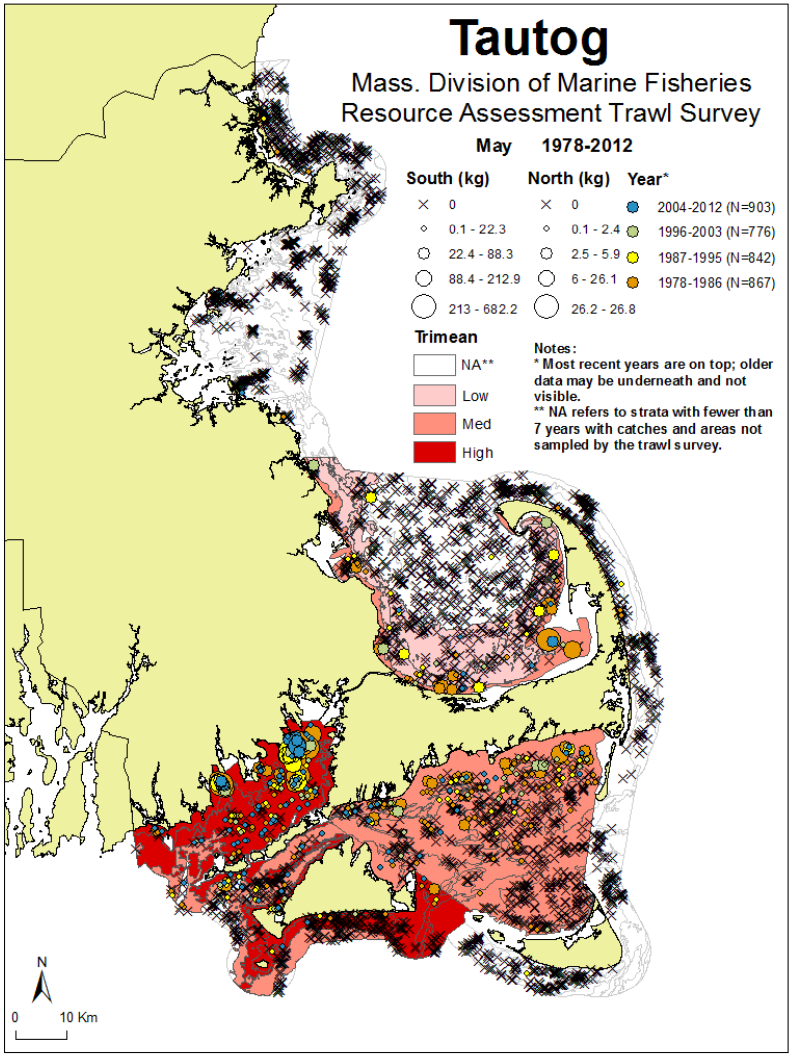

Silver Hake
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 3.6
3.7 - 15
15.1 - 49.5
49.6 - 125.1
North (kg)
0
0.1 - 6.4
6.5 - 16.6
16.7 - 29
29.6 - 150.9
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0 10 Km

