Charting Anecdotal Information and Oral Histories on Stellwagen Bank from Local Commercial Fishermen

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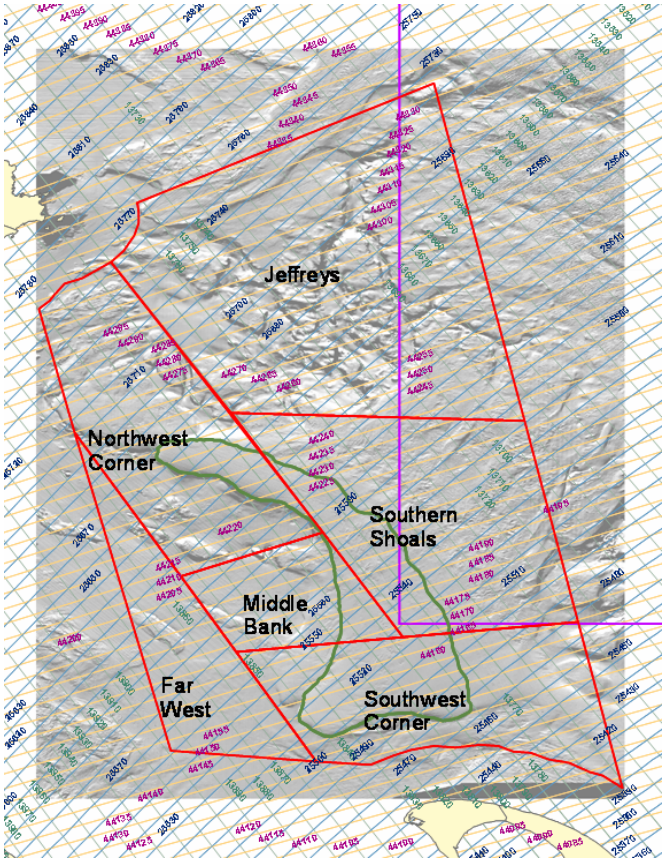

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Abstract

The goal of this project was to document the extent and value of fishing activities on Stellwagen Bank over three decades and to see how this may have changed over time. Specific objectives were to involve fishermen in the data collection, charting and analysis in order to tap into their local knowledge and experience; to develop charts that depicted seasonal fishing grounds by gear sectors, target species, economic value, and sea floor characteristics on Stellwagen Bank; and to build working relationships among the commercial and recreational fishing and scientific communities.

High-resolution charts were developed that depict seasonal fishing grounds by gear sectors and target species. Interviews elicited information about the significant economic value of fishing on the Bank to multiple fishing sectors and obtained some information about sea floor characteristics. The project found that the combination of charts and interviews were an extremely valuable, non-threatening method to obtain and present information of interest to both the fishing industry and to managers.

Finally, the project accomplished the goal of documenting the patterns associated with three decades of the use of Stellwagen Bank by commercial and recreational fishermen. That clusters and patterns could be discerned for the different gear groups and target species suggest that the information recorded was accurate.

Introduction

The potential for increasingly strict regulatory and management measures governing commercial and recreational fishing on Stellwagen Bank motivated fishermen to help design and participate in a collaborative project to document their use of the bank over the last three decades.

Though only officially “discovered” and mapped in 1854 by Captain Henry Stellwagen of the U.S. Navy, Stellwagen Bank had a long and valued history as a destination for New England’s fishing vessels. Located just outside of Massachusetts Bay, stretching between Gloucester and Provincetown, the Bank’s natural resources boast a diverse range of marine life. Designated as a National Marine Sanctuary in 1992, Stellwagen Bank (SBNMS) continues to support commercial and recreational fishing industries, whale watching, and other tourism related activities. The location of SBNMS also places it in the midst of the major shipping lanes between New England and international ports and near areas proposed for gas and pipelines, dredged material dump sites, and a proposed liquid natural gas docking area.

Clearly, the management of the sanctuary requires balancing commercial use with the protection of resources and opportunities for scientific enquiry. The SBNMS is developing a new management plan that includes, among other objectives, site characterization, ecosystem alteration, and ecosystem management. In spite of there being representatives of commercial and recreational fishing, the whale watching industry, scientists, and other stakeholders on the Sanctuary’s advisory board and also as

participants in each of the working groups, no broad-based consensus on long-term management has yet been achieved. Part of the reason for this is a lack of data on the use of the resources of the Bank as well as the social and economic impacts of such use and/or loss of use.

The Commonwealth of Massachusetts, the US Ocean Commission and federal agencies are all discussing the use of ocean zoning to resolve potential user conflicts. Rational management decisions concerning appropriate uses of areas require detailed, spatially-based information that is only beginning to be made available. Commercial users of marine resources are concerned about marine protected areas and other broad brush approaches to protection. At times, areas are closed to commercial fishing based on data aggregated at a level too general to accurately identify critical habitat. Furthermore, little work has been done to analyze the social and economic impacts of such closures. A recent study of SBNMS using geographic information systems (GIS) to develop a web-based participatory program underscores the lack of data on fisheries, benthic communities, and use of the Sanctuary (Adams 2004).

Research has found that the management of marine resources is most successful when the users of the resources have a voice in their management (Ostrom 1990). Not only are such users more likely to have the detailed knowledge of the resources necessary for their management, but they also have an interest or stake in assuring that management is for long-term sustainable use.

With the downturn in the groundfish stocks in the 1990's, managers identified areas that they believed should be closed for the protection of cod. Later, the closures were extended for habitat and juvenile groundfish protection. Two of the areas closed to commercial fishing for the recovery of groundfish fall within SBNMS. No published analysis of either the habitat or socio-economic impacts of these closures is available; however, a summary of data looking at paired sampling locations has been provided to one of the Sanctuary's working groups (Lindholm and Auster 2004, http://stellwagen.noaa.gov/management/workinggroups/wgpdf/easumapr27.pdf). Based on this report, some habitat types, such as boulder and mud, appear to be more impacted by fishing than other habitat types, such as sand and gravel. Caveats to the data analysis were limitations in being able to select paired habitat types in the fished and unfished areas, inadequate sample sizes, and uncertainty about the appropriate time frame to adequately document changes.

In Canada, there is now legal precedent for using traditional ecological knowledge (TEK) as the basis for treaty negotiations between First Nations and the Provincial and Federal governments. "Within these legal frameworks, mapping is emerging as a common language for giving a voice to TEK in a science-dominated field. This new language is bridging communications between traditional and scientific ways of knowing" (Carruthers and Olive, n.d.). Other researchers have documented the value of using local knowledge in fisheries management elsewhere in the world (Ruddle 1994, Neis and Felt 2000, Chiarappa 2000 and Acheson 1988).

Building on the use of Geographic Information Systems (GIS) to gather information on fishing activities in several other projects, this project adds to our knowledge about how to obtain more accurate and finer-scale data from users that can then be applied to spatially-based management. It also warns of some of the constraints and challenges of collaborative research and GIS data management.

The overall purpose of this project was to collect historic data so we could begin to understand the extent and value of fishing activities on Stellwagen Bank and how they have changed over time. Explicit objectives of the project included:

1. Assist fishermen in charting and analyzing their data in order to contribute accurate information to fisheries managers;
2. Develop high-resolution charts that depict seasonal fishing grounds by gear sectors, target species, economic value, and sea floor characteristics on Stellwagen Bank;
3. Work with commercial fishermen to design a longer-term project that will build on initial efforts to compile accurate data;
4. Build working relationships among the fishing and scientific communities.

The value of having an industry umbrella organization in a coordinating role cannot be overstated. The breadth of MFP made it possible to hire fishermen from all areas and sectors to participate in project planning and to serve as interviewers. The fishermen also trusted the MFP to collect, store and share data appropriately. Consequently, the interviewers were able to convince fellow fishermen to be honest and forthcoming with the data they were imparting, information that has traditionally been considered proprietary. In addition, MFP served as intermediary between the fishermen and scientists, answering questions and building trust. Clearly, MFP's history of effective communication with both commercial and recreational fishermen contributed to the success of this project.

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Methods

Three types of data were sought: locational data to be used for GIS mapping; social-cultural and economic data; and ecological data. Ed Barrett, president of MFP, and Richard Taylor, former commercial fisherman turned consultant who is skilled in the use of GIS, worked together to create nautical charts recognizable to commercial fishermen fishing on Stellwagen Bank. Their work also began to provide MFP with a list of boats that traditionally and currently fish on Stellwagen as well as an overview of seasons, years, variability of landings and economic returns. Fishermen who have in-depth knowledge about Stellwagen and its ecosystem, as well as those who have logbooks documenting their use of Stellwagen over time, were identified. For this project the nautical chart was used to gather data appropriate for GIS mapping. A brief survey was also developed by project participants to guide interviewers in the gathering of social-cultural, economic and ecological data.

Methods to gather similar data from fishermen were initially piloted by MFP in another region. The willingness of the fishermen to meet and provide data to the researchers built confidence in the process and outcomes to be expected. The MFP board and staff then selected a number of well-respected fishermen and invited them to act as research partners on the project. The fishermen chosen represented different port sizes and locations and the variety of gear types typically found on Stellwagen. It was considered important to choose individuals well-known in their fishing community and knowledgeable about Stellwagen fisheries, i.e., experts in their field, so that they could select key representatives to interview and would be able to answer questions credibly about both the project design and potential uses of the project results in management.

Six fishermen agreed to each interview 10-12 other Stellwagen fishermen. These six also participated in the design of the charts and the survey questions. After the project began, one fishermen decided not to continue as a researcher, so another took his place.

The interviewers were asked to use the charts and supplementary questions as guides for their interviews. In accordance with the protocol on the use of human subjects in interviews, we emphasized that interviewees could choose not to answer specific questions. The interviewers were asked to select individuals who were representative of the group of fishermen who fish on Stellwagen Bank and were instructed to conduct the interviews in person.

MFP staff monitored project progress and assisted project scientists in deciding when the project team needed to meet. These meetings were important to monitor and guide industry participants and provide important feedback to the project science team as they began to analyze the data. Early on, to verify the preliminary results of the charting and interviewing, two of the investigators presented summary results at a meeting of fishermen and scientists held by MFP.

Negotiating the open-ended interviews

As the project began, the principal investigators (PI's) met with the project's fishing industry partners who would be selecting the interviewees and conducting the interviews. The group agreed upon the details that should be shown on the nautical chart and discussed which questions should be included on the questionnaire. The numbers of questions were pared down considerably from the set originally proposed by the PI's. The fishermen interviewers were primarily interested in the second goal of the project, that is, to document the spaces of Stellwagen that have traditionally been used by fishermen. Most of the interviewers were not interested in conducting lengthy wide-ranging interviews or collecting oral histories. Nor did the interviewers agree to tape record the interviews. This negotiation was very important in securing full industry participation.

The information sought included each gear type's usual fishing locations (according to season and year), species targeted, landings (quantity and value), species life cycles noted, home ports, gear type, and to the extent possible, bottom type, bycatch data, and other ecological information. One hundred, forty-two interviewees circled areas on the charts where they worked, noting details about timing, species, etc. The questions offered participants further opportunity to elaborate on the information marked on the charts.

Originally, three dates were chosen to sample fishing activity in the three decades of interest: 1984, 1994 and 2004. These specific years were selected to elicit impacts of regulatory change on fishing effort. However, interviewees annotated the charts and responded to the survey questions on a decadal scale instead. This complicated analysis. For example, in 1997 the Western Gulf of Maine was closed to commercial groundfish trawlers and gillnetters, but remained accessible to recreational party/charter boats. Consequently, the chart notation summaries showed fishing in the closed area in the 1990s though, in fact, commercial fishing ceased in 1997.

Other problems in the administration of the interviews occurred when some of the interviewers gave individuals copies of the charts and questions and asked them to fill them out and send them in, rather than guiding them through the process. Whether by choice or oversight, many of the sets of questions were incompletely answered and so, the results are based on varying numbers of responses. However, the number of responses for each result is clearly stated in each summary and graph.

Representative samples

This project relied on chain-sampling, also known as the "snowball" approach, to develop a representative sample that selects interviewees by networking through key individuals. As with other methods that social scientists typically use to select a sample in the absence of an acceptable sampling frame, this non-random method has potential sources of error or bias. However, it has been found to be an effective way to identify a variety of informed individuals in commercial fishing communities who are willing to participate in

research.[1] Preliminary efforts to test the accuracy of the results of this research were conducted by presenting the findings at a joint meeting of scientists and fishermen sponsored by the MFP. Further testing will be forthcoming through the posting of this report on MFP's web page with an invitation to comment. In the meantime, the investigators warn that the results of this project should not be generalized to the whole population of those who fished on Stellwagen Bank in the last three decades, but used as an indicator of trends over time and a basis for further investigation.

Obtaining corroborating information

The project planned to use NOAA fisheries data and fishermen's logbooks to compare interview data with information collected by other means. A lengthy process preceded access to a limited set of data from NOAA fisheries. Because of the delay in receipt of the data, interviews had already started and it was not until much later in the project that we discovered the challenges of tracking change with the limited data points we had obtained. Fortunately, a colleague who had access to vessel permit data was able to offer summary information from 2002 for comparative purposes.

Logbook access was initially agreed to by about a third of the interviewees. When we sought the books, however, only one fisherman actually shared his. Time to locate them, agree to meet and actually discuss them, constrained some of the others. We plan to renew efforts to investigate logbooks in future work.

Collecting spatial data

The interviewed fishermen were given 11 x 17 inch printed copies of a chart and asked to draw on the chart to indicate where they fished during the years 1974, 1984, 1994, and 2004. The printed chart showed the coastline of Cape Ann and the tip of Cape Cod in Massachusetts, an outline of Stellwagen Bank, the Gulf of Maine Closure Area, and the outlines and commonly used names of Stellwagen Bank National Marine Sanctuary fishing areas. The chart was superimposed with the Loran C navigational grid. The boundary of the chart also showed latitude and longitude tic marks. An image of this chart is shown below in Figure 1 and a copy appears (named *surveychart.pdf*) on the attached disk.

The fishermen were asked to outline areas on the chart showing where they fished and to note the target species, gear type, bottom type, season, and years fished for each area drawn. Most fishermen drew on three blank charts, one for the 1980s, 1990s and 2000s. Only seven out of 142 fishermen interviewed indicated they fished during the 1970s.

[1] See Hall-Arber 2007 for a lengthier discussion of similar methods used in fishing communities.

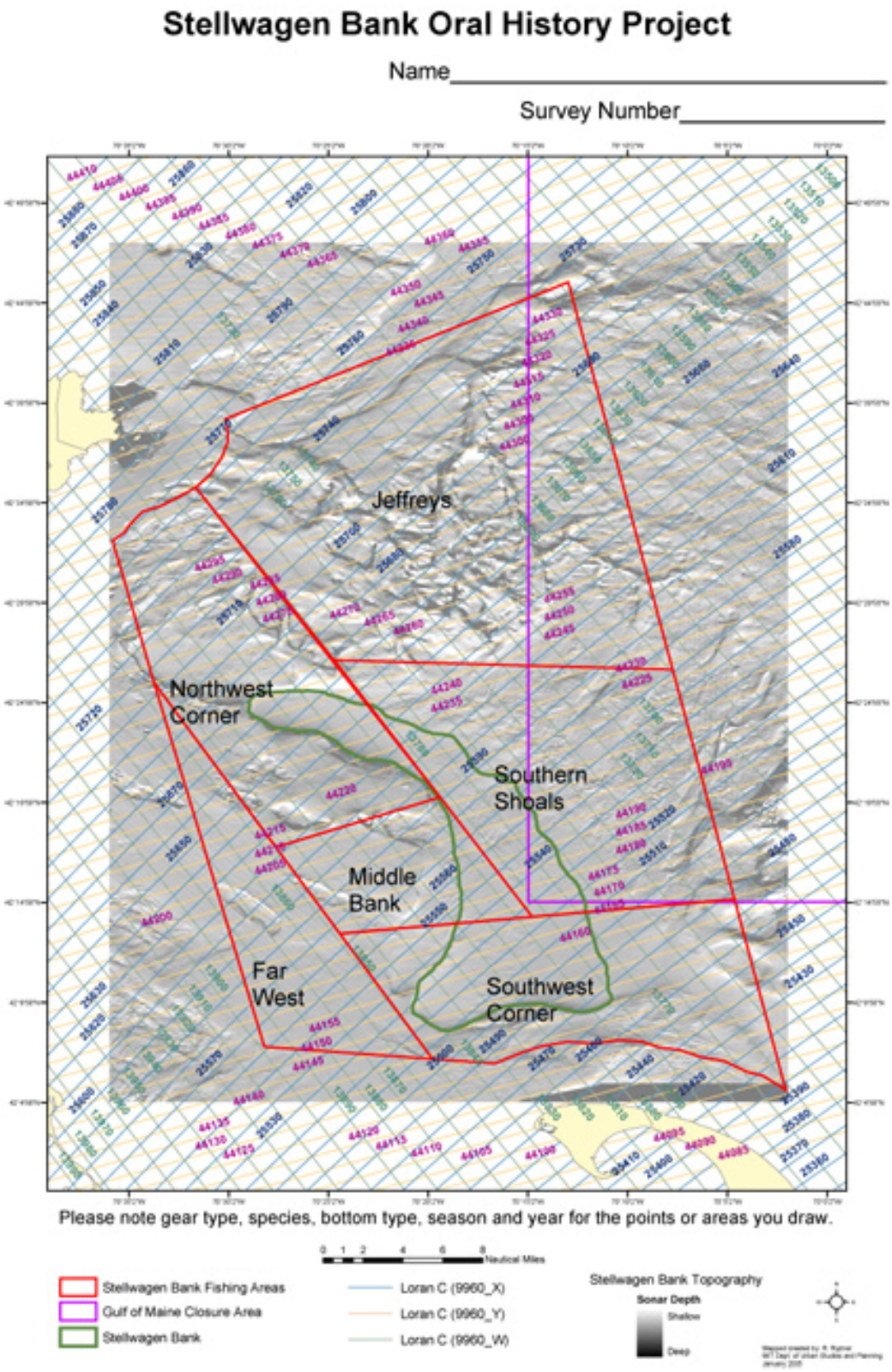

Figure 1. Chart used to collect spatial data during interviews.

Processing the data

Processing the questionnaire survey data

A Microsoft Access database was created to enter the information collected by the questionnaire portion of the interviews and the data was entered by MFP staff. Access software was used with the intention of linking the database with the GIS database. Ultimately, this linkage proved cumbersome, so many of the data summaries were tallied separately. To facilitate this effort, the Access files were converted to Excel. [2]

The proliferation of common names for target species, gears used, and other fishing industry jargon make it difficult to ensure that data is entered consistently and accurately. This is particularly true when multiple researchers obtain information from a variety of sources with different levels of specificity. For example, some respondents named their target species as "multispecies," others referred to as "groundfish" and still others listed "cod," "tuna," or "blackback." For the analyses of the data elicited by the questionnaire and the charts, results were aggregated under the most general appropriate term.

Although a checklist of ecological features and observations was originally designed for the questionnaire, the interviewers requested that in the final version the questions be open-ended. As a result, details of specific features were not necessarily discussed or explained, even if the interviewee said that they had noted changes over their fishing career. The benefit, however, was that certain observations that were raised repeatedly and independently may reflect greater and more wide-spread concern. As discussed below, the frequently mentioned observation about the proliferation of dogfish was striking.

