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Technical Report TR-50

Results of an Industry-Based Survey for Gulf of Maine Cod, May 2006—December 2007

W. S. Hoffman, S. J. Correia, and D. E. Pierce

Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
Department of Fish and Game
Massachusetts Division of Marine Fisheries

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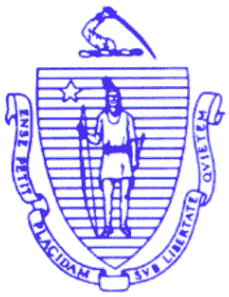

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Commonwealth of Massachusetts
Deval Patrick, Governor
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Richard K. Sullivan, Jr., Secretary
Department of Fish and Game
Mary B. Griffin, Commissioner
Massachusetts Division of Marine Fisheries
Paul Diodati, Director

RESULTS OF AN INDUSTRY-BASED SURVEY FOR GULF OF MAINE COD, MAY 2006 – FEBRUARY 2007

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ABSTRACT

The Industry-Based Survey for Gulf of Maine Cod Pilot Study, funded through the National Marine Fisheries Service and administered by the Massachusetts Division of Marine Fisheries, began in November 2003. This cooperative research effort was designed to study cod stock distribution and demographics in Gulf of Maine waters from Cape Cod to the Bay of Fundy. Working together, scientists and fishermen combined their knowledge of cod stocks to devise a cod survey optimized for studying spatial and temporal distribution of cod in the inshore Gulf of Maine. This unique survey design utilized a standardized grid as well as sampling locations recommended by fishermen to assure sampling areas with traditionally high catch rates. Four commercial fishing otter trawlers from the States of Maine, New Hampshire and Massachusetts were contracted to serve as the survey vessels. Since 2003 two contracts were created to fund the Industry-Based Survey for Gulf of Maine Cod Pilot Study. The first contract covered the dates from March 2003 through December 2005 and the second contract covered the dates May 2006 through February 2007. This report covers the second contract period. A report detailing work done for the first contract was submitted to the National Marine Fisheries Service in July 2005. During the 2006/2007 contract period four complete cruises and one partial cruise was completed. Data were audited into master data format and are now available on the WHOI/SUN database for authorized users. In addition, specific summary data are available to commercial fishermen, managers, scientists, and the general public on a GIS-based website which is housed on a Northeast Fisheries Science Center server.

EXECUTIVE SUMMARY

In 2000, U.S. congress allocated to the National Marine Fisheries Service (NMFS) $15 million dollars in New England groundfish disaster relief funds to be used for cooperative research efforts. NMFS and the New England Fishery Management Council Research Steering Committee decided that the primary focus of the funds should include establishing an industry-based survey (IBS) fleet and began the process to develop several pilot studies.

On September 26, 2003, the Massachusetts Division of Marine Fisheries (*MarineFisheries*) was awarded the initial contract from the National Marine Fisheries Service (NMFS) to implement a pilot study for the Industry-Based Survey for the Gulf of Maine (GOM) cod (referenced hereafter as the cod IBS) and on May 12, 2006 they received a second contract in continue the pilot study. The pilot study was the intended starting point for the development of a long-term IBS and a collaborative effort incorporating both the traditional knowledge of fishermen and net builders and the statistical design expertise of state and federal scientists.

The primary objective of the cod IBS was to define a broad-scale distribution of cod aggregations in the Gulf of Maine, in space and time, by age and size composition. The secondary objectives were to provide information on the age/length structure during current rolling closure areas (November, April-May) when fishery-dependent data are unavailable and to provide information on the seasonal distribution and length composition of other groundfish within the GOM where data was sufficient.

Given the hierarchy of objectives, the cod IBS utilized two types of grid systems as its design, the systematic grid and stratified random grid. The strata and stations for the survey were established in cooperation with federal and state government, participants from the commercial fishing industry, and a committee that was tasked with overseeing the implementation of the cod IBS. Each calendar year included five cod IBS cruises (Jan-Feb, Feb-Mar, Mar-April, April-May, and Nov-Dec) during which approximately 225 stations were attempted to be sampled, totaling 1,125 stations each year. A cruise consisted of a defined time period where all of the systematic grid tows and the randomly selected industry tows (industry tows were identified by commercial fishermen) were sampled. Approximately 64% and 36% of the stations samples were grid tows and industry tows, respectively, each cruise.