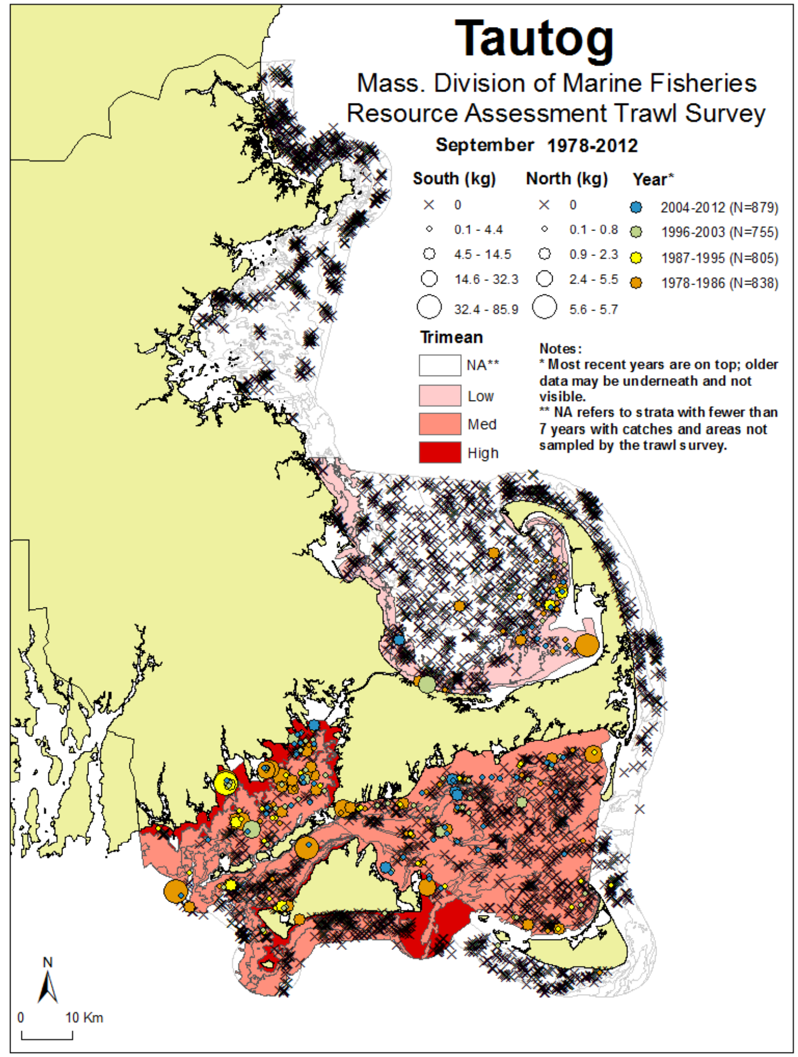

Spiny Dogfish
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 53
54 - 265
266 - 1025
1026 - 3084
North (kg)
0
0.1 - 57
58 - 232
233 - 521
522 - 2605
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0 10 Km

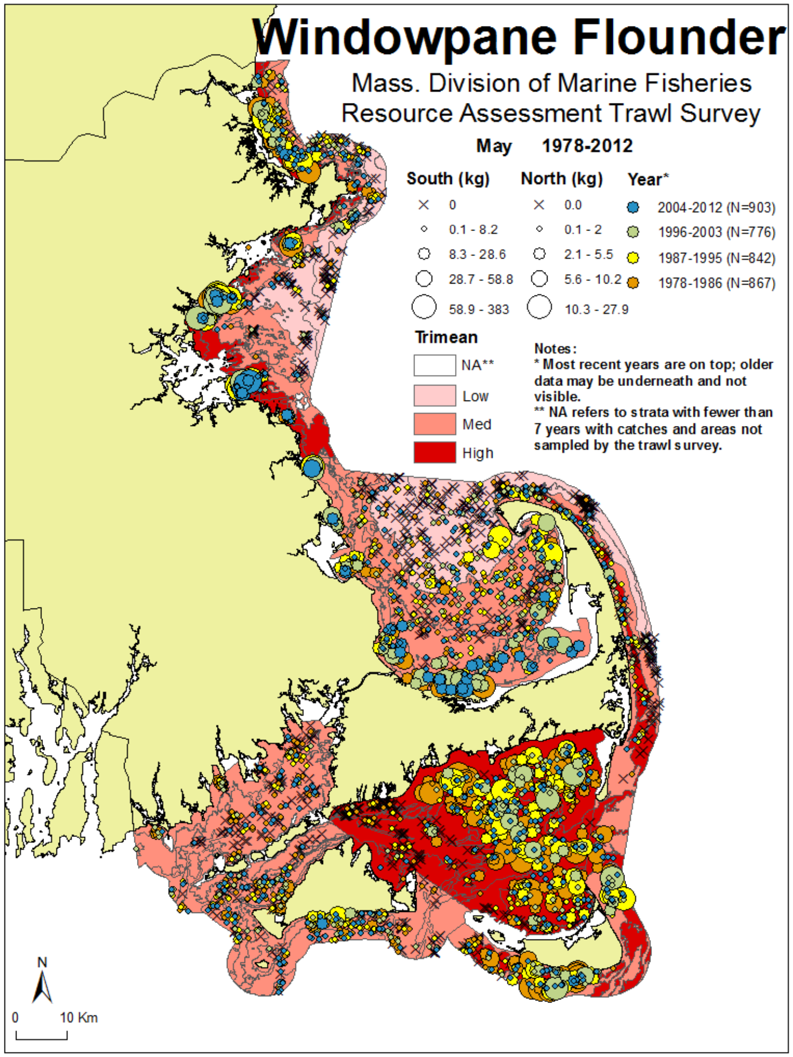

Spiny Dogfish
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
in thousands
0
0.1 - 2.0
2.1 - 10.8
10.9 - 29.3
29.4 - 60.8
North (kg)
in thousands
0
0.1 - 0.6
0.7 - 4.1
4.2 - 17.0
17.1 - 65
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0 10 Km