Technical information on the processing of the chart data

Digitizing the interviewees' marks on the charts

During the course of data collection, 142 individual fishermen were interviewed. These 142 individuals produced over 300 marked charts showing a total of 1,726 areas, called "polygons" in GIS jargon, where they fished. MFP staff followed up with interviewees to double check data where markings seemed questionable and assisted in identifying and correcting errors. The marks drawn on the charts during the interviews were later entered into a GIS through on-screen digitizing. This was done by displaying the same chart used in the interviews on the computer screen, locating the position of the drawn areas using the Loran grid, and then redrawing the same areas on the screen. This was a painstaking process that took several weeks to accomplish.

This process produced a single digital map containing all of the 1,726 individual polygons as shown in Figure 2.

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[2] As a warning to other researchers collaborating with others, be aware that the computer platforms for data handling can be problematic. For example, Access is not available for Macintosh computers.

Figure 2. All of the polygons drawn in the interviews shown on one chart.

Each polygon became a record (row) in the GIS map database and contained an ID field that corresponded to the questionnaire number of the interviewed fisherman, as well as the fisherman's name, boat name, month, season, year, decade, target species, other species, gear type, bottom conditions, depth seen, how many seen, and other conditions pertaining to each marked area on the chart.

A table of the fields for each polygon in the ArcMap digital map file *forgridnoprehomeprt.shp* are listed below. The homeport field was added to this file by linking the digital map with one of the Access databases through the survey number.

Table 1. Fields found in *forgridnoprehomeprt.shp*.

Field Name	Description
Id	Survey number
Dateseen	Date written in polygon regarding when a species was fished or seen there
Howmany	Approximate number of fish seen
Depth	Approximate depth of fish seen
Othercondi	Notes regarding bottom or water conditions
Otherspeci	Other species seen while fishing target species
Name	Name of fisherman
Targetspec	Target species being fished
Nodate	Logical field (0, 1) indicating a 1 if the respondent did not give a date as to when they fished the area
AltID	Survey number as a text field
BoatName	Vessel Name
Year	Year or years fished the designated area
GearType	Gear type used
MapID	Text field for map ID number followed by an a, b, or c (pertaining to decades fished) indicating multiple maps from one interview
Month	Name of months during the year when the area was fished
Season	Spring, Summer, Fall, Winter
textid	Survey number as a text field
preclosure	Since some fishermen indicated they fished in the closure area this logical field (0,1) was added to indicate the fishing took place before the closure took effect. If yes, the value "1" was given.
RealID	Sequential ID used to make grid maps for the time/space images (explained later)
Seventies	Logical field (0, 1) indicating whether the area was fished during that particular decade. If yes, the value "1" was given.
Eighties	Logical field (0, 1) indicating whether the area was fished during that particular decade. If yes, the value "1" was given.
Nineties	Logical field (0, 1) indicating whether the area was fished during that particular decade. If yes, the value "1" was given.
Twothou	Logical field (0, 1) indicating whether the area was fished during that particular decade. If yes, the value "1" was given.
Area	Area of the drawn polygon in square meters???
OID_	An early ID number that is no in use
Homeport	The homeport of the interviewee
SNUM	Survey number used to link to Access databases

Shape files created during the processing

The file named "surveycharts.shp" contains all of the chart data from the interviews, including the data gathered when the questionnaire was tested. The data from the testing

of the questionnaire are called preliminary cases. The preliminary cases are designated in the surveycharts.shp attribute table with a phrase that begins with 'prelim#' in the field named AltID.

From surveycharts.shp, a new shapefile was created called "forgridsnoprelims.shp". This file contains everything that was in surveycharts.shp *except* none of the preliminary test records. These were removed from surveycharts.shp by selecting on "AltID LIKE '%prelim%', switching the selection, and then exporting the selected set (i.e., every record EXCEPT the preliminary ones) to forgridsnoprelims.shp.

Also, forgridsnoprelims.shp has the fields named 70s, 80s, 90s and 2000s removed because a module of the GIS software (particularly the INFO module of ArcInfo used later to create images from queries) would not accept a dbf file with a field that starts with a number. The data in 70s, 80s, 90s and 2000s was saved to "Seventies," "Eighties," "Nineties," and "Twothou" before the old fields were deleted.

Finally, the file *forgridnoprehomeprt.shp* (fields of which are shown in Table 1 above) was created when *forgridsnoprelims.shp* was linked to the Access file containing homeport information from the survey. The link was done in ArcMap by joining the Access file to the shape file based on SNUM.

Steps to Creating the Three Dimensional Images of Fishing Activities

A dbf file was created from the surveycharts.shp attribute table named RealID.dbf which contains a unique identifier for each of the over 1700 polygons. (Saved in C:\temp and included on the accompanying disk). A separate shape file was then created for each polygon in surveycharts.shp with the MakePoly button. The MakePoly button runs from a compiled visual basic program. The MakePoly button was created and compiled by Daniel Sheehan, GIS specialist, at MIT. After pushing the MakePoly button in ArcMap, the Tablefolder was set as C:\temp, the Table was set as RealID.dbf, and the output folder was set as C:\temp\tempshapefiles. The entire set of individual shapefiles saved in tempshapefiles is included on the accompanying disk.

To create the three dimensional fishing activity summary maps we first produced a query from forgridsnoprelims.shp for the activity of interest. For example, if we wanted to know how many draggers were active in the decade from 2000 on, we created a query to select records in forgridsnoprelims.shp where Twothou = 1 and Gear Type LIKE '%Drag%'. We then saved the results in a dbf file in C:\temp, named, for example, Drag00.dbf. (All of our queries are also on the accompanying disk.)

Then we opened an ArcInfo workstation session and typed in the following commands at the Arc prompt.
Arc: w c:\temp
Arc: dbaseinfo Drag00 Drag00

The syntax for the Arc command to create an INFO file from a dbf file is “dbaseinfo dbasefilename infofilename”. In the case above the dbf file we previously created from the query was called ‘Drag00’ and so, we also named the new INFO file ‘Drag00’.

Then we opened the GRID module from the Arc prompt.
Arc: GRID

In the GRID module we ran a program called “addgrid”. It is in a file called addgrid.aml. The addgrid.aml program creates individual grid files for each polygon listed in the INFO file that resulted from a query. The grid files are based on a grid called “zerogrid.”

After creating the grids from the polygons in the query, the program then stacks the grid files and counts the number of “hits” in each grid cell. The number of “hits” is the number of grid files overlapping a cell, i.e., the number of times a particular cell was part of some fishing activity named in a particular query (such as, draggers in 2000). The number of “hits” in a cell was recorded in the final grid map. This map is then opened in ArcScene and the number of “hits” becomes the “z” value or height of a cell. In this way, we made three dimensional maps of fishing activity. (The ArcScene projects created from the queries are also included on the disk.)

The program addgrid.aml is listed below.

```
/* begin code in grid
/* workspace is c:\temp
/* zerogrid is a copy of bathygrid with all cells = 0
/* query dbf needs to be converted to an info file first
/* by invoking 'dbaseinfo dbasefile infofile' at the arc prompt
/* realid is a copy of the fid column in the original shapefile
/* change directory names and info file names as needed
/* run the aml in GRID in the c:\temp workspace

setcell zerogrid
setwindow zerogrid

tempgrid = zerogrid


cursor currentpoly declare gillnet70 info ro
cursor currentpoly open
&do &while %:currentpoly.aml$next%
 &sv currentid %:currentpoly.realid%
 &if [exists grids3\grid_%currentid% -grid] &then
 &do
  kill grids3\grid_%currentid% all
 &end
 grids3\grid_%currentid% = shapegrid (tempshapefiles\poly_%currentid%, Id) + 1
```

```
 tempgrid2 = tempgrid + con(isnull(grids3\grid_%currentid%),0,1)
 kill tempgrid all
 tempgrid = tempgrid2
 kill tempgrid2 all

 cursor currentpoly next
&end

gillnet70 = tempgrid
kill tempgrid all

cursor currentpoly close
cursor currentpoly remove

/* end code
```

As you can see, the program addgrid.aml expects to see certain files in C:\temp. They are: a grid called "zerogrid" which is a copy of the bathymetry grid (named *bathygrid*) of Stellwagen Bank (acquired from NOAA and available with the map data used for this project). Zerogrid is an exact copy of the bathymetry grid except all of the cells have a value of zero. This is used as a base grid for summing the fishing activities.

Before running the program addgrid.aml one needs to change the name of the info file to that which was created from the query dbf. In the example of addgrid.aml above, you would need to change all instances of "gillnet70" to "Drag00" the name of the info file created from our example query dbf. In the addgrid.aml program, "gillnet70" appears in two places. Make sure the INFO file, the addgrid program, and the RealID.dbf are in C:\temp and all the separate shapefiles for each polygon from surveycharts.shp are in C:\temp\tempshapefiles.

After changing the filenames in addgrid.aml to the INFO filename that resulted from a query, run addgrid.aml from the GRID module in ArcInfo.
GRID: &run addgrid

Addgrid.aml will produce a grid called Drag00 with the cell values equal to the number of times a particular cell had "draggers in 2000."

Tips on Displaying the Resulting Query Grids in Three-Dimensions in ArcScene

Open ArcScene and add the grid Drag00. Right-click on the grid layer name and go to Layer Properties->Symbology and create about five categories of grid cell values and corresponding colors as shown in the image below.

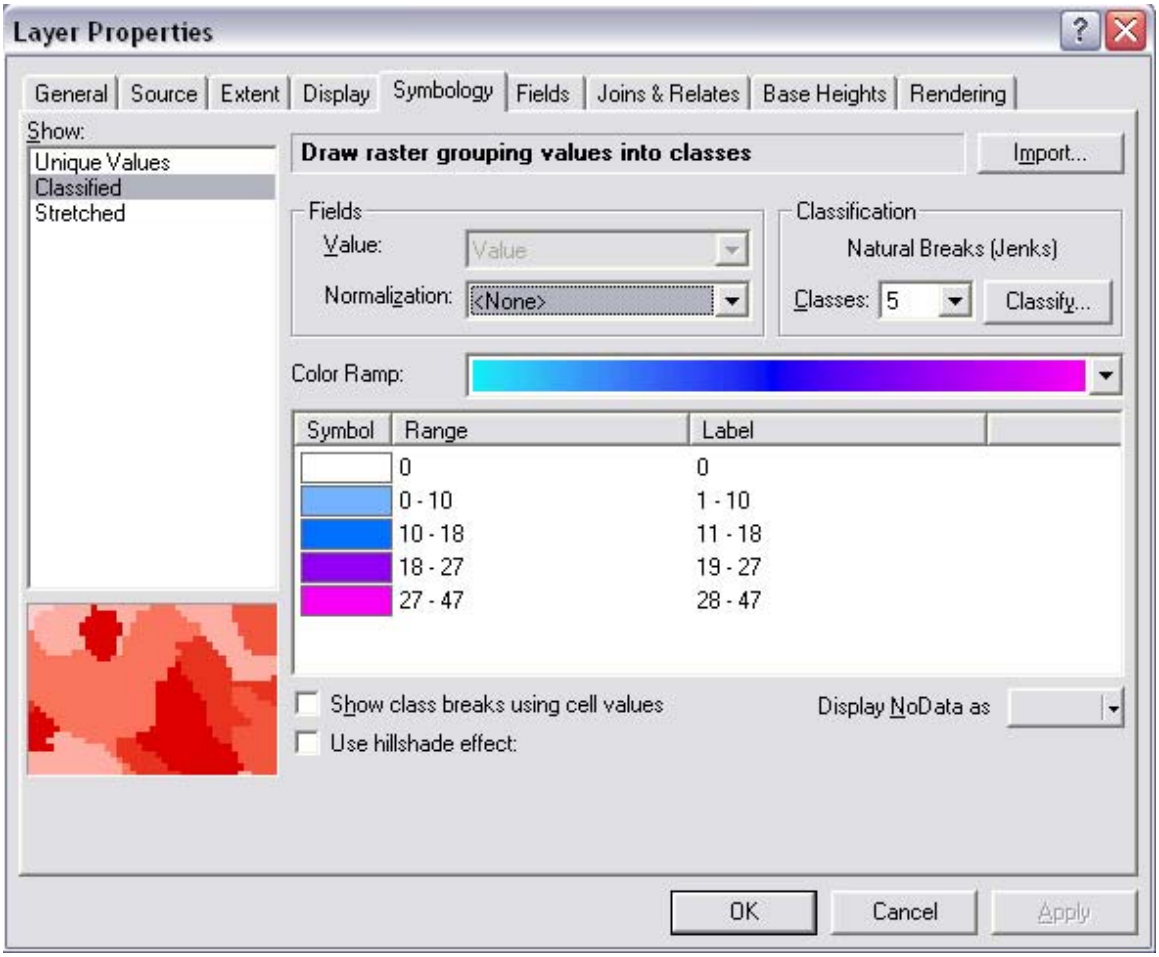


Figure 3. Classifying the number of cell hits in a grid of fishing activities in ArcScene.

While in Layer Properties click on the Base Heights tab and fill in the dialog box as the one shown below. Especially important is the Z Unit Conversion as this will scale down the original grid cell values to a value that can more easily be shown in the 3D capabilities of ArcScene.

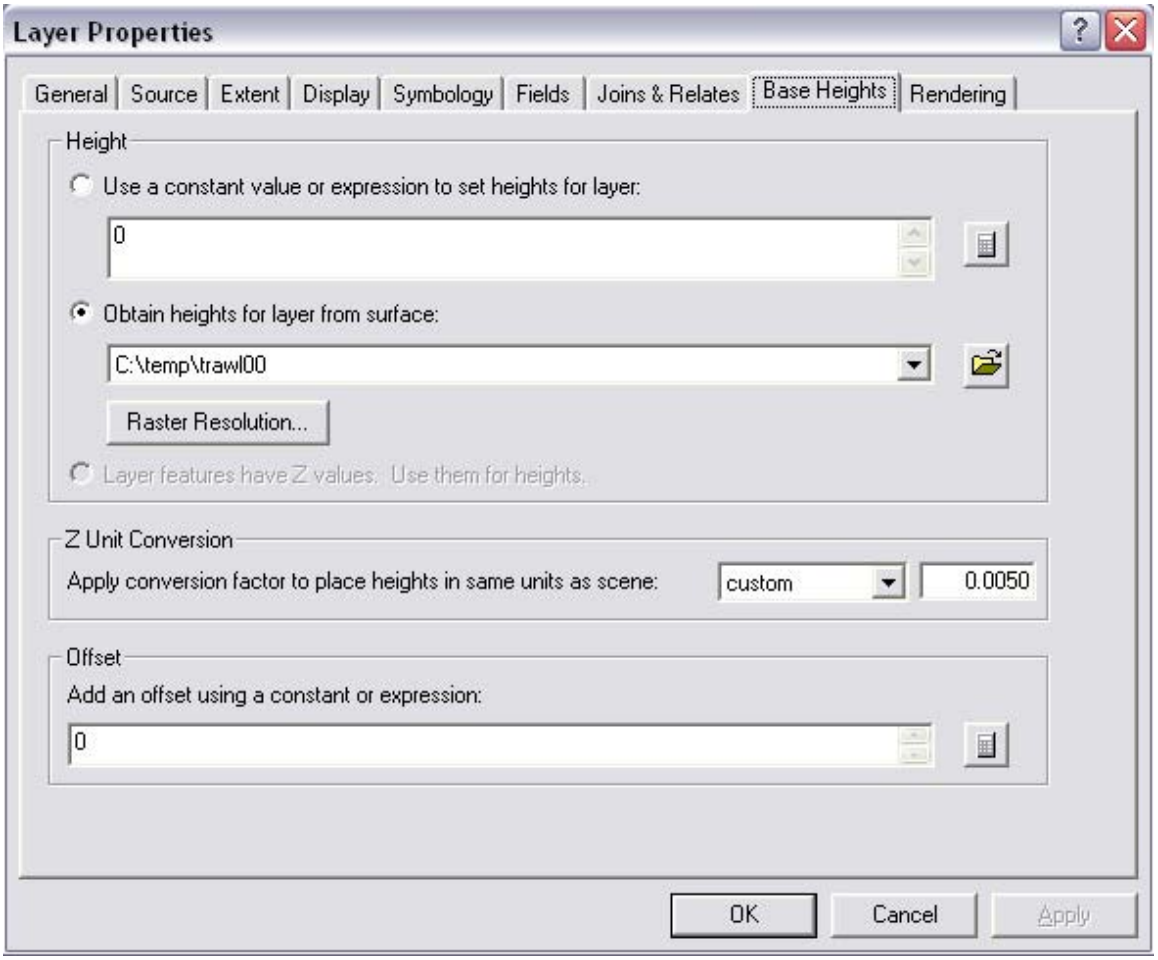


Figure 4. Designating the heights of a three-dimensional grid (in this case trawlers in 2000).

You can also add layers, such as StellwagenBank.shp, sbnms.shp, and gulfofmaine.shp to give some spatial context to the 3D representation of the fishing activities. After adding these layers, go to the Base Heights tab in their Layer Properties and click on "Use a constant value or expression to set heights for layer" and type "50" in the dialog box below this option. This will raise the Stellwagen Bank, the Stellwagen Bank Management Area and the Gulf of Maine boundary files above the 3D grid map so you can see the full outline of their boundaries.

The image below shows a side view of the 3D map for tuna fishing activities in the 2000's time period with the Stellwagen Bank, etc. boundary files on top of it.

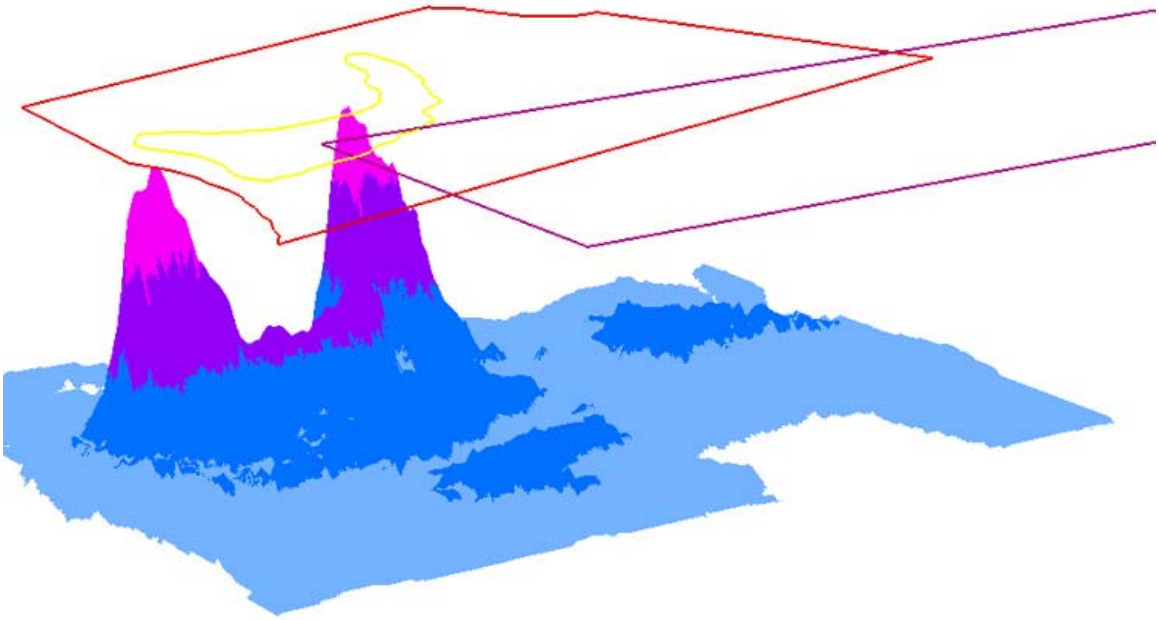


Figure 5. An example of a three dimensional view (looking back in a westerly direction from the east) of tuna fishing activities in 2000's decade.