Four commercial fishing otter trawlers from Maine, New Hampshire, and Massachusetts, and a net builder from Massachusetts were contracted through a competitive bidding process to implement the survey. Two full-time personnel were hired to administer survey operations and several contracts were created with fisheries observers to supply sea sampling. The trawl used in the survey was a product of many meetings and personal interviews held with participants from the commercial fishing industries from Rhode Island to Maine. The trawl was a two seam high-rise design that was specifically designed to catch a full range of cod year classes, while targeting the larger spawning size fish. The design also allowed fishing over all substrate types that were anticipated to be encountered during the survey (i.e. soft mud to hard rocky ledge).

The cod IBS utilized a commercial-style survey tow rather than the more traditional straight-line survey tow. A commercial style tow is usually influenced by depth, bottom and substrate type, presence of fish, presence of fixed gear, and presence of other fishing vessels, and as a result, it

did not always result in a straight-line tow. A successful tow was standardized to 30 minutes in duration with a minimum of 20 minutes, with no more than 30% damage to trawl net, no large obstructions in the gear, and the tripper must have remained closed.

During each cruise, data were collected manually and electronically by the scientific staff and vessel crew. Scientific staff recorded data elements such as date, time, location, depth, weather, sea state, specific gear characteristics, and bottom temperature. Two NETMIND™ Trawl Monitoring Systems (net mensuration systems) were used to monitor net geometry and ensure that the nets were standardized and operating correctly.

Biological sampling was conducted on a list of prioritized species. Atlantic cod, being the focus of the study, were sampled on all tows recording individual length, individual weight, sex, stomach contents, and maturity stage and age structures. Individual lengths were collected for other commercially-important species including American lobster, American plaice, Atlantic halibut, Atlantic wolffish, monkfish, Greenland halibut, haddock, pollock, redfish, white hake, winter flounder, witch flounder, and yellowtail flounder.

Cruises were completed under this contract during the calendar years 2006 and 2007. Cruise numbers 4 and 5 were completed in 2006 and cruise number 1 and 2 were completed in 2007. Cruise completion rates were variable throughout the survey period and ranged from 44% to 96% with an average of 77% for the four completed cruises. During all surveys completed under the two contracts, the fall cruises had the lowest completion rates due to high concentrations of fixed gear, limited amount of daylight (the survey was only conducted between half-hour before sunrise and half-hour after sunset), and high catch rates with large species diversity (which equated to long catch processing times).

Outreach was a key component to the cod IBS and a considerable amount of time and finances were dedicated toward this effort. Fishermen, industry representatives, scientists and managers were targeted through advertisements in industry periodicals, legal ads, internet, e-mail, displays at trade shows, presentations at workshops and industry meetings, general announcements on VHF channel 16, and posters that were displayed in areas of high visibility. The outreach efforts were successful in creating general awareness about the survey and the utility of the data; however, they were not effective in the request to remove fixed gear from areas to be surveyed.

Post-cruise data processing included converting the raw data collected at sea into master data files stored in the Oracle survey database (SVDBS) located at the NMFS, Northeast Fisheries Science Center in Woods Hole, MA. All data collected from the 2006/2007 survey is in master data format and available to managers, scientists, and the general public. Survey data has been used to generate length compositions for several important species to illustrate general trends in distribution, stock demographics, and the co-occurrence of cod with other species. Other utilities of the data were demonstrated through the generation of maps depicting catch per tow for cod, haddock, pollock, redfish, winter flounder, yellowtail flounder, American plaice, witch flounder, windowpane flounder, halibut, white hake, monkfish, and American lobster. Data collected during the cod IBS are anticipated to continue to provide critical information to managers, scientists, and fishermen for the enhancement of management of cod. In addition it is anticipated that information collected during the cod IBS will be used in the 2008 Groundfish Assessment Review Meeting (GARM).

1 PURPOSE

On May 12, 2006, the Massachusetts Division of Marine Fisheries (*MarineFisheries*) was awarded contract number EA133F-06-CN-0109 (contract 0109) from the National Marine Fisheries Service (NMFS) to continue a pilot study for the Industry-Based Survey (IBS) for the Gulf of Maine (GOM) cod (referenced hereafter as the cod IBS). This contract was created to continue work that being done under contract number EA133F-03-CN-0010 (contract 0010), which was awarded to *MarineFisheries* on September 26, 2003. This cod IBS was designed by the Industry-Based Survey Fleet Committee (IBS committee) and was the starting point for the development of a long-term Industry-Based Survey. This collaborative effort incorporated both the traditional knowledge of fishermen and net builders and the statistical design expertise of state and federal scientists. This report summarizes the sampling work performed, survey and sampling design, findings, and evaluates the cod IBS pilot study. Photographs were taken to document the implementation process of the survey. Several of these photographs are provided in the attachment Photographic Documentation at the end of this report.