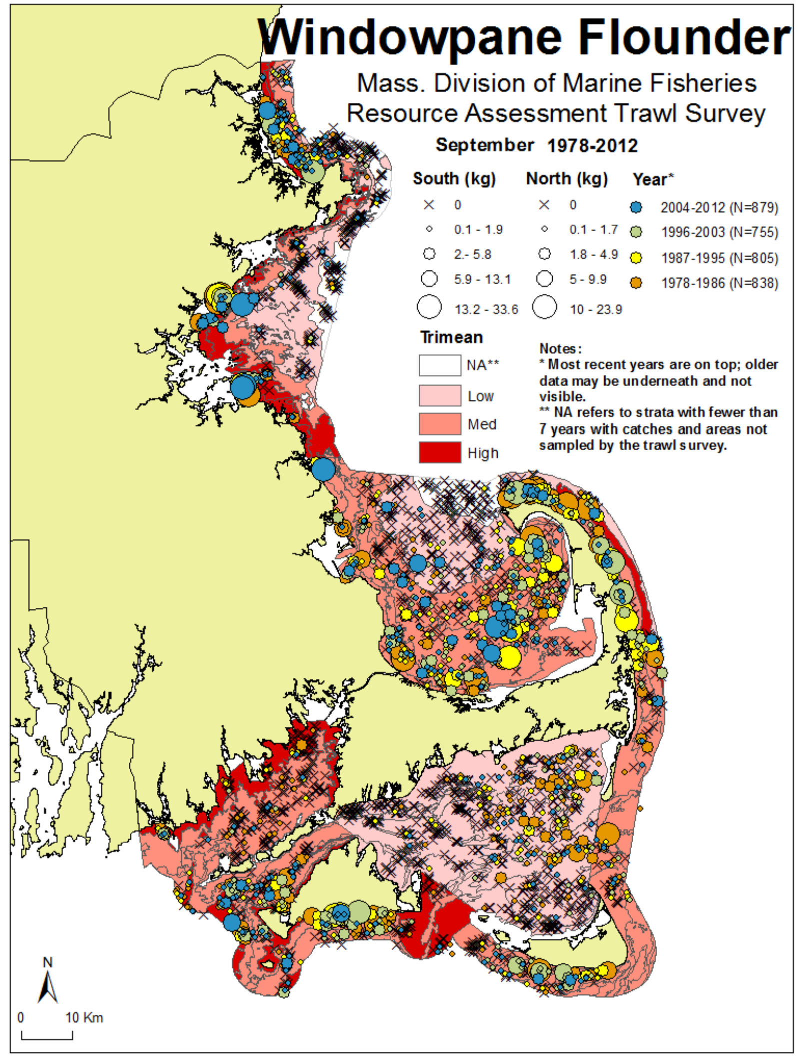

Summer Flounder
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 3.8
3.9 - 8.9
9 - 15.4
15.5 - 44.2
North (kg)
0
0.1 - 0.7
0.8 - 1
1.1 - 1.5
1.6 - 1.8
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0 10 Km