Summarizing the Findings

Statistics from the questionnaire data

Profile of interviewees, vessels and homeports

NOAA vessel trip report (VTR) data show 343 unique permits for commercial fishermen reporting landings from Stellwagen Bank in 2002. Of the 142 interviews conducted for this project, 81 individuals fish commercially only, 42 fish both commercially and recreationally and 9 are recreational only. The 142 interviewees fished an average of 30 years, though the range was from 4 to 60 years. The average number of years the interviewee had been captain or owner was 23, ranging from one to 45 years.

The average length of the vessels is 43 feet, 20 boats are/were 67 feet or greater. The oldest boat was built in 1935, the newest in 2004. However, the average age of the vessels is getting older. In 1984, the average was 10 years old; in 1994 the average was 14 and in 2004, the average was 20 years old. Tonnage varied from 2 tons to 190 tons with an average of 30 tons and a median of 17 tons.

Interviewees said that decisions about where to fish were primarily guided by the perception of the availability of the target species. Few changes in ports of landing were made by interviewees. Two interviewees noted changing seasonally between Nahant and Gloucester in one case and between Provincetown and Gloucester in the other. Three

others noted seasonal changes between Hull and Hingham, Plymouth and Sandwich, Sandwich and Harwichport. Only 4 noted changes over the decades: from Swampscott to Marblehead; Gloucester to Marblehead; Boston to Scituate to Plymouth/Provincetown; and Beverly to Gloucester to Beverly.

Economic dependency, gear and target species

Interviewees from 128 vessels reported deriving income from fishing on Stellwagen Bank at some period of time during the three decades of 1984, 1994 and 2004. Furthermore, on average, they noted that half of their annual income came from this area. Among our interviewees, otter trawl and rod/reel are the most commonly used gear types. For the last two decades the numbers of otter trawls used by our interviewees have remained fairly stable (1994, 38.5 vessels over the course of the year; 2004, 36 was the median number fished annually). Rod & reel participation, however, noticeably increased from 49.5 (median) in 1994 to 58.5 in 2004. Gillnet use among our interviewees ranged between 9 and 10 and the use of hooks slightly decreased from 7.5 to 5.5. The use of lobster pots noticeably increased from 10.5 in 1984 to 16.5 in 1994 and 17 in 2004.

NOAA vessel trip report (VTR) and permit data from 1995, 1998, 2001 and 2002 reflects these trends. Dragger/trawlers varied from 79 to 74 vessels, gillnet use varied from 31 to 35, while lobster pot use increased from 27 to 44 (with a high of 47 in 2001).[3]

NOAA VTR data for 2002 shows 343 vessels fishing on Stellwagen with a unique permit. Of these, 123 were from Gloucester (36 percent). These123 permits out of Gloucester made 4,121 trips (using 4,365 days or an average of 35.5 days per permit) to Stellwagen catching 10,983,551 pounds (89,297 lbs/permit). Since groundfish vessels with "fleet" DAS have only 56 days, 35.5 days would constitute 63% of their DAS. Brant Rock, Green Harbor and Marshfield boats (29 permits) made 634 trips using 645 days or 22.24 DAS/permit (40% of the Fleet DAS allowance of 56 days). Based simply on their average DAS usage, the claims of making 50% of their income on Stellwagen is believable.

While the target species most frequently noted are “groundfish,” lobster and tuna are also specifically noted. In addition, various combinations of dogfish, scallops, whiting, lobsters and/or stripers constituted a typical catch for many of the years. Recently, restrictions, particularly on dogfish possession, have reduced the variety of species fishermen can land. Typically, fishing trips were 12 to 18 hours long, though trips of 1 to 5 days were also noted.

[3] These numbers should be considered relative rather than absolute. Though the VTR and permit data was scoured for trips made to Stellwagen, some trips/vessels may be undercounted. Reporting errors and mistakes in data entry were common when VTR requirements were first implemented. Furthermore, since VTRs require a single location point for the whole day’s fishing, not all mobile vessels’ trips may have been counted (e.g., if the vessel began its trip elsewhere but fished on the Bank during the trip.)

Among our interviewees, the largest numbers of vessels that derive income from Stellwagen come from the homeports of Gloucester, Marshfield, Provincetown and Scituate. Of the 85 vessels that reported income in 1984, 34 percent came from Gloucester, 13 percent from Marshfield, 12 percent from Provincetown and 10 percent from Scituate. Of the 104 vessels that reported income for 1994, 31 percent came from Gloucester, 20 percent from Marshfield, 10 percent from Provincetown, and 9 percent came from Scituate. Of the 115 vessels with income from Stellwagen in 2004, 31 percent were from Gloucester, 25 percent from Marshfield, 9 percent from Provincetown, and 7 percent from Scituate.

According to the NOAA permit data sorted for those with unique permits, Gloucester had by far the largest number of vessels fishing on Stellwagen in 2002. If Rockport and Pigeon Cove are included with Gloucester, 41% of the permits (142 of 343) are accounted for. Marshfield (with Brant Rock and Green Harbor) comprises 8% or 29 permits. Provincetown had 22 permits (6%); and Scituate had 21 (6%). New Bedford and Plymouth had 21 (6%) and 14 permits (4%), respectively. Our interviewees' homeports, therefore, are a similar, but not exact, reflection of the NOAA database.

NOAA Fisheries Data

Attempts to use NOAA Fisheries contacts and landings data to support interview data were only partially successful. A major constraint on our ability to use the data to track our interviewees over time is the fact that the landings data are based on statistical blocks and Stellwagen Bank is not specifically identified. The data we analyzed were for vessels reporting landings from catches in statistical blocks that include Stellwagen. Trip reports were not required until 1994, however, so 1980s and early 1990s data are incomplete. Furthermore, as fishermen often note, trip reports are based on a single geographic location for each trip and since vessels are constantly moving over the course of their trip, the single points identified may or may not have corresponded to the portions of their effort expended on Stellwagen or even the statistical blocks identified. Another difficulty in attempting to use this database was that we did not obtain permit numbers or hull numbers from our interviewees, so tracking individuals was impossible.

What is clear from both the interviews and the landings data is that Stellwagen Bank is an economically significant fishing ground for Gloucester vessels and important to a number of other ports.

Summary results from interviews by decade

Tables 2, 3, 4 and 5 following the section below summarize the information in the next paragraphs regarding percentage of income, gear types used, homeports and seasonal variation of activities over the decades.

1984
The 85 boats that reported earning income from fishing in Stellwagen in 1984 said that 5 to 100% of their income came from Stellwagen. The average was 50.6% and median was 50%. Of the 52 boats for which gear type was recorded for 1984, 5 were strictly gillnetters, 1 harpoon, 6 rod & reel, 7 lobster traps, 13 trawlers and the rest (20) used various combinations of gear (e.g., one cited gillnet, rod & reel, longline, and dredge). Only 7 fished only for lobsters and three only for tuna, the rest fished for multispecies and a combination of other species such as dogfish, scallops, whiting, lobsters and/or stripers. Twenty-nine came from Gloucester (including Pigeon Cove and Rockport); 14 from Marshfield (including Green Harbor, North River and Brant Rock); 6 from Marblehead; 5 Plymouth and Duxbury; 10 Provincetown; 9 from Scituate; 3 Sandwich; 2 Beverly; 2 Boston; 1 each from Revere and Barnstable.

1994
The 104 boats that reported earning income from fishing in Stellwagen in 1994 said that 2 to 100% of their income came from the Bank. The average was 52.6%, the median 50%. Of the 64 boats for which gear was recorded, five used gillnets only, 1 harpoon, 9 rod & reel, 11 lobster traps, 14 trawls and the rest used various combinations. Eleven fished only for lobsters, four for tuna, the rest fished for multispecies and others (as listed for 1984). Thirty-two came from Gloucester (including Pigeon Cove and Rockport); 25 from Marshfield (including Green Harbor, Humarock, South and North River and Brant Rock); 6 from Marblehead; 5 from Plymouth and Duxbury; 11 from Provincetown; 4 from Sandwich; 9 from Scituate; 2 Beverly; 2 Boston; 1 each from Barnstable, Harwichport, Hull, and Revere (4 no record).

2004
One hundred, fifteen boats reported earning 1 to 100 percent of their income from fishing in Stellwagen in 2004. The average cited Stellwagen as the source of 55.6% of their income and the median was 50%. Gear was recorded for 64 boats, 3 used gillnets only, 12 used lobster traps, 11 rod & reel; 1 harpoon and 14 trawls, the rest used various combinations of gear. Of these, 12 fished for lobster and three for tuna specifically, the others fished for multispecies and various other species. Thirty-six boats were from Gloucester (including 3 from Pigeon Cove and Rockport); 34 from Marshfield (including Green Harbor, Brant Rock, Humarock, North River and South River); 5 from Marblehead; 6 from Plymouth (including Duxbury); 10 from Provincetown; 4 from Sandwich; 8 from Scituate; 2 from Beverly, 2 from Boston, 1 each from Barnstable, Harwichport, Hull, and Point Judith (4 no record).

Table 2. Boats and percentages of incomes for vessels working on Stellwagen

	1984	**1994**	**2004**
Boats reporting income	85	104	115
Average (percent)	50.6	52.6	55.6
Median (percent)	50	50	50

Table 3. Target species of vessels working on Stellwagen

Target species	1984	1994	2004
Lobster	7	11	12
Tuna	3	4	3
Multispecies and others	42	49	49

Table 4. Homeports of interviewees and permit homeport records of vessels landing catches from Stellwagen

Homeport	1980s	1990s	2000s	NOAA-2002
Gloucester	29	32	36	142
Marshfield*	14	25	34	29
Provincetown	10	11	10	22
Scituate	9	9	8	21
Marblehead	6	6	5	3
Plymouth	5	5	6	14
Sandwich	3	4	4	4
Unknown	3	4	4	
Beverly	2	2	2	6
Boston	2	2	2	12
Revere	1	1	0	1
Barnstable	1	1	1	(Hyannis/Dennis/Orleans) 3
Harwichport		1	1	1
Hull		1	1	3
Point Judith, RI			1	2
TOTAL	85	104	115	263
*Includes Marshfield, Brant Rock, Green Harbor, North River, South River, Humarock				

Table 5. Seasonal differences in gear used on Stellwagen over 3 decades

Year	**Season**	**Otter trawl**	**Diver**	**Dredge**	**Gillnet**	**Handline/ hook/jig/ tub**	**Harpoon**	**Long -line**	**Rod & reel**	**Lobster pot**
1984	**F**	29	1	2	10	7	2	2	33	12
	Sp	31	1	1	11	9	1	4	32	10
	Su	29	1	3	10	12	2		34	10
	W	32		4	10	8		5	8	11
Median		30			10	8.5			32.5	10.5
1994	**F**	37		2	7	7	1	4	51	21
	Sp	40	1	2	11	8		4	48	16
	Su	35	1	3	10	8	4	2	56	17
	W	40		4	7	6		6	13	16
Median		38.5			8.5	7.5			49.5	16.5
2004	**F**	36		4	7	5	6	2	58	25
	Sp	39	1	4	11	10		6	59	16
	Su	36	1	6	9	4	7	3	59	16
	W	36		5	9	6		7	22	18
Median		36			9	5.5			58.5	17

Notice in Table 5 above that the most significant seasonal change is found among the rod & reel users. Winter has traditionally had only a few participants, however, by 2004, the numbers fishing in the winter rose.

Recreational Fishermen

Six interviewees were strictly recreational groundfishermen from Marshfield, Green Harbor, Duxbury, Scituate and Gloucester. Four fished in the 1990s and 2000s, two had also fished in the 1980s.

Ecological information

Relatively little ecological information was shared by the interviewees. Shellfish bycatch data was noted by lobstermen (crab). Some non target finfish bycatch was noted by others. The most commonly mentioned bycatch, however, was dogfish. “Too many dogfish” was also noted 55 times in the response to a request for comments on observed changes in the ecosystem. This observation was recently corroborated by scientist Les

Kaufman (2007) in a report on his research on Stellwagen Band and the Western Gulf of Maine closure: "The correlation between total biomass in the samples and dogfish biomass is about 0.998. The catch data support fishermen's observations using normal commercial gear, that dogfish are concentrated on Stellwagen Bank and aggregate there during the late summer and fall, particularly within the Western Gulf of Maine Closed Area." One other individual noted that the numbers and sizes of dogfish varies. Striped bass were also accused of feeding on young groundfish by a few fishermen. The significance of these observations is also noted by Kaufman (2007), "The dogfish themselves are likely to significantly alter ecosystem processes in the Closure if they choose regularly to aggregate there. For ecosystem-based management to succeed in the Gulf of Maine, the ecosystem effects of seasonal movements and aggregation patterns of dogfish and other key species must be understood and taken into account."

Table 6. Mentions of dogfish as bycatch over three decades

Year	**Fall**	**Winter**	**Spring**	**Summer**	**Total-Year**	**Numbers of Interviewees (seasonal variation)**
1980	11	6	10	15	42	127-134
1990	12	5	21	13	51	139-142
2000	17	10	12	16	55	119-142
Total seasons	40	21	43	44		

Other observations noted in the ecological observations section included 27 complaints about the outfall. Most blamed the outfall for a subsequent loss of bait fish including sand eels and herring. One individual however noted that the North and South Rivers had better water quality due to the opening of the outfall. Plastic pollution was noted by 5 individuals and 7 suggested that the water temperature was cooler than in the past. While the questions that focused on ecosystem observations were open ended and thus elicited issues important to the interviewees, it would be interesting to do a more systematic collection of the TEK of the local fishermen. Though not all are equally observant, even a relatively few fishermen's participation can lead to hypotheses and research that could help achieve a stronger knowledge base.

Summarizing the data gathered on the charts into images showing change over time and space

Images were created through the query and grid creation process described previously to visually summarize the intensity of fishing activities throughout the study area over time. Queries were developed to create images of fishing activities by gear type, season and/or

year (i.e., corresponding decade). Figures 6, 7, 8, and 9 below show all fishing activities by season for each decade. For example, Figure 6 contains four images showing all fishing activities in the spring season of each decade. The colors in each map indicate the number of times a grid cell was selected by a fisherman as a spot that was fished at that time. The colors on the images represent categories of the number of "hits" for a particular grid cell, i.e. the number of times the grid cell was chosen when a query was conducted.

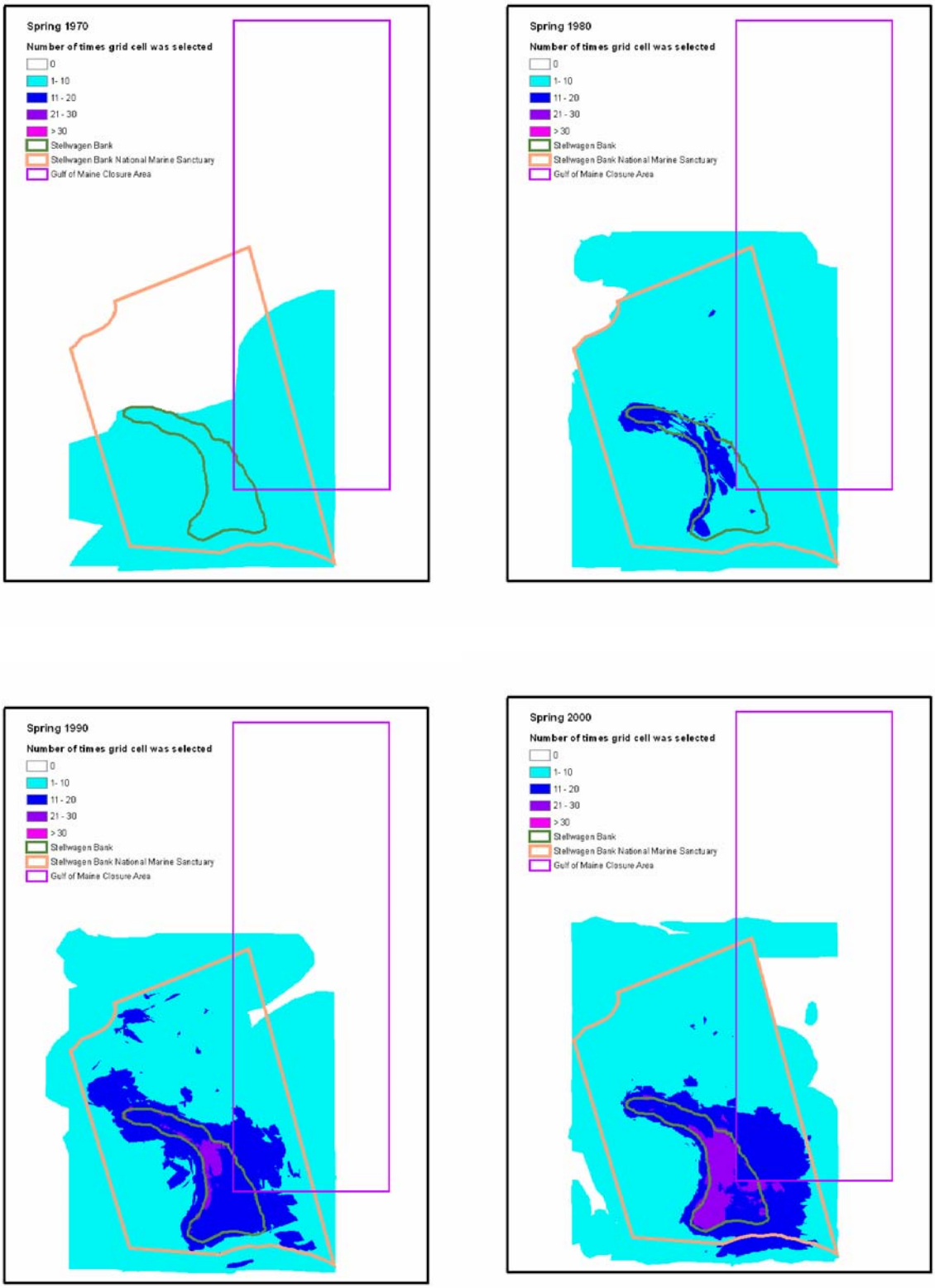


Figure 6. Spring season, all fishing activities

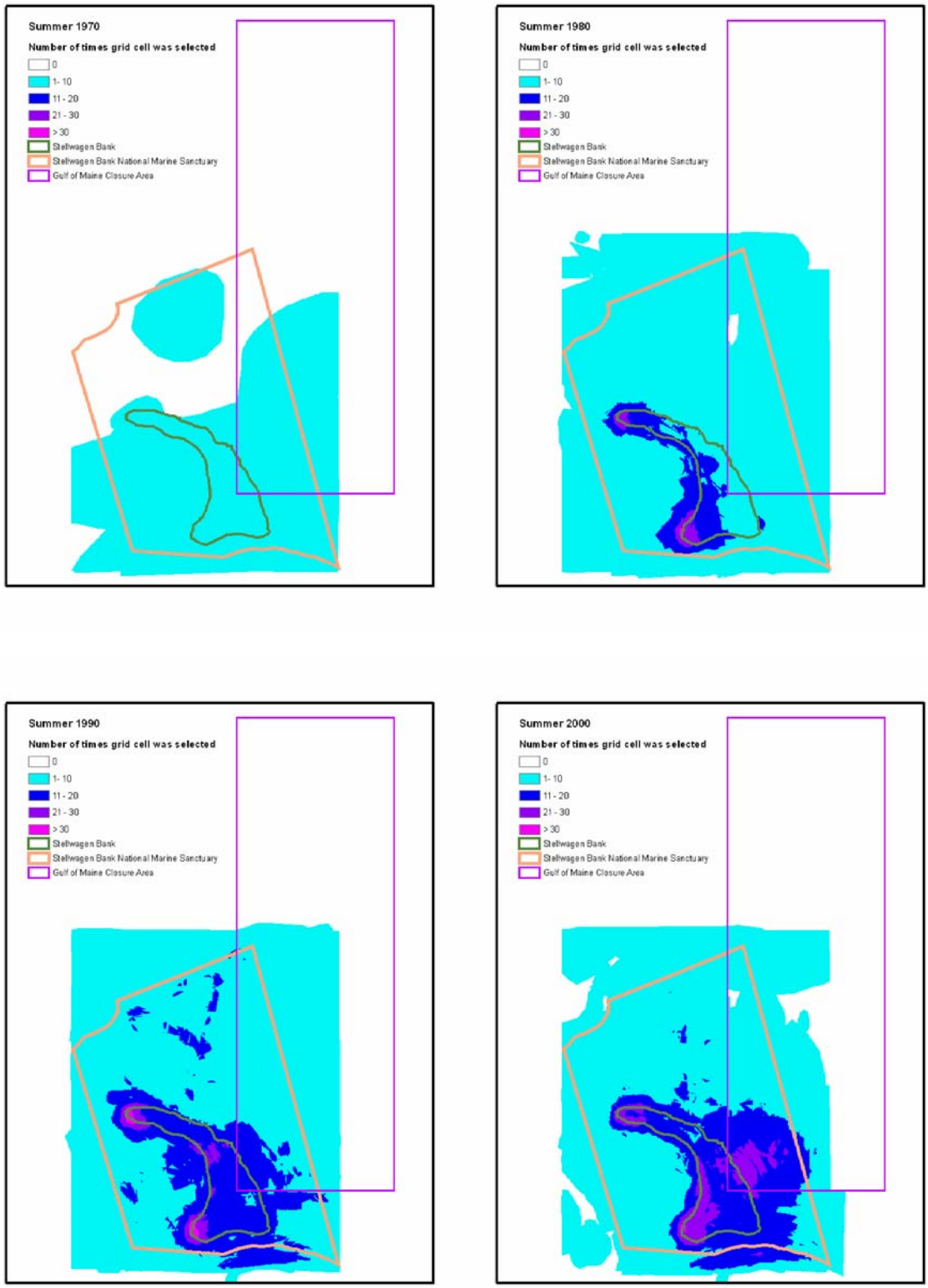


Figure 7. Summer season, all fishing activities

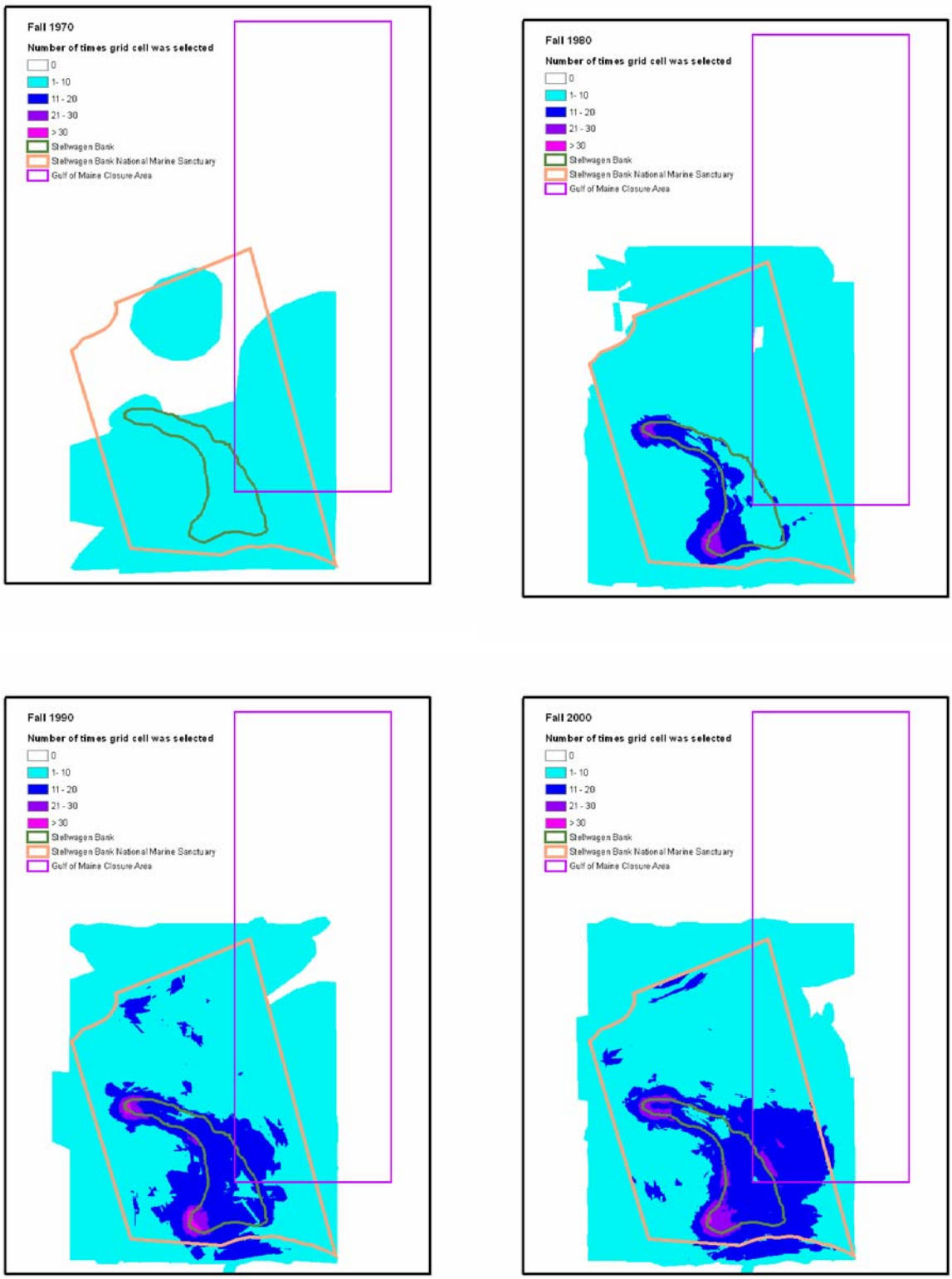


Figure 8. Fall season, all fishing activities

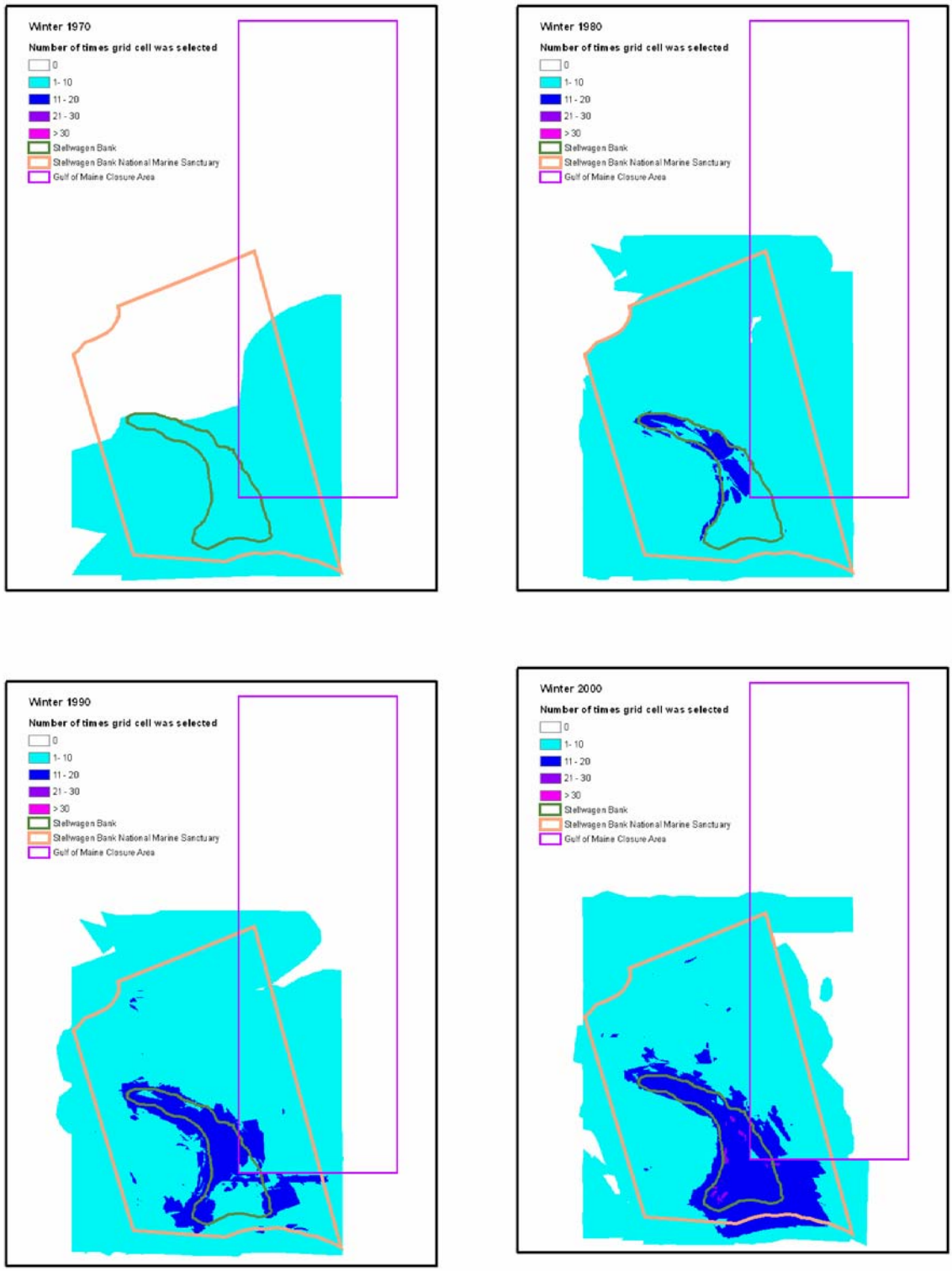


Figure 9. Winter season, all fishing activities

Historical use of Stellwagen

The graphic representations of fishing activity over time and space show that at least since the 1980s, the whole of SBNMS has been fished either commercially or recreationally. It should be pointed out that the intensity of fishing activities is, of course, subject to the number of fishermen interviewed and to the number that indicated they fished during a particular decade. For example, the 1970s decade has sparse activity not necessarily because there were few fishing activities taking place at that time, but because there were only about 7 fishermen in the study who said they were fishing during that time period. The value of the images, however, are not so much in the actual counts of the number of times a grid cell showed activity during a certain time, but in the relative intensity over time and over space. In other words, even if the study could have interviewed every fisherman who fishes Stellwagen, one might expect the spatial pattern of activity and the corresponding "hotspots" of intensity to be the same or similar to the patterns in these images. And, as you can see, the intensity of certain spots changes over time and with each season.

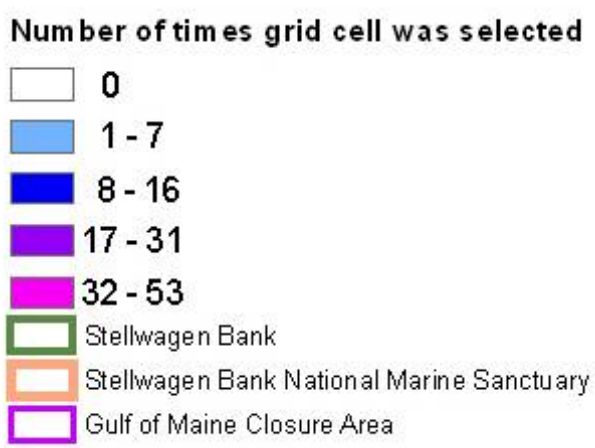
When these images are shown in a three dimensional view the "hotspots" of fishing intense fishing activity are particularly compelling. Figure 10 shows tuna fishing over time (each decade). Recall that as the grid maps are created the number of "hits" in a grid cell are recorded. So a query of tuna fishing by decade created three grid maps each with the "hits" recorded in a cell location. The "hits" can be used as a value for a third dimension, thereby creating a "height" at each grid cell. These maps have been tilted so the viewer can see the three dimensions and the areas that have higher intensity of fishing activity look like mountains in the three dimensional view.

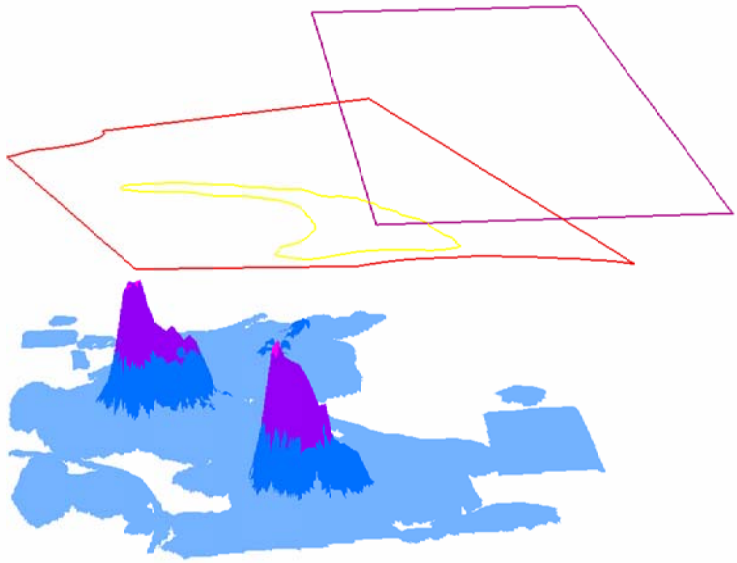
The 3D tuna fishing maps by decade were particularly interesting. Both the flat views and 3D views show high intensity of tuna fishing in two spots at opposite ends of the bank. Over time, the intensity increases in between these two hotspots forming a sort of ridge in the 1994-2004 decade. As stated earlier, naturally we would expect more fishing activity to be shown in the latest period simply due to the fact that the respondents in our study are more likely to be currently fishing. But in spite of that, it is interesting to see that even among the few who have been fishing the bank for decades, the data show the most intense activity in the same hotspots. The fact that the intensity of activities later spread out along a "ridge" between the two end points on the "porkchop" could indicate some change or increase in the actual area used for tuna fishing.

Draggers/trawlers

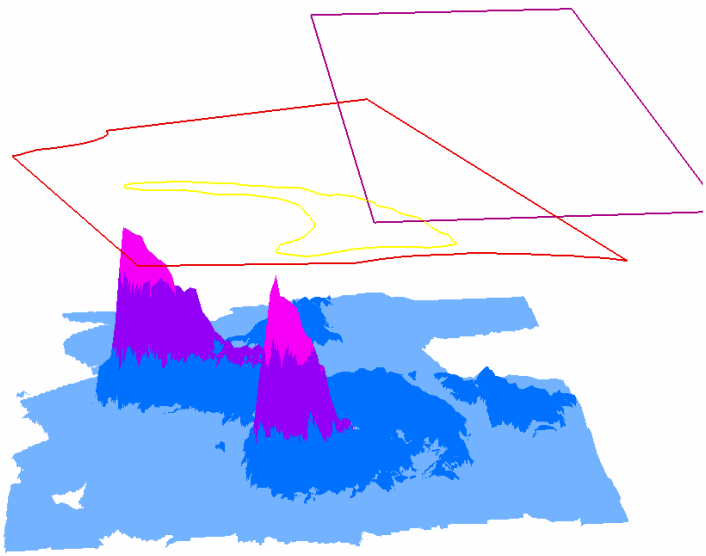
Again, looking at trends and patterns rather than specific numbers, dragger fishermen interviewed for this project indicated that they fished almost all of SBNMS in the spring seasons during the 1980s (Figure 11). A similar pattern showed for the springs of the 1990s, though the numbers were higher over the Bank itself and to the southeast of the Western Gulf of Maine (WGOM) closure. In the springs of the 2000s, the pattern was similar to the 1990s, though a little less spread out to the southeast.