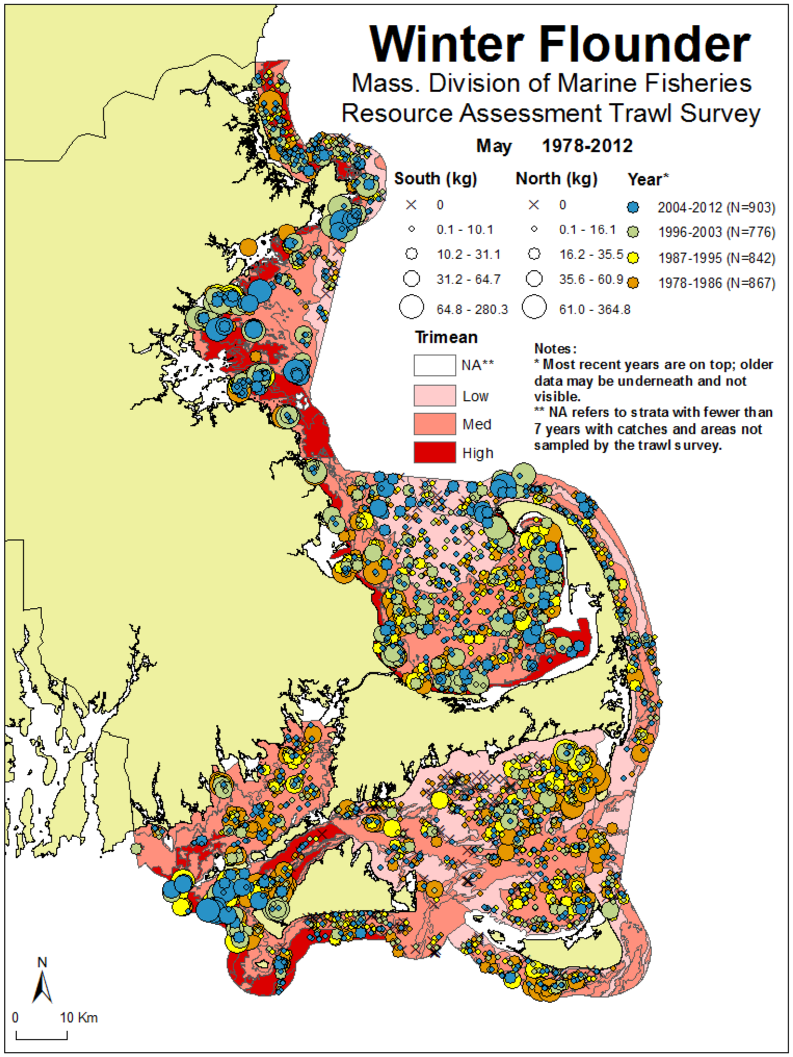

Summer Flounder
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 4.8
4.9 - 10
10.1 - 15.7
15.8 - 39.4
North (kg)
0
0.1 - 3.2
3.3 - 6.6
6.7 - 9.8
9.9 - 19.1
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
Trimean quartiles were manually calculated for this layer.
N
0 10 Km

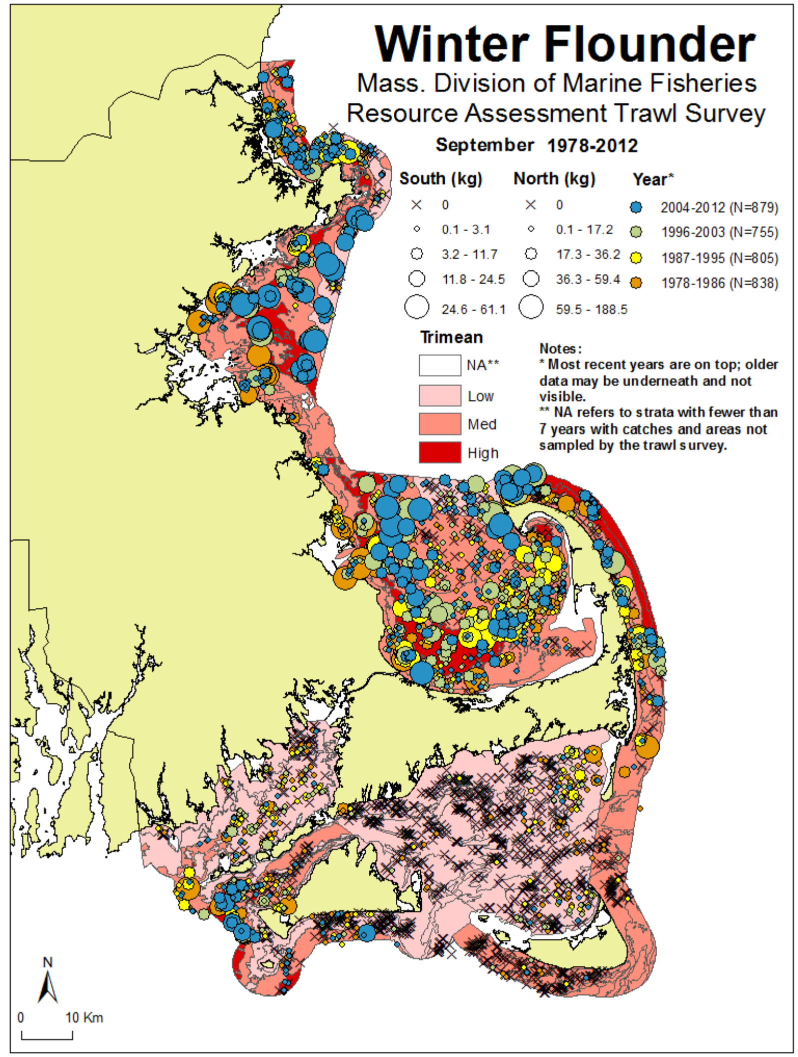

Tautog
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 22.3
22.4 - 88.3
88.4 - 212.9
213 - 682.2
North (kg)
0
0.1 - 2.4
2.5 - 5.9
6 - 26.1
26.2 - 26.8
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