Figure 10. 3-D Views of Tuna Fishing Activities – All Seasons

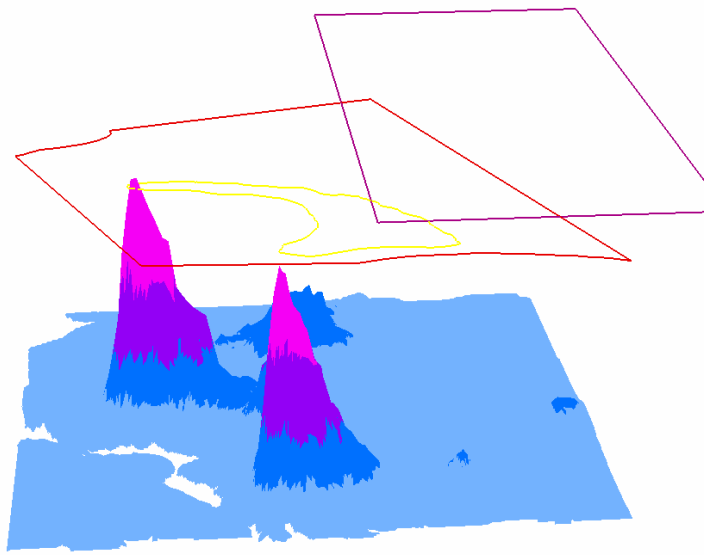




1980's

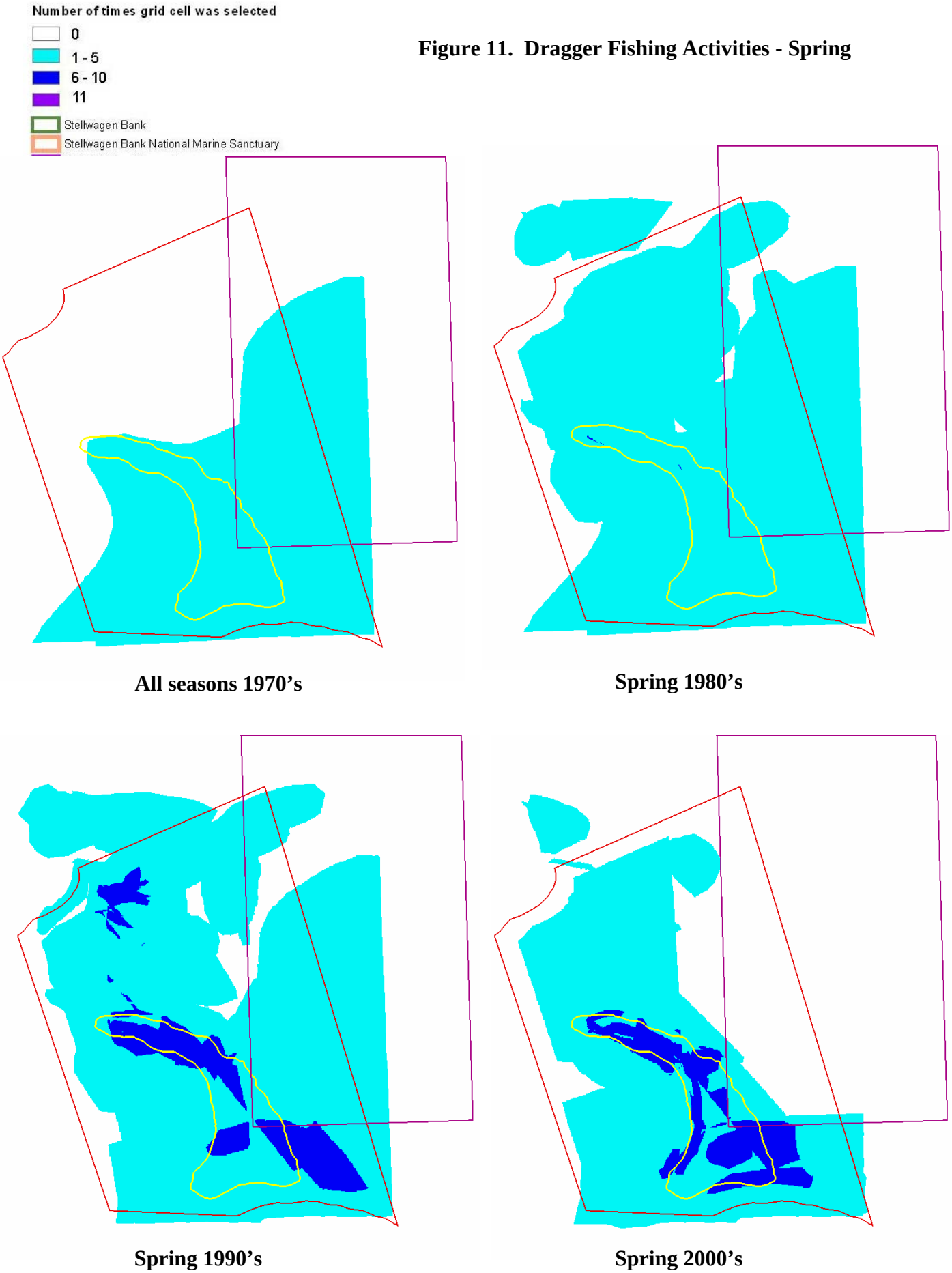


1990's



2000's

Figure 11. Dragger Fishing Activities - Spring



The overall summer pattern (Figure 12) is similar to that of the springs' though the polygons are concentrated (showing greater use) in a much smaller portion of the Bank (southeast corner and spreading out southeast of the closed area). The summers of the 2000s, however, have almost no indication of concentrated effort. This could be because the proliferation of dogfish has made it difficult to catch groundfish without serious bycatch; alternatively, it could be because fishermen are fishing farther from home to concentrate on high-priced species while the weather permits. (The reduction in days-at-sea means that fishermen must maximize economic returns in the time they are allowed to fish.)

The fall pattern of all three decades (Figure 13) shows some contraction in the area our interviewees fished, though overall it is remains similar. The concentrated fishing however primarily shows up for the whole southern portion of the Bank as well as the southeast of the WGOM closure in the 1980s; more concentrated effort shows over the whole southern portion of the Bank and extends farther west and south of the Bank, though still within the boundaries of SBNMS, in the 1990s. In the 2000s, the pattern is similar, though the concentrated effort is not as extensive. In all three decades there are also one or two "hotspots" on the northern edge of the Bank.

The overall winter pattern (Figure 14) is again similar for all three decades, showing use of most of the SBNMS. Concentrated effort shows in only two spots in the 1980s, one on the northern edge of the Bank and one limited area south of the WGOM closure. In the 1990s there are four areas of concentrated effort: a larger area of the northern and middle portion of the Bank, one spot north of the Bank (within the Sanctuary boundary), one area extending from the southeast corner of the Bank to the south of the closed area and one at the south west corner of the Bank, extending west. Winters of the 2000s however show the greatest concentration of effort covering the whole Bank, extending east, south and west at the approximate latitude of the southern boundary of the WGOM closure almost as far as the Sanctuary boundaries.

Rod and reel

Rod and reel fishermen were active over the northern portion of SBNMS, though not in what later became the WGOM closure, and over the Bank itself to the southern boundary of the Sanctuary in the fall seasons of the 1980s (Figure 15). In the falls of the 1990s, rod and reel effort spread over most of the SBNMS area, including the WGOM closed area, with hot spots at the northern and western ends of the Bank. The falls of the 2000s show a large area of concentration within the portion of the WGOM closure that lies within the Sanctuary borders. Smaller hotspots are at the northern and western ends of the Bank. The concentration of effort within the closed area may be a result of the fact that the WGOM closure does not apply to rod and reel fishermen; therefore, there is less competition for space and little gear conflict.

Winter patterns for all three decades are spottier though they do show increasing effort and areas fished over time (Figure 16). The winters of the 2000s show a small concentration of effort in the corner of the Bank that lies within the closed area.

Figure 12. Dragger Fishing Activities - Summer

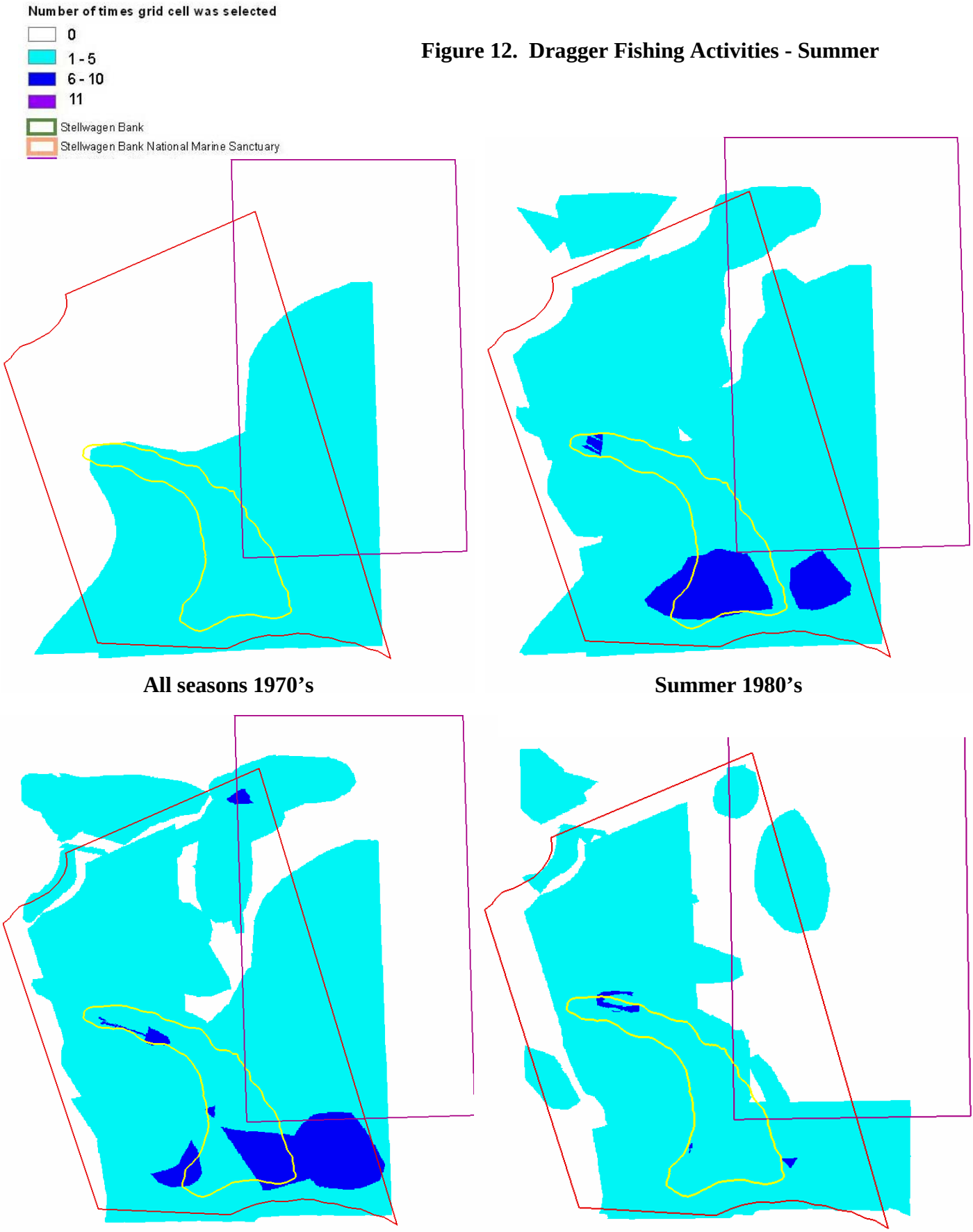
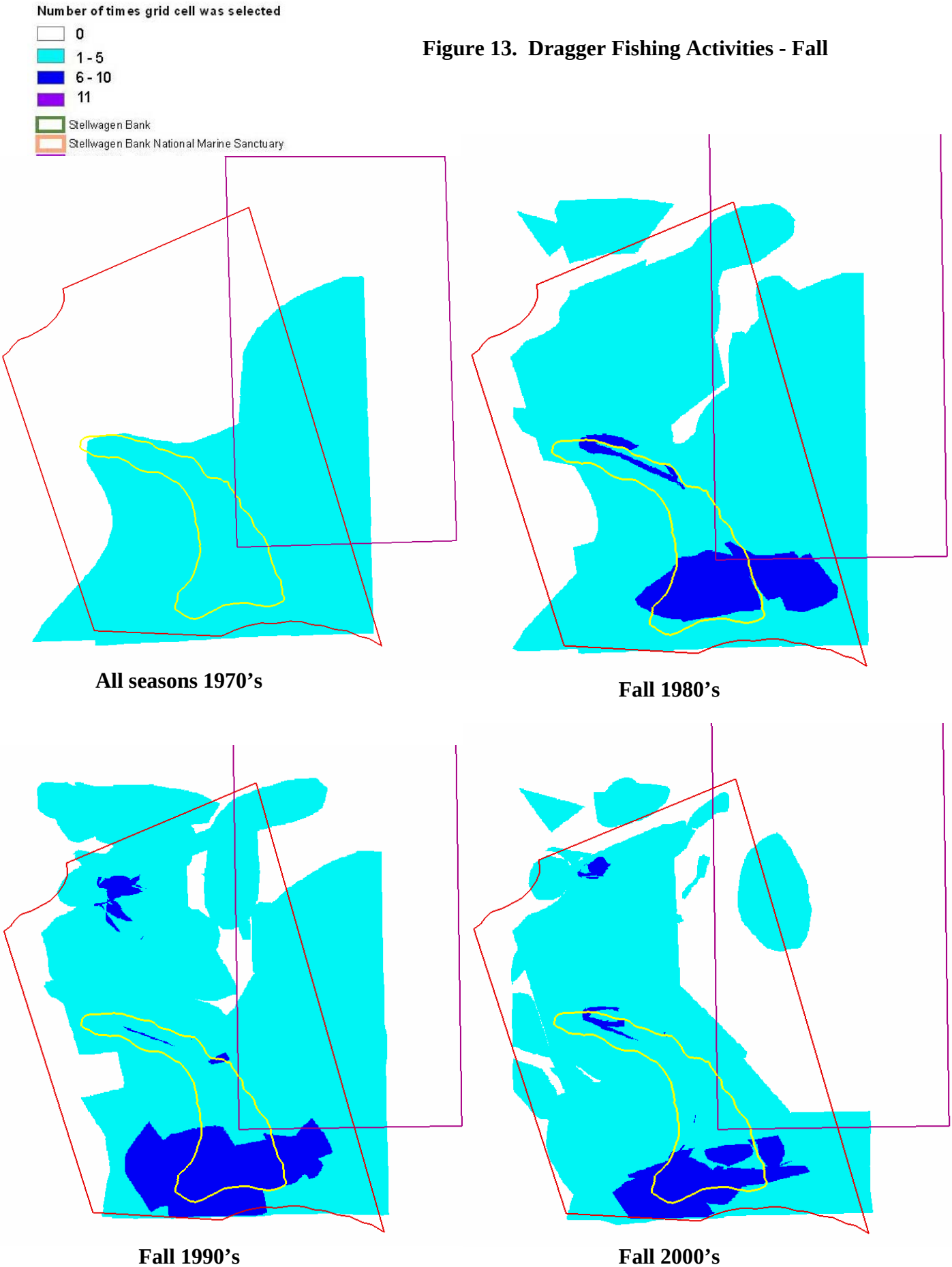


Figure 13. Dragger Fishing Activities - Fall



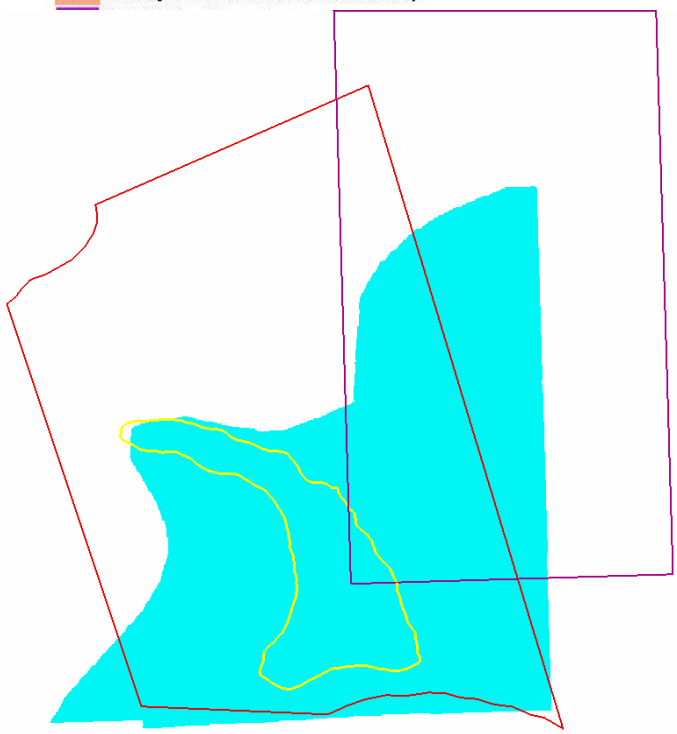
Number of times grid cell was selected

- 0
- 1 - 5
- 6 - 10
- 11

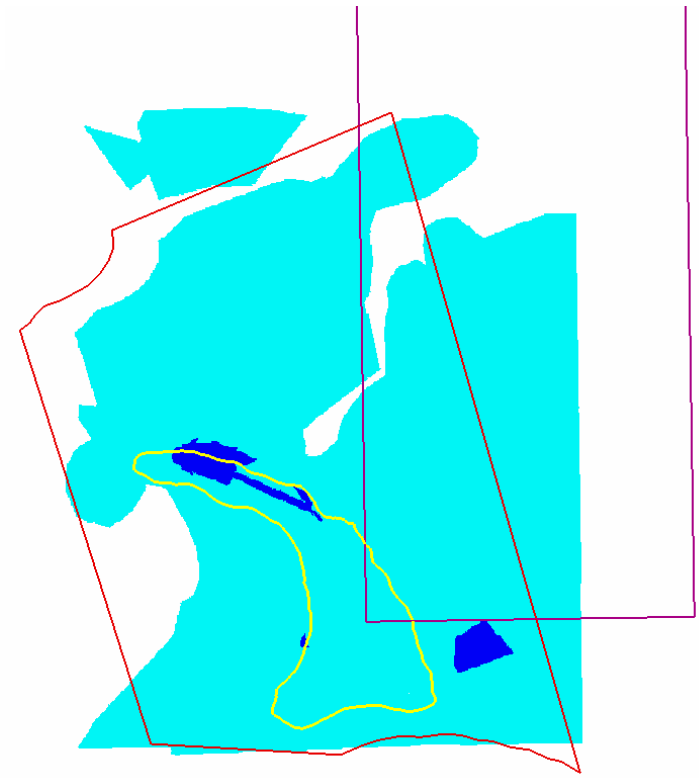
Stellwagen Bank

Stellwagen Bank National Marine Sanctuary

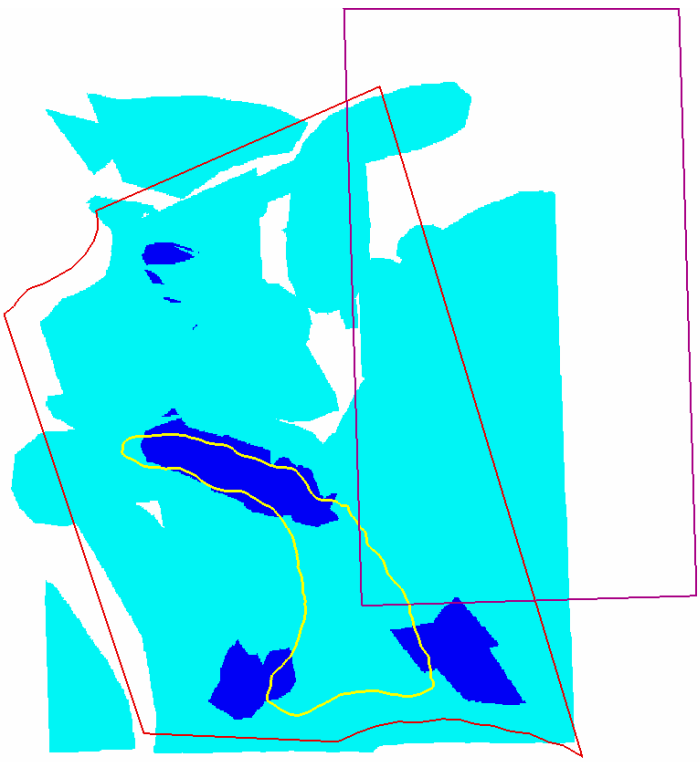
Figure 14. Dragger Fishing Activities - Winter



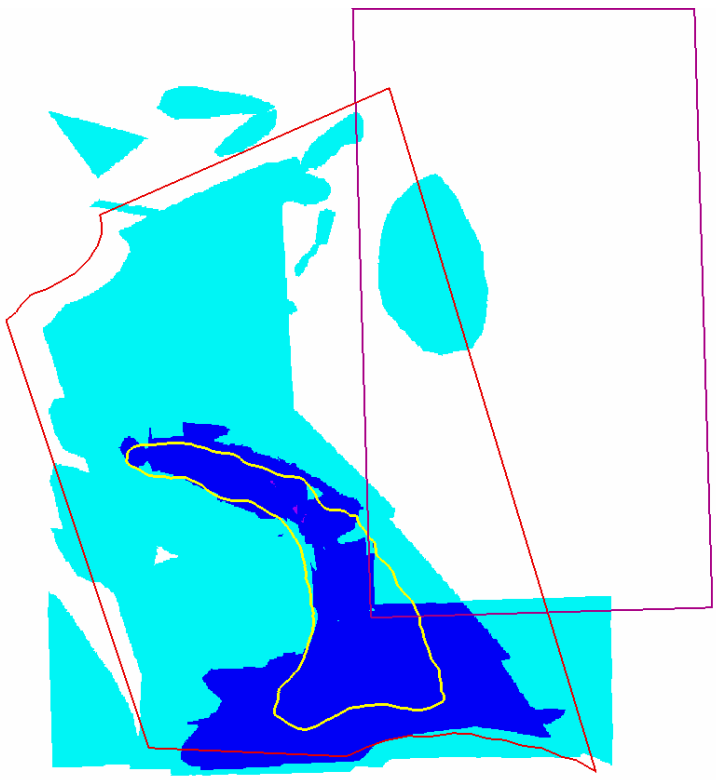
All seasons 1970's



Winter 1980's



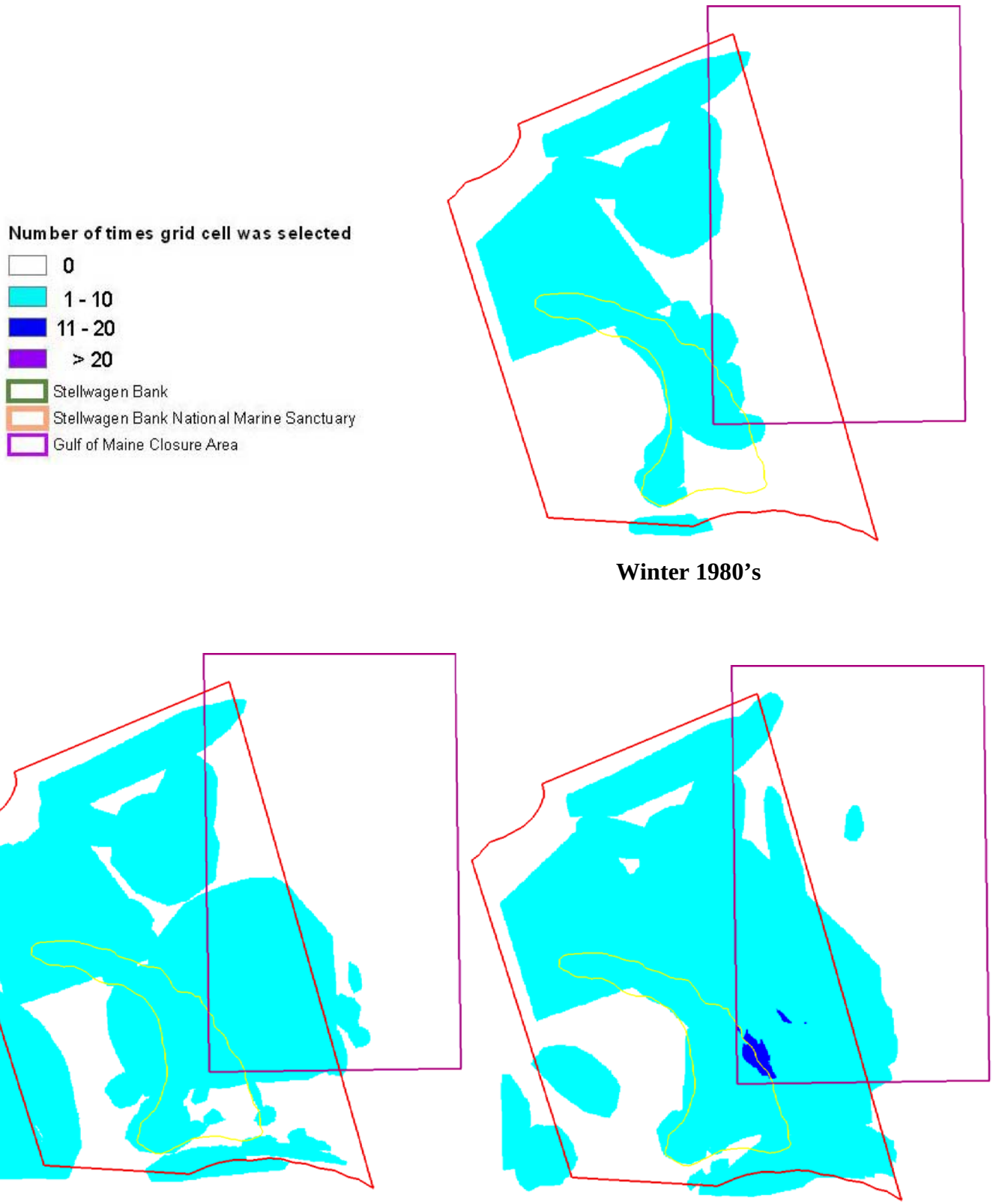
Winter 1990's



Winter 2000's

Figure 15. Rod & Reel Fishing Activities -Fall

Figure 16. Rod & Reel Fishing Activities -Winter



Gillnets

Gillnet fishing was most prevalent in the 1980s in all four seasons (Figures 17, 18, 19 and 20). The area of concentrated effort showed consistently as the middle of the Bank to the east as far as SBNMS border including in the WGOM closure. Other pockets of hotspots along the eastern edge of the Bank and south of the closure in the springs and winters of the 1980s. Springs and winters of the 1990s shows concentrated activity shifted towards the northern end of the Bank with the winter showing more activity at the middle, eastern side of the Bank. Spring 2000s shows only one or two gillnetters on the northern segment of SBNMS. Summers of 1990s also shows very modest effort spread over most of the Sanctuary, but the summers of 2000s show some concentrated effort along the northern edge of the Sanctuary's boundaries. Falls of the 1990s show modest effort spread over the southern half of SBNMS, but no hotspots. Falls of the 2000's show only very minor effort at the northern edge of Stellwagen and northern portion of the Bank.

These patterns are a direct result of regulations developed to reduce the catch of cod. The most productive gillnet grounds were closed in 1997 when the Western Gulf of Maine closure was implemented. The effort to reduce gear entanglements with marine mammals, particularly harbor porpoise, which began in 1994 with Amendment 5 to New England Fishery Management Council's Multispecies Fishery Management Plan also affected gillnet fishing on Stellwagen. Regulations have limited the numbers of nets fishermen can set and the time they are allowed to soak. In addition, the attachment of pingers, a sounding device that warns marine mammals of the presence of nets, are mandatory for certain times and areas. Sink nets are required in some areas and 4-day blocks of time out of the fishery are mandated, as well as some additional closures. Some long term gillnet fishermen have switched to other gear.

Hooks

A modest amount of hook fishing (Figure 21) was conducted over almost the whole area of Stellwagen Bank and large segments of SBNMS in the 1980s. Two slightly concentrated areas of effort were indicated at the northern and western tips of the Bank. Effort in the 1990s spread over most of the SBNMS with larger areas of concentration over the Bank and again at the hotspots at the northern and western tips and in the middle of the Bank. In the 2000s, effort over the whole Bank intensified, with major effort east of the Bank especially in the WGOM closed area out to the boundary of SBNMS. The northern and western tips of the Bank also showed hotspots.

Lobster fishing

Lobster fishing (Figure 22) in the 1980s was present at modest levels over the majority of SBNMS and beyond the eastern boundary to a point over halfway across the WGOM closure area. Hotspots were to the west of the northern half of the Bank. In the 1990s,

Number of times grid cell was selected

0

1 - 2

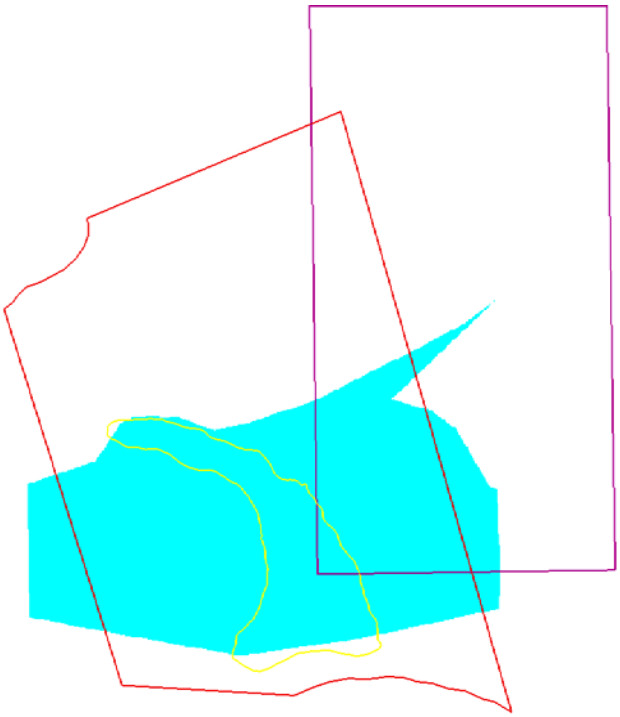
3 - 6

Stellwagen Bank

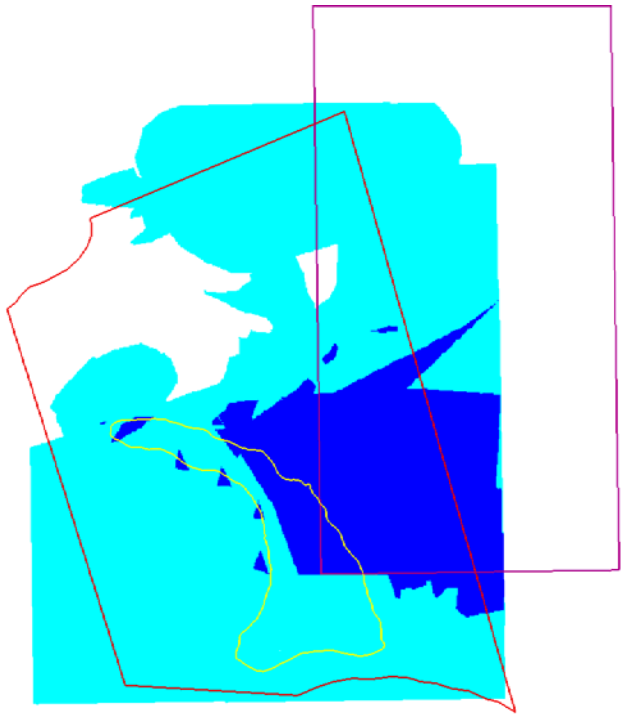
Stellwagen Bank National Marine Sanctuary

Gulf of Maine Closure Area

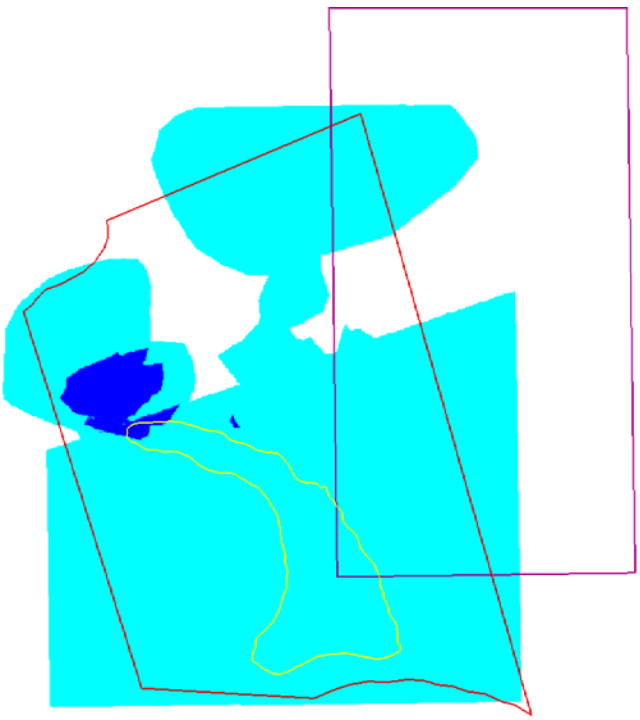
Figure 17. Gillnet Fishing Activities - Spring



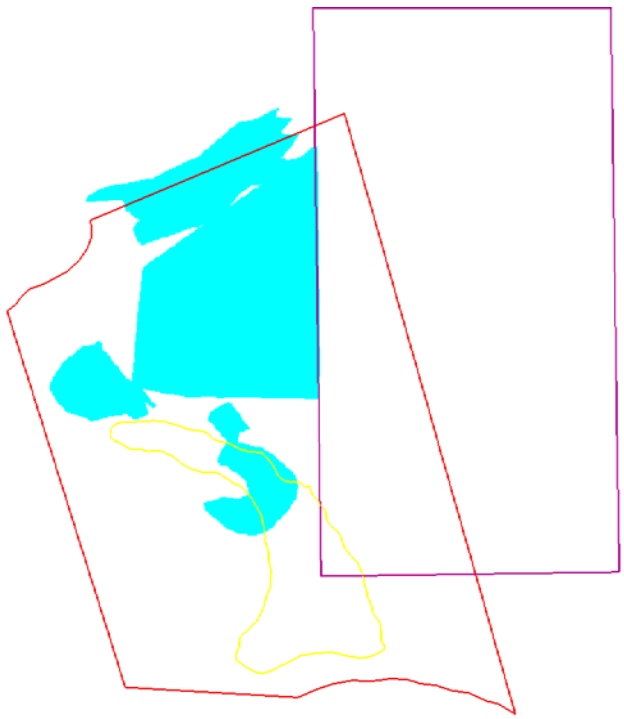
All seasons 1970's



Spring 1980's



Spring 1990's



Spring 2000's

Number of times grid cell was selected

0

1 - 2

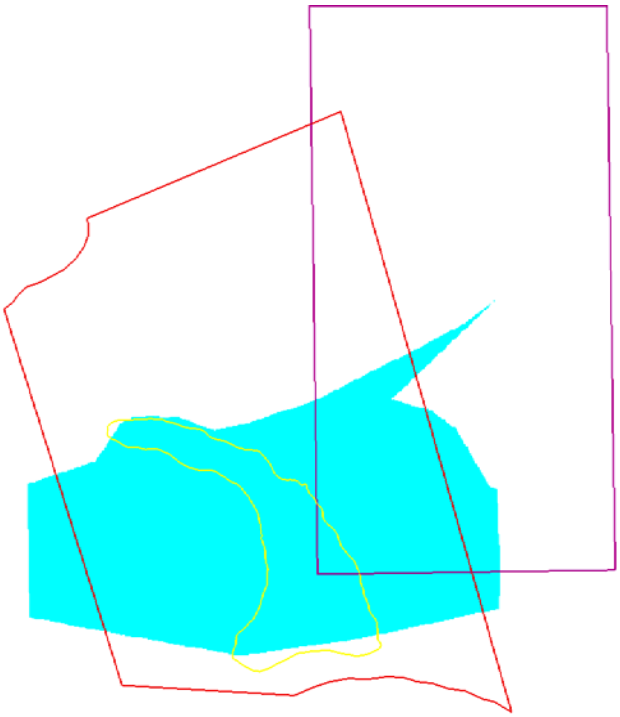
3 - 6

Stellwagen Bank

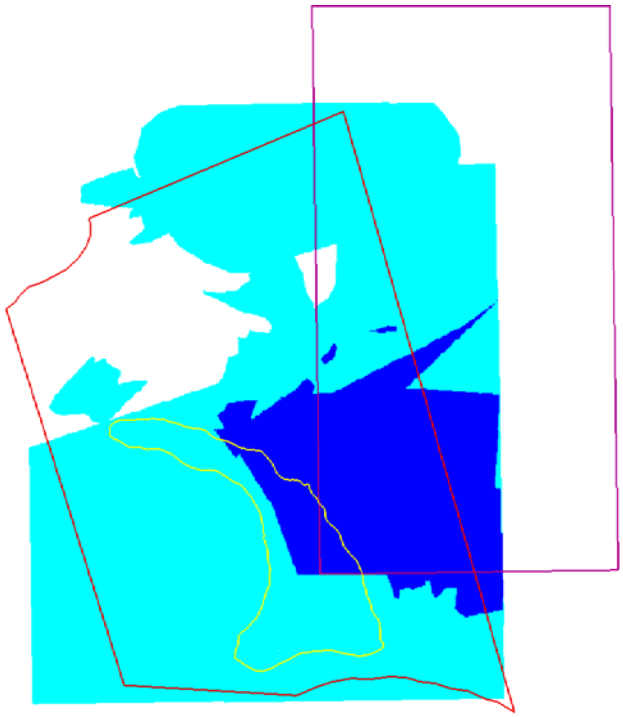
Stellwagen Bank National Marine Sanctuary

Gulf of Maine Closure Area

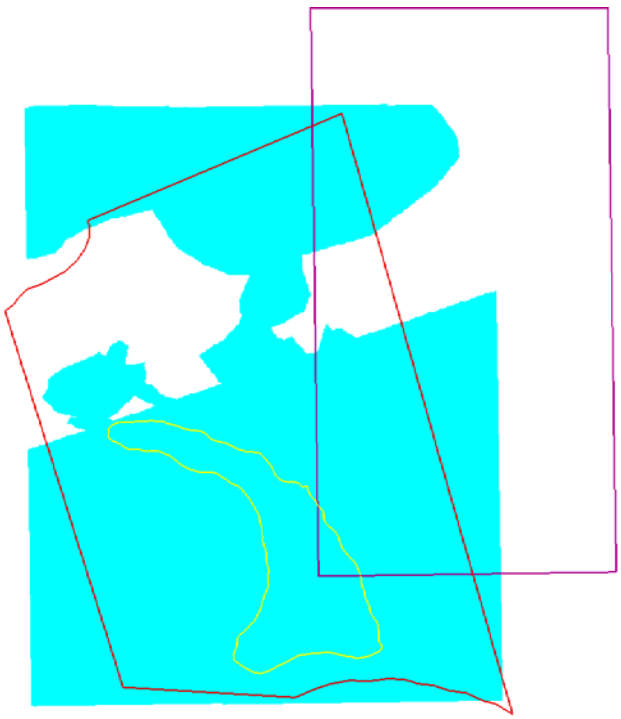
Figure 18. Gillnet Fishing Activities - Summer