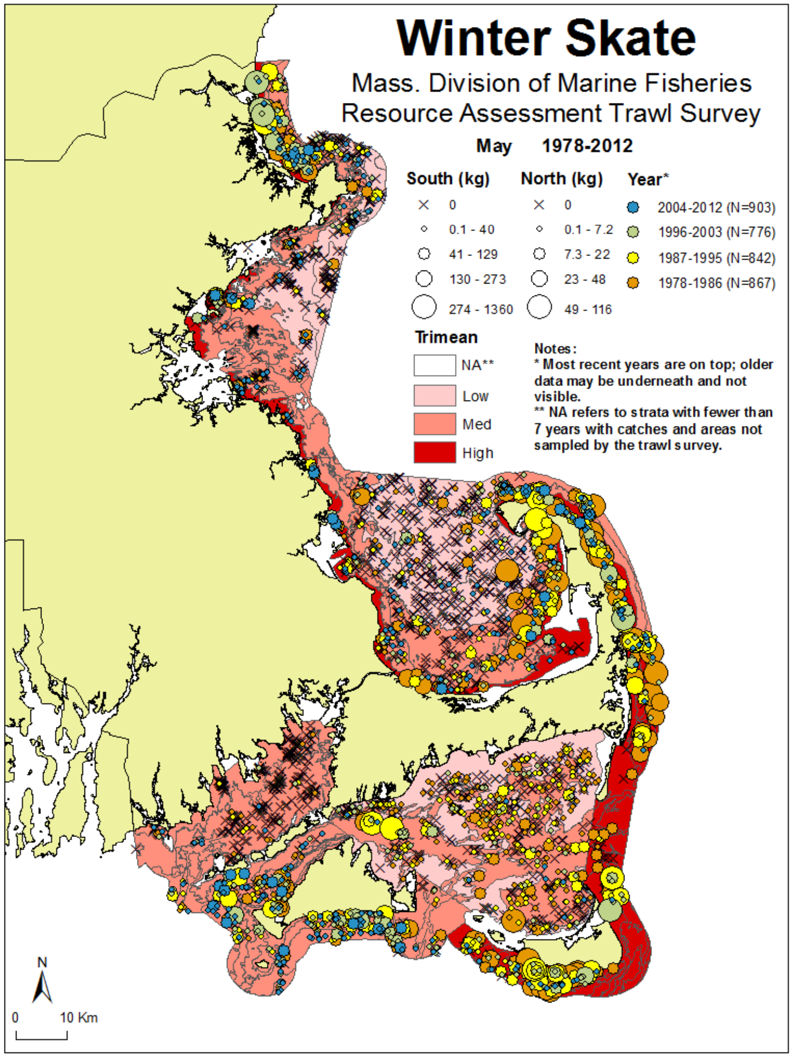

Tautog
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 4.4
4.5 - 14.5
14.6 - 32.3
32.4 - 85.9
North (kg)
0
0.1 - 0.8
0.9 - 2.3
2.4 - 5.5
5.6 - 5.7
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

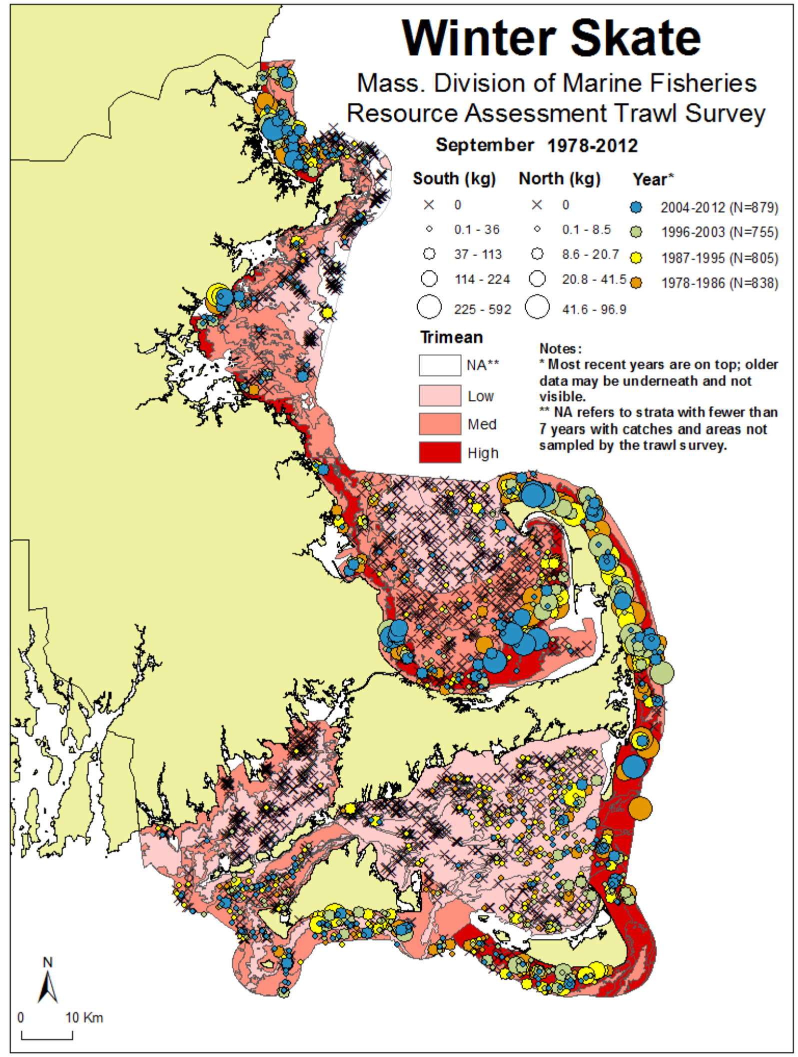

Windowpane Flounder
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 8.2
8.3 - 28.6
28.7 - 58.8
58.9 - 383
North (kg)
0.0
0.1 - 2
2.1 - 5.5
5.6 - 10.2
10.3 - 27.9
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