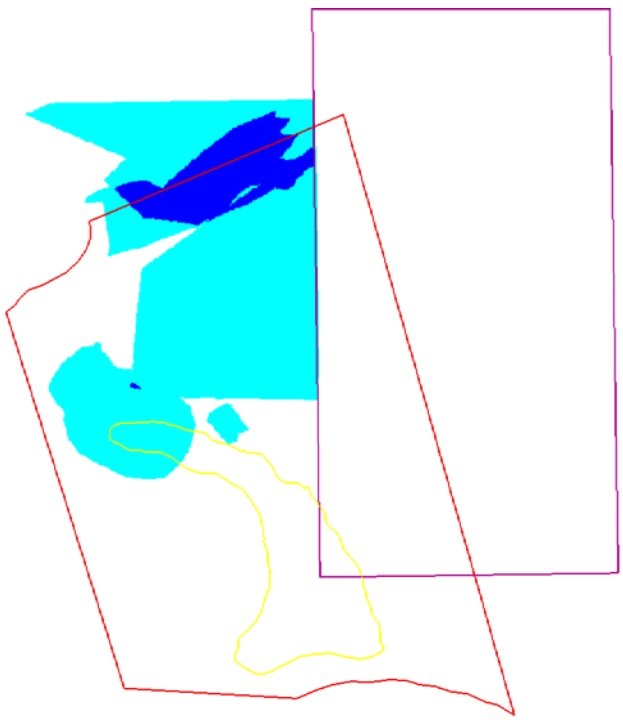
All seasons 1970's



Summer 1980's



Summer 1990's



Summer 2000's

Number of times grid cell was selected

0

1 - 2

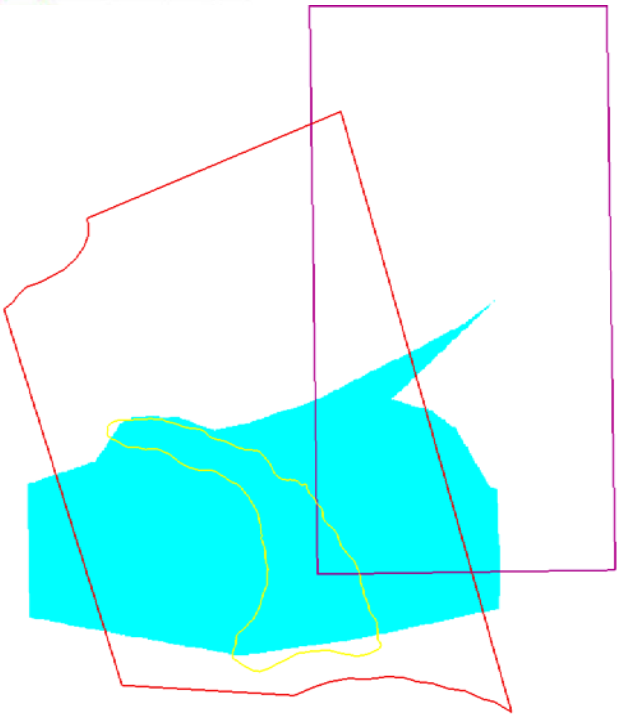
3 - 6

Stellwagen Bank

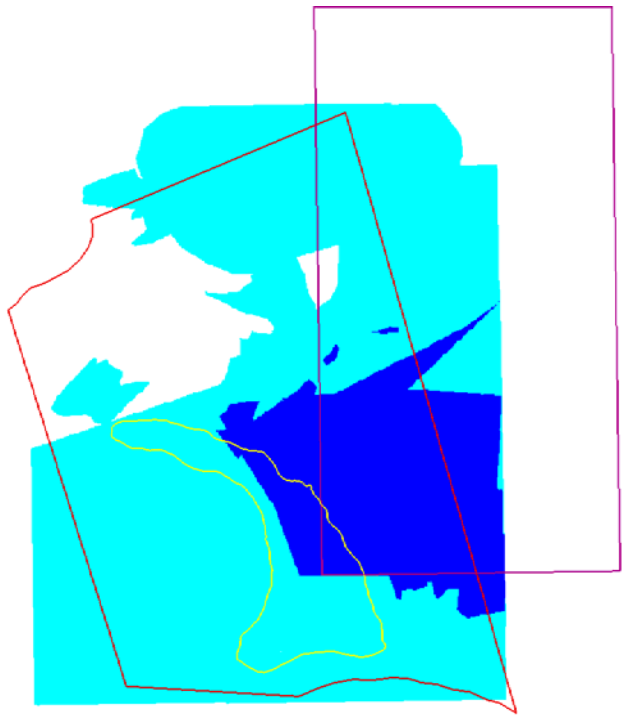
Stellwagen Bank National Marine Sanctuary

Gulf of Maine Closure Area

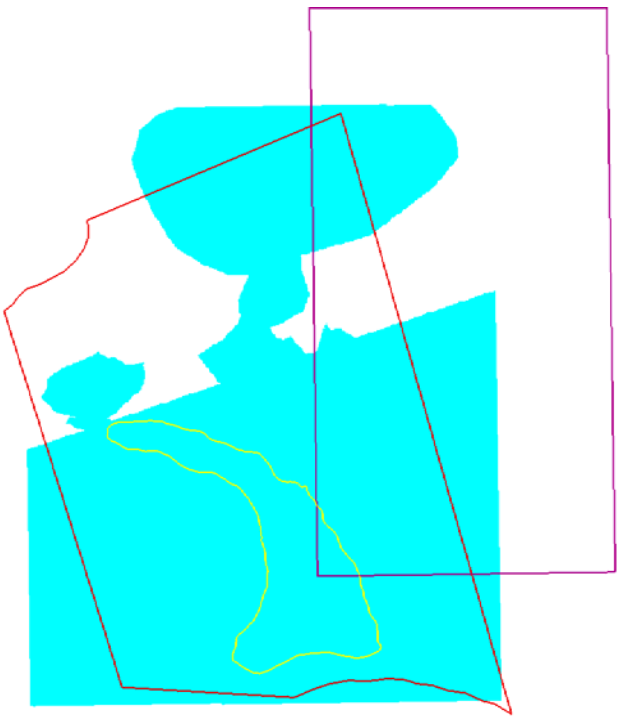
Figure 19. Gillnet Fishing Activities - Fall



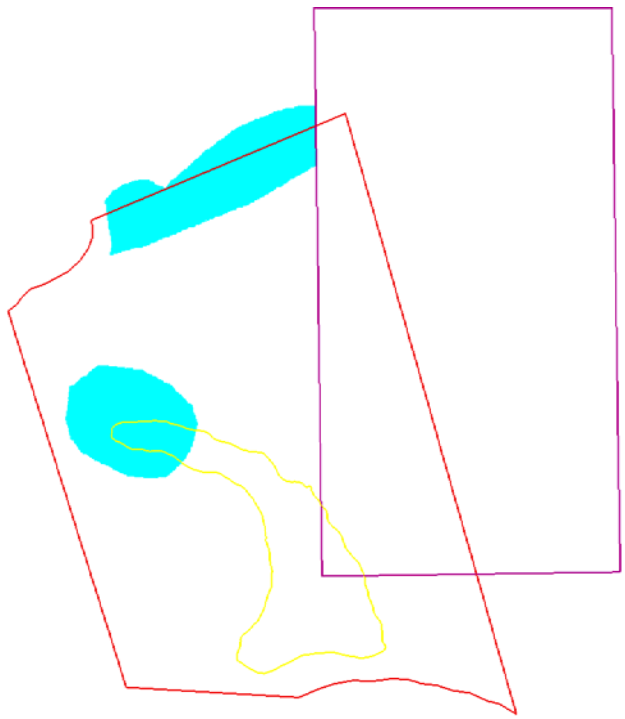
All seasons 1970's



Fall 1980's



Fall 1990's



Fall 2000's

Number of times grid cell was selected

0

1 - 2

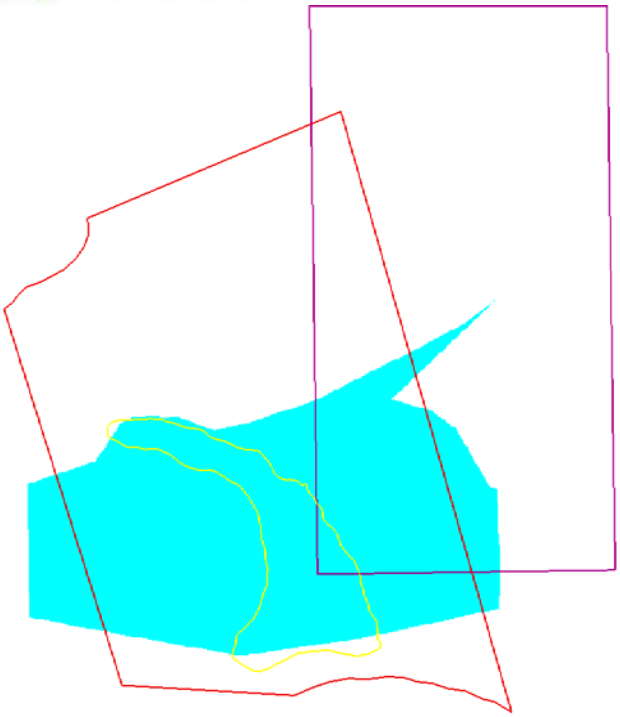
3 - 6

Stellwagen Bank

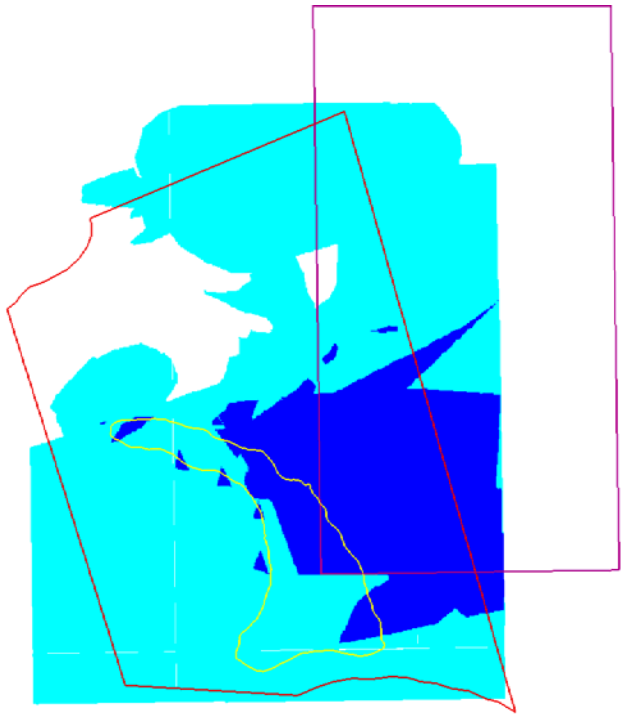
Stellwagen Bank National Marine Sanctuary

Gulf of Maine Closure Area

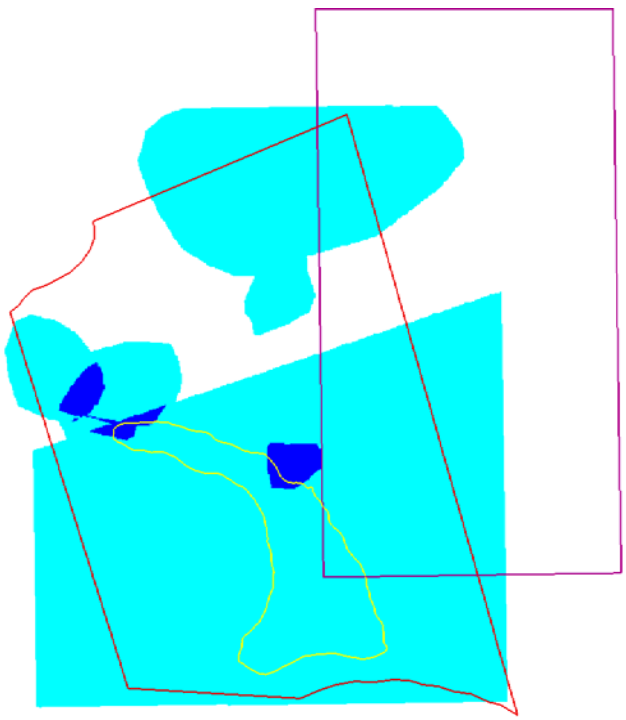
Figure 20. Gillnet Fishing Activities - Winter



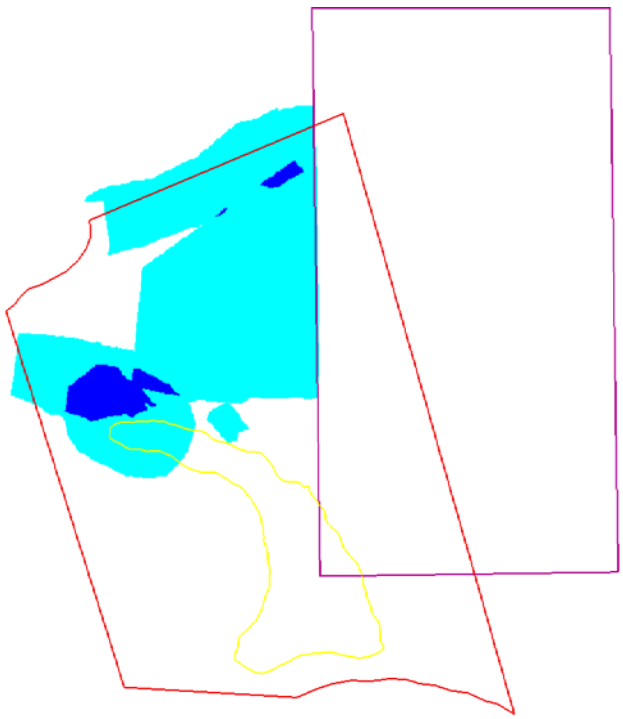
All seasons 1970's



Winter 1980's



Winter 1990's



Winter 2000's

Figure 21. Hook Fishing Activities – All Seasons

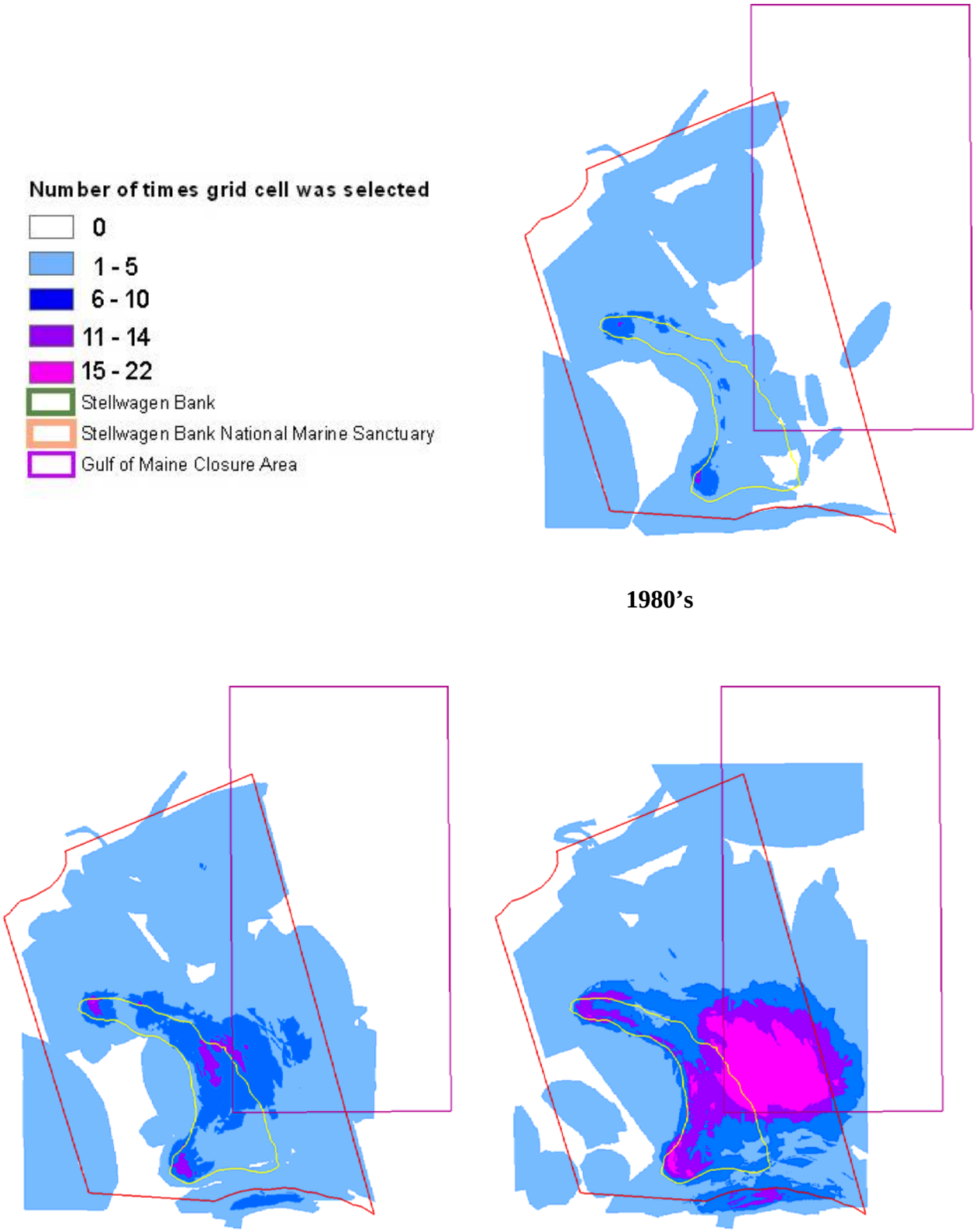
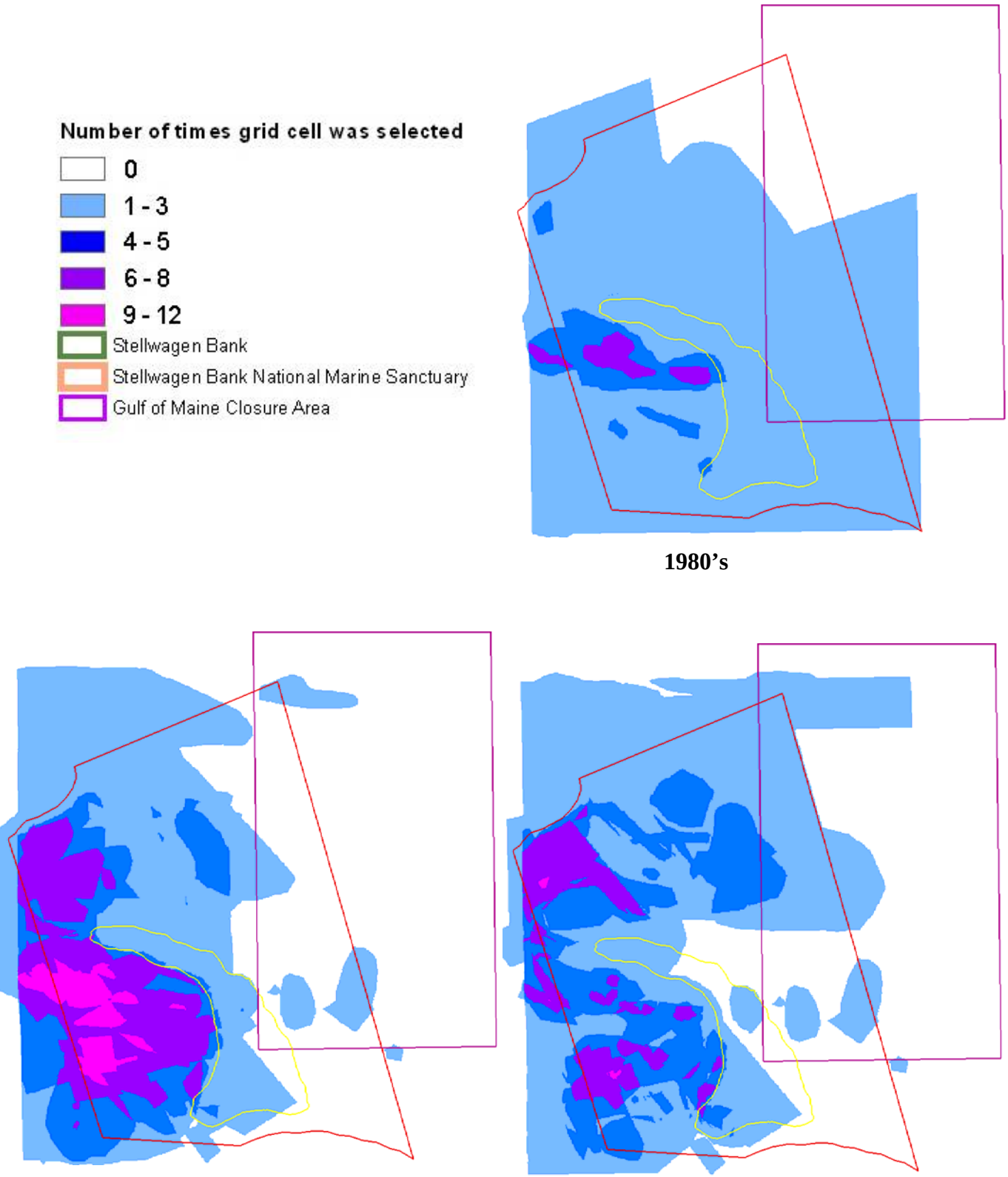


Figure 22. Lobster Fishing Activities – All Seasons



lobster fishing appeared to intensify along western side of the Bank, out to the western border of the SBNMS and north of the Bank. No fishing showed up in the WGOM closed area in the 1990s. In the 2000s the intensity lessened, but spread out further, including the eastern portion of the Sanctuary and beyond into the northern portion of the WGOM closed area. Although the lobster effort does not show up in the charts as particularly intense in a specific spot, the wider area covered by some lobster activity may be a reflection of access to bottom formerly used primarily by gillnet fishermen.