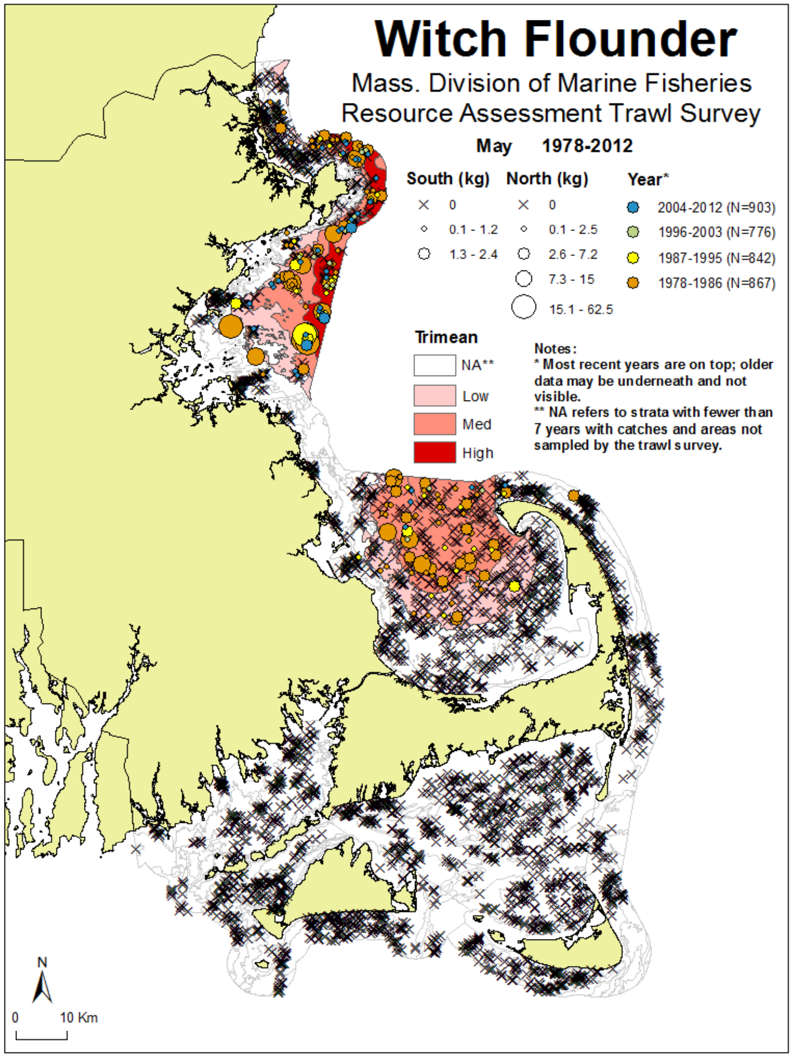

Windowpane Flounder
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 1.9
2 - 5.8
5.9 - 13.1
13.2 - 33.6
North (kg)
0
0.1 - 1.7
1.8 - 4.9
5 - 9.9
10 - 23.9
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