Groundfishing

Looking at the use of Stellwagen Bank and SBNMS from the perspective of target species rather than gear, groundfishing activity (Figure 23) showed up in the southern half of the SBNMS in the 1970s, the whole Sanctuary in the 1980s, with more intense activity in the middle of the Bank. Charts of the 1990s and 2000s show increasing intensity in the middle section of the Bank. The intensity that spills over into the WGOM closure reflects permitted rod and reel and/or hook fishing.

Tuna fishing

As noted earlier (Figure 10 and in the two dimensional image in Figure 24), the tuna fishing images are particularly striking. The 1970s show relatively minor levels of fishing with intensity increasing over the next three decades. In the 1980s, tuna fishing covered a larger portion of SBNMS but was more intense at the western and southern points of the Bank. This pattern continued through the 1990s and 2000s with ever increasing intensity. The hotspots spread also along the western border of the Bank. The increase in tuna fishing corresponded with the rise in popularity of sushi globally. “By the 1990s, Gloucester fishermen had become essential players in the worldwide bluefin market” (Dupree 2002).

Recommendations

Digitizing charts for analysis with GIS software demands a considerable amount of time. As graduate students become more adept at using the software, it may be possible to do the necessary work without requiring experienced scientists to volunteer their weekends and vacations to complete the project. However, the hours required to design the program, digitize charts, and then query the data to create graphics that offer opportunities to extract useful information in the visual format should not be underestimated.

Similarly, if interviews are to be undertaken by those who are not experienced social scientists, and data entered by someone who is not familiar with the terminology (in this case, of the fishing industry), supervision must be carefully planned. In addition to introductory training, a point early in the data collecting stage should be selected for

Figure 23. Groundfish Fishing Activities – All Seasons

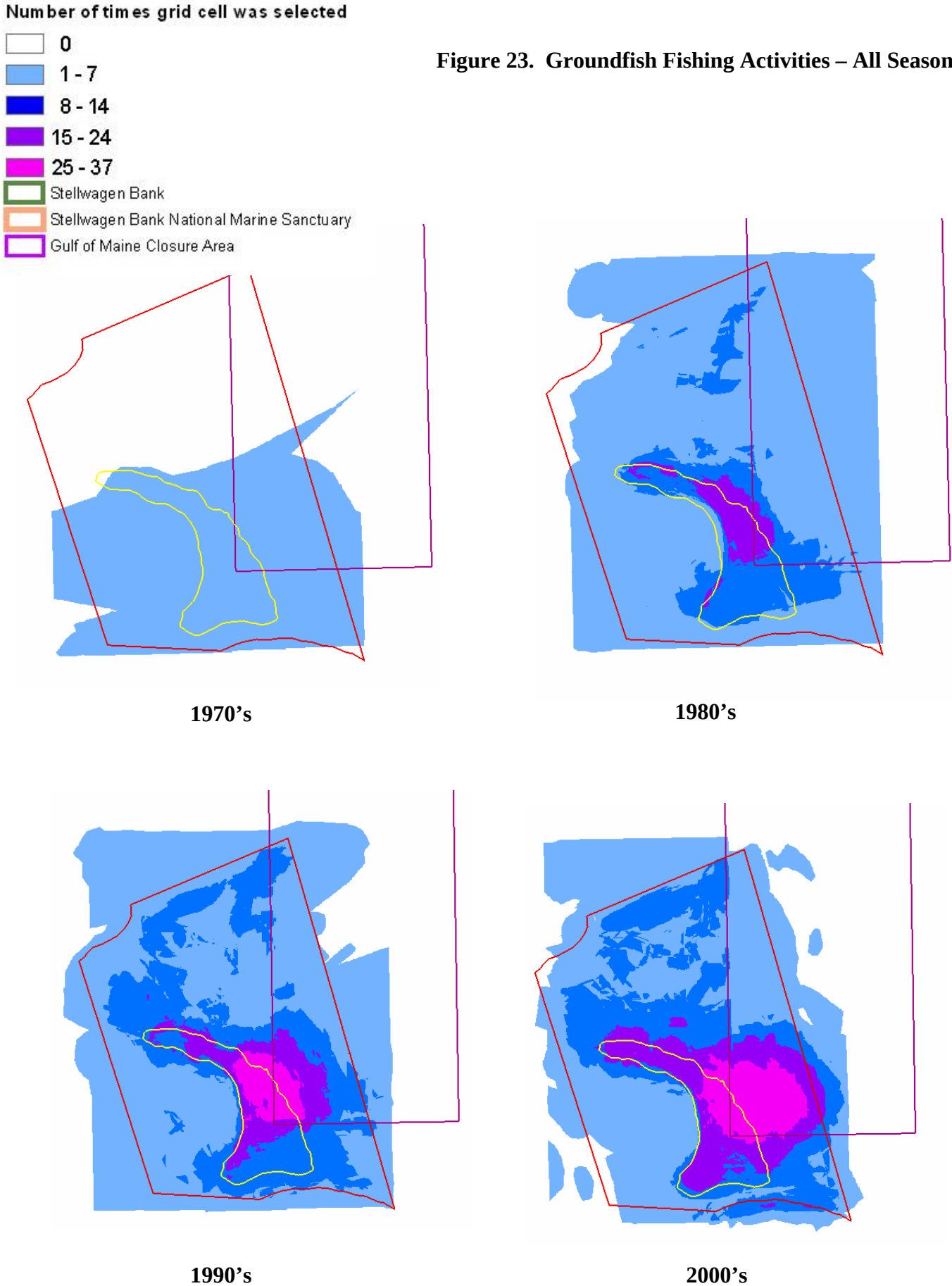
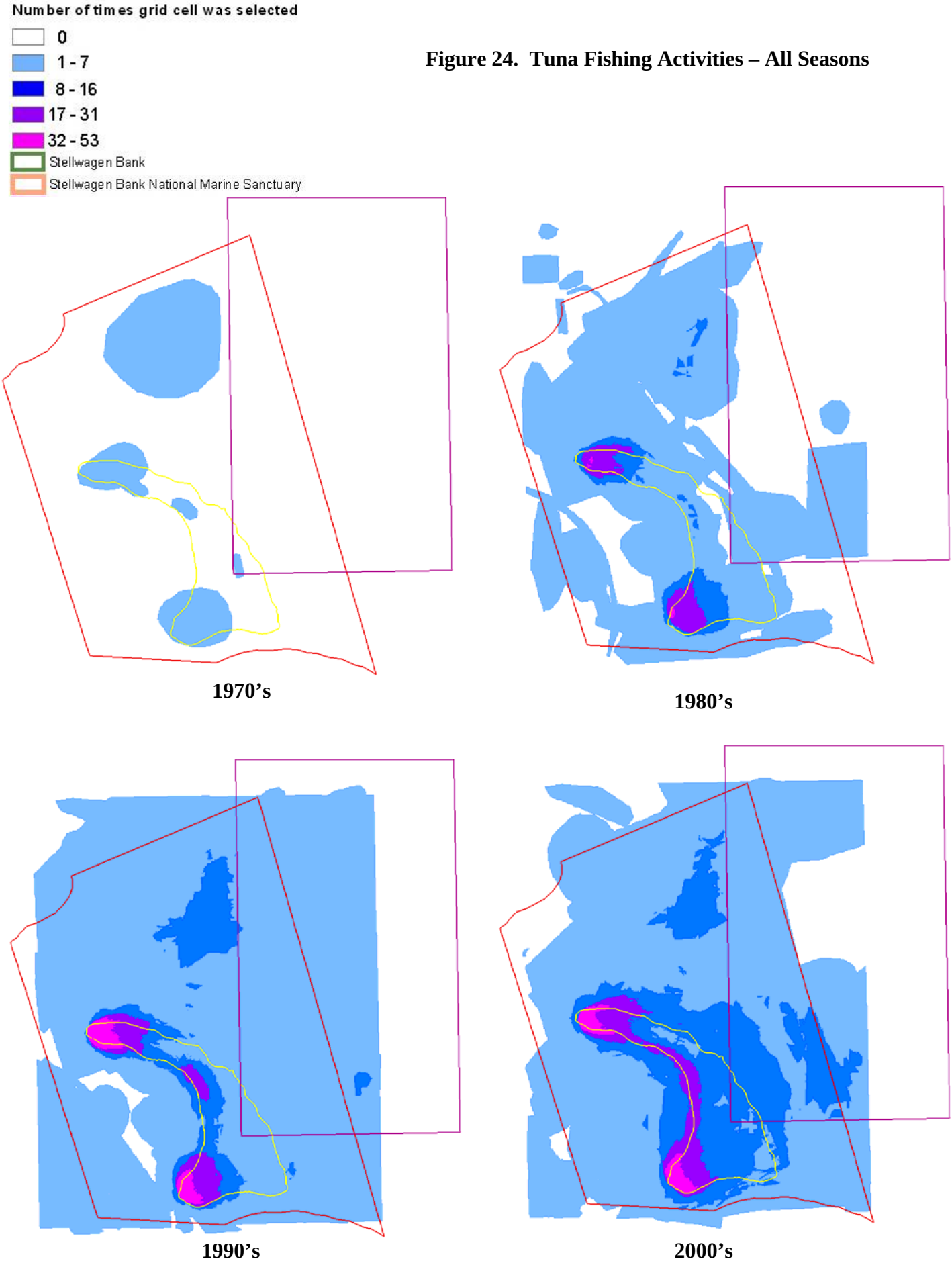


Figure 24. Tuna Fishing Activities – All Seasons



meeting interviewers as a group to review techniques, results, issues, etc. The selection of interview style must be carefully weighed. Experienced social scientists can extract valuable information from open-ended questions, probing to follow-up on issues or topics raised. Such interviews should be recorded for further data mining. If the interviewers, however, prefer a faster, less meandering process, a survey form with multiple choices to check off might be more efficient. What might be lost, however, is the opportunity to discover new ideas or explanations.

Data entry must be accurate and the terminology consistent. Otherwise, the analysis is extremely time-consuming, requiring a great deal of editing. Survey forms with multiple choices would facilitate data entry. This would eliminate, for example, the situation in which responses to hold capacity and tonnage questions were given in several different units of measure, not always explicitly stated. Also, mentioned earlier, is the importance of fitting the software selected to the computers available.

When attempting to analyze change over time in the fishing industry, permit numbers and hull identification would facilitate the process. Vessel names are changed, owners buy and sell vessels, crewmembers change boats and, at least in the past, were able to work up to buying their own boats and becoming captains. Consequently, using NOAA Fisheries data to corroborate information based on personal interviews is very complicated.

Plans to use logbooks to corroborate personal interviews were not carried out. Although several captains volunteered to share their logbooks, only one actually did so. We do plan to look at his books to learn how these might be useful tools for future research if we are able to access others in a timely fashion.

Conclusion

This project addressed two of the Northeast Consortium's goals: "to develop partnerships between commercial fishermen and researchers, educators, and coastal managers," and "to help bring fishermen's information, experience and expertise into the scientific framework needed for fisheries management." In addition, it responded to the following topic areas: fish habitats, socioeconomic impacts, and commercial harvest and species.

Although Hartley and Robertson's (2006) study of collaborative research in the Northeast concluded that "it remains unclear how fully empowered stake-holders have become, what impact cooperative research has had on management decisions," they found that both fishermen and scientists became more informed and more active in management after participating in collaborative research. Industry leadership facilitated the collection of sensitive data important to management in this project and the methods used should be replicated in future research.

High-resolution charts were developed that depict seasonal fishing grounds by gear sectors and target species. Interviews elicited information about the significant economic

value of fishing on the Bank to multiple fishing industry sectors and obtained some information about sea floor characteristics. The combination of charts and interviews are an extremely valuable, non-threatening method to obtain and present information of interest to both the fishing industry and to managers. More work is needed to further develop additional data sources that can be used to evaluate the accuracy of the information collected.

Finally, the project accomplished the goal of documenting the patterns associated with three decades of the use of Stellwagen Bank by commercial and recreational fishermen.

Partnerships

The project was initiated by fishermen, but addressed questions of immediate interest to managers and scientists. All were interested in the documentation of the use of Stellwagen Bank, the feasibility of using fishermen as researchers as well as the utility of GIS and survey responses. The commercial and recreational fishermen who were involved in the research component of the project helped develop the tools used for the project, that is, the charts and the questionnaire.

Impacts and Applications

The results of this project will be of great interest to managers of Stellwagen Bank National Marine Sanctuary since appropriate management requires a balancing of commercial use with the protection of resources and opportunities for scientific enquiry. It has been difficult to reach a broad-based consensus in the development of the Sanctuary's Five-Year Management Plan due in part to a lack of data on the use of available resources as well as the social and economic impacts of such use and/or loss of use.

The State of Massachusetts has also begun discussing the use of ocean zoning to resolve potential user conflicts. Rational management decisions concerning appropriate uses of areas require detailed, spatially based information that is not currently available. Commercial users of marine resources are concerned about marine protected areas and this broad brush approach to protection. Areas are closed to commercial fishing based on data aggregated at a level too general to accurately identify critical habitat and little work has been done to analyze the social and economic impacts of such closures.

The methods used would also be of interest to regional fishery management councils and others who are seeking ways to incorporate accurate local knowledge into their management deliberations.

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Appendix A: Questionnaire

Massachusetts Fishermen's Partnership
Mapping Fishermen's Movements on Stellwagen Bank

Consent Form

The goal of the Massachusetts Fishermen's Partnership's project, Mapping Fishermen's Movements on Stellwagen Bank, is to create GIS-based charts that clearly show the use of Stellwagen Bank by the fishing industry over time.

This project originated with the industry and is being conducted by industry members in collaboration with scientists. We believe that all who are interested in Stellwagen Bank will find the information gathered through this process invaluable.

This project is offering participants the opportunity to systematically investigate and record importance of Stellwagen Bank to many of the fishing communities in the Northeast for the past thirty years.

- Participation in this project is voluntary
- You do not have to answer any questions
- You may quit the project at any time
- Any information you give us will be considered confidential and will only be released in aggregate form.
- Confidentiality and/or anonymity are assured.
- Collected information will be maintained in secure files at the Massachusetts Fishermen's Partnership office and/or at the Center for Marine Social Sciences, Massachusetts Institute of Technology.

By signing this, you agree to participate in the study.

_____ _____

NAME **DATE**

Instructions/Hints For Interviewers

Survey number: Please use your initials and assign a separate number for each person you are interviewing. Write that number on each copy of the charts that you are using in the interview and the questionnaire.

Marking chart: Please make sure to indicate what color marker you are using for each fishery somewhere on the chart or on the questionnaire. (For example: Red=lobsters). Or, if you are indicating different spots for various fisheries over time, please note if you are using different colors for different time periods. You could also note in pen, beside the area marked, the species, season and/or year.

Community and economics questions: The value of fishing around Stellwagen spreads beyond your own families and those of your crew to the communities where you live and where you buy your fishing supplies, etc. As we chart the use of Stellwagen, this is an important piece of information that will help show how important access to Stellwagen is and has been over time not only to the individual fishermen who work there, but also the communities in which you live and/or buy supplies, etc.

Ecosystem (including by-catch) questions: The knowledge that fishermen have gained from being on the water every day is important to recognize. Some fishermen have noticed changes in the ecosystem over time that may have affected where and what they catch. We would like to record such observations.

Interview Information

_____ SURVEY NUMBER _____
Date

_____ _____
Location of interview Interviewer

Interviewee Contact Information

_____
Name

_____
Street address

_____
City State Zip code

_____ _____
Phone Email

_____ _____
Fishing Vessel Name Home port

Personal Information

*Please **circle** every category that describes your fishing:*

Commercial Recreational Owner Captain Other _____
Specify

How long have you been fishing? _____*years*

*How long have you been an owner or captain?*_____*years*

Which years did you fish on Stellwagen Bank and Jefferies Ledge?

_____

Do you keep a record of where you fish and what you caught, apart from the required logbooks? (For example, do you have plotter papers?) **Yes** **No**

Did you keep a logbook before it was required? **Yes** **No** *Would you be willing to share some of that data?* **Yes** **No**

Vessel information

	2004	1994	1984
Vessel Name			
Length			
Tonnage			
Horsepower			
Hold capacity			
Year built			

Decisions about where and how to fish
Please rank the reasons you chose to fish where you did (most important=1):

	2004	1994	1984
Availability of target species			
Bottom type			
Price (anticipated)			
Close to homeport			
Fuel Costs			
Days-at-Sea (DAS)			
Other areas closed due to regulations			
Other (specify)			

	2004			
	Spring	**Summer**	**Fall**	**Winter**
Gear used				
Target species				
Average length of trip (in days)				
By-catch: Finfish, shellfish, invertebrates or algae (coral, sea urchins, kelp)				

	1994			
	Spring	**Summer**	**Fall**	**Winter**
Gear used				
Target species				
Average length of trip (in days)				
By-catch: Finfish, shellfish, invertebrates or algae (coral, sea urchins, kelp)				

	1984			
	Spring	**Summer**	**Fall**	**Winter**
Gear used				
Target species				
Average length of trip (in days)				
By-catch: Finfish, shellfish, invertebrates or algae (coral, sea urchins, kelp)				

Community

Where did you tie-up?

	2004	1994	1984
Spring			
Summer			
Fall			
Winter			

Where did you land your catch?

	2004	1994	1984
Spring			
Summer			
Fall			
Winter			

Economic reliance on specific fishing grounds

*What **percentage** of your boat's **gross annual income** was from the places and years noted?*

	2004	**1994**	**1984**
Stellwagen Bank Sanctuary			
Western Gulf of Maine Closed Area			
Massachusetts state waters			
Gulf of Maine federal waters			
All remaining waters			

Ecosystem observations of Stellwagen Bank

*Have you noticed any **changes** in the ecosystem over time? (Answer yes/no)*

	2004	**1994**	**1984**
Predator-prey relationships			
Chemical pollution			
Plastic pollution			
Currents			
Water temperature			
Bottom type			

*If you answered "yes" to any of the characteristics noted above, or if you've seen other changes you consider important, please explain:*_____

_____