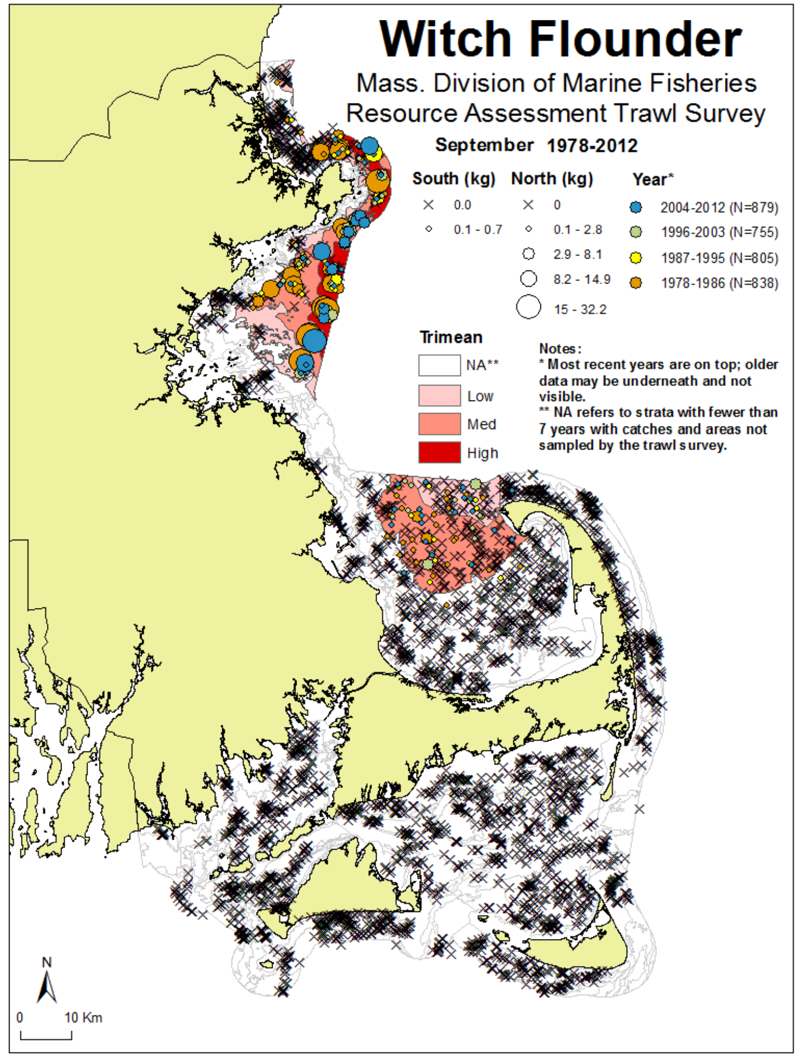

Winter Flounder
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 10.1
10.2 - 31.1
31.2 - 64.7
64.8 - 280.3
North (kg)
0
0.1 - 16.1
16.2 - 35.5
35.6 - 60.9
61.0 - 364.8
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

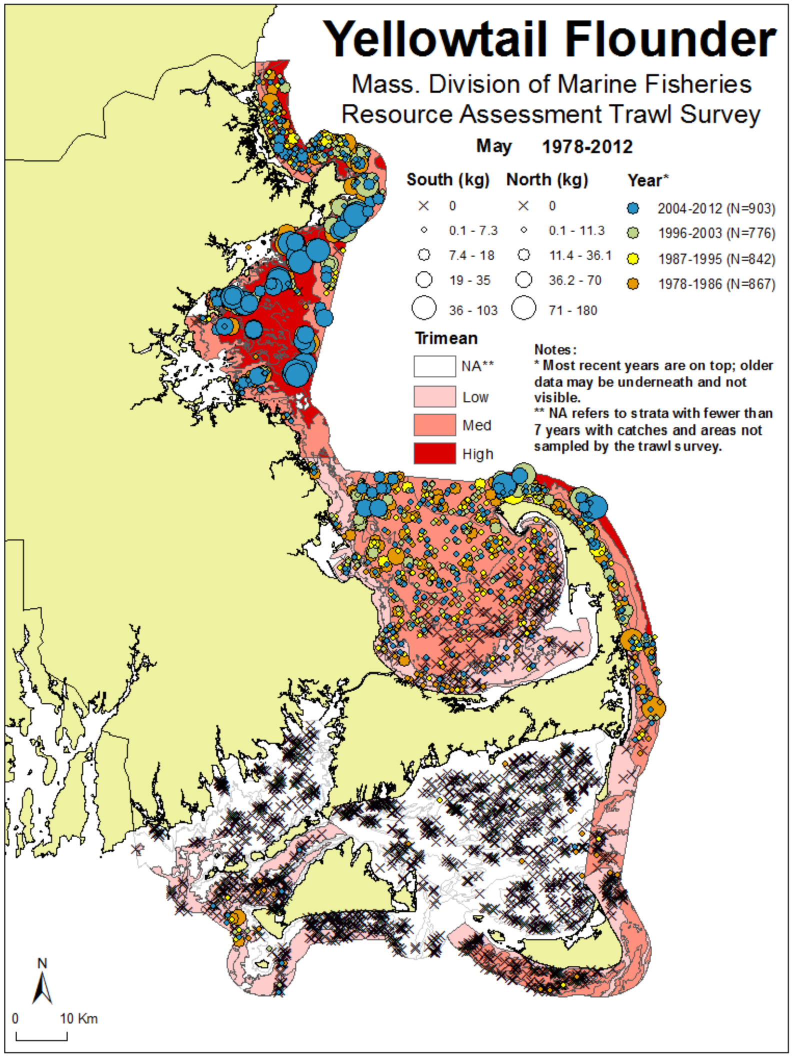

Winter Flounder
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 3.1
3.2 - 11.7
11.8 - 24.5
24.6 - 61.1
North (kg)
0
0.1 - 17.2
17.3 - 36.2
36.3 - 59.4
59.5 - 188.5
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km

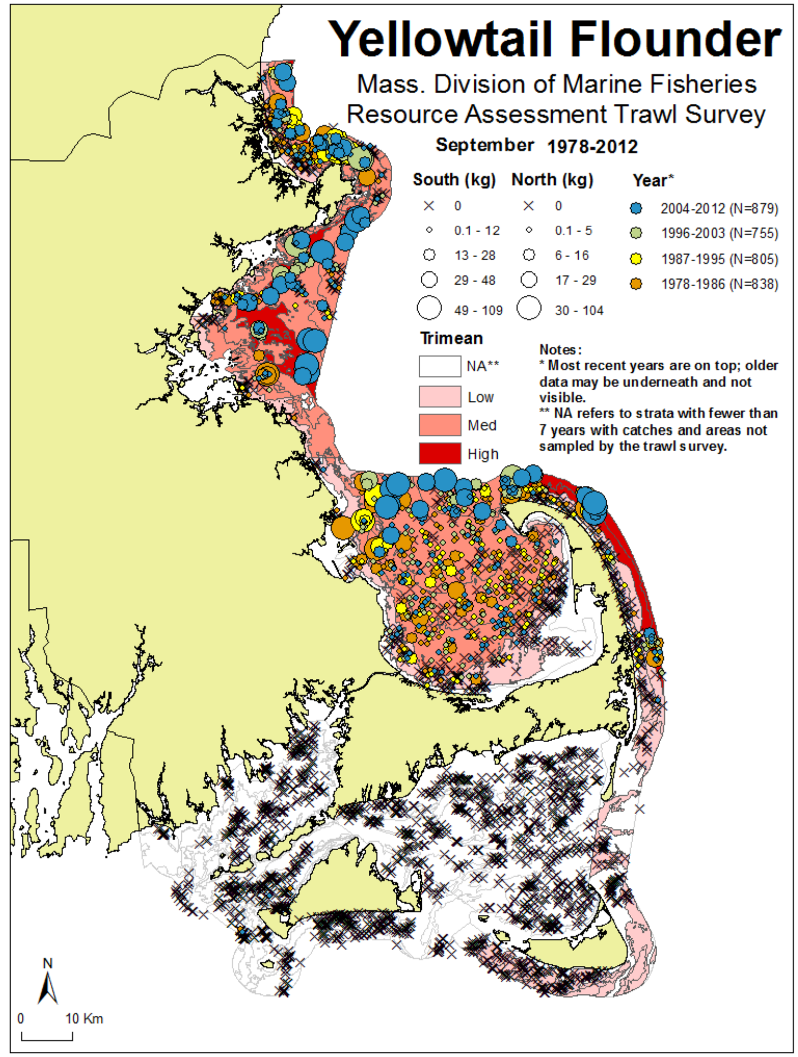

Winter Skate
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 40
41 - 129
130 - 273
274 - 1360
North (kg)
0
0.1 - 7.2
7.3 - 22
23 - 48
49 - 116
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km


Winter Skate
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 36
37 - 113
114 - 224
225 - 592
North (kg)
0
0.1 - 8.5
8.6 - 20.7
20.8 - 41.5
41.6 - 96.9
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km


Witch Flounder
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 1.2
1.3 - 2.4
North (kg)
0
0.1 - 2.5
2.6 - 7.2
7.3 - 15
15.1 - 62.5
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km


Witch Flounder
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0.0
0.1 - 0.7
North (kg)
0
0.1 - 2.8
2.9 - 8.1
8.2 - 14.9
15 - 32.2
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0
10 Km


Yellowtail Flounder
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
May 1978-2012
South (kg)
0
0.1 - 7.3
7.4 - 18
19 - 35
36 - 103
North (kg)
0
0.1 - 11.3
11.4 - 36.1
36.2 - 70
71 - 180
Year*
2004-2012 (N=903)
1996-2003 (N=776)
1987-1995 (N=842)
1978-1986 (N=867)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0 10 Km


Yellowtail Flounder
Mass. Division of Marine Fisheries
Resource Assessment Trawl Survey
September 1978-2012
South (kg)
0
0.1 - 12
13 - 28
29 - 48
49 - 109
North (kg)
0
0.1 - 5
6 - 16
17 - 29
30 - 104
Year*
2004-2012 (N=879)
1996-2003 (N=755)
1987-1995 (N=805)
1978-1986 (N=838)
Trimean
NA**
Low
Med
High
Notes:
* Most recent years are on top; older data may be underneath and not visible.
** NA refers to strata with fewer than 7 years with catches and areas not sampled by the trawl survey.
N
0 10 Km