Contract 0109 was intended to be a continuation of the pilot study that was conducted under contract 0010. Many of the project elements were identical between the two survey periods, and therefore, this report presents identical information regarding its approach and management as did the final report for contract 0010 that was submitted in July, 2006.

1.1 PROBLEMS TO BE ADDRESSED

In April 2001, the IBS Committee convened by the NMFS, recommended implementing an industry-based survey pilot fleet in New England. Those recommendations pertained to IBS pilot projects and aimed to:

(1) provide timely information for evaluation of resource status and the development of sustainable fishing practices,
(2) develop information on demographics and distribution of GOM cod and southern New England yellowtail flounder,
(3) provide cost effective research platforms, while expanding the pool of vessels involved in and increasing the capacity for special purpose research, within the GOM and southern New England,
(4) promote cooperation and reduce conflict between fishermen and managers by providing opportunities for jointly collected and shared data, and
(5) coordinate with other cooperative research efforts (e.g., cod tagging projects).

The primary motivation for these surveys was $15 million provided by Congress to the NMFS for New England groundfish disaster relief and the decision by NMFS and the New England Fishery Management Council Research Steering Committee that a primary focus of the funds should include establishing an industry-based survey fleet.

The IBS committee, which included federal and state fisheries scientists, managers, and fishermen from Massachusetts, New Hampshire, Maine, and Rhode Island, defined the objective to characterize the broad-scale spatial and temporal distribution by age and size composition of cod aggregations in the GOM. The project's purpose was to:

(1) Complement NMFS, states and other surveys to characterize cod distribution;
(2) Contribute to filling the gaps in time and space that are inherent in NMFS and state surveys and improve robustness of stock assessments for cod;
(3) Collect stock demographic (age structure and spawning condition) of cod;
(4) Investigate the association of cod with other species in space and time;
(5) Provide opportunities for complementary projects to take advantage of ancillary cruise information; and
(6) Move toward the development of an optimal survey design for cod.

The cod IBS was a response to the great concern about the status of GOM cod and the socioeconomic impacts of federal rules adopted to reduce fishing mortality and rebuild spawning stock biomass. Emphasizing that concern, the NMFS on June 11, 1999 published in the Federal Register a request for comments on "Disaster assistance for Northeast Multispecies fishery failure." NMFS proposed a plan "for disbursing funds to assist persons who have incurred losses from a commercial fishery failure due to declining stocks of groundfish which has caused harm to the Northeast Multispecies fishery." NMFS's two goals were to provide a mechanism to get financial assistance as quickly as possible to fishermen most affected by the groundfish collapse, and to involve the industry in fisheries and gear research, thereby providing additional data for the long-term management of the fishery (emphasis added).

The Commonwealth of Massachusetts, being the state most affected by cod and other groundfish regulations, was especially supportive of industry-based surveys that potentially would engender greater confidence in GOM cod assessments necessary for management of the cod fishery and achieving stock rebuilding goals. Consequently, the Commonwealth, other states, and NMFS agreed that the cod IBS should be initiated as a pilot as a way to improve management of the cod fishery by involving fishermen in net and survey designs (including station selection), data gathering, and interpretation of results. Shared "ownership" of a survey through the IBS concept was and still is considered to be an excellent approach for providing additional fisheries science to improve assessments and create/maintain sustainable fisheries.

1.1.1 Project Objectives

The primary objective of the cod IBS was defined in April 2001 by the IBS committee and was included in a report that was created by Gulf of Maine Aquarium (now the Gulf of Maine Research Institute) and entitled: "Implementing an Industry-Based Survey Fleet Pilot Program; April 2002" (April 2002 Report). The primary objective of the cod IBS is:

"*To define a broad scale distribution of cod aggregations in the Gulf of Maine, in space and time, by age and size composition.*"

The April 2002 Report also detailed the program's purpose, and incorporating the items of the list, two secondary objectives were created. The first was to provide information on the age/length structure during current rolling closure areas (November, April-May) when fishery-dependent data are unavailable. The second was to provide information on the seasonal distribution and length composition of other groundfish within the GOM where data was sufficient.

Summarizing the objectives and information in the April 2002 Report, the cod IBS was designed to study cod distribution, monitor inshore cod stocks, assess the importance of areas as nursery and spawning grounds, and to enhance data used for management decisions. The information on cod distribution and demographics from this survey is of higher resolution than is currently available from existing surveys and is intended to assist the development of future area management initiatives.

2 APPROACH

Prior to deployment, and during the survey, several key cod IBS components were developed. During contract 0010 *MarineFisheries* worked with the IBS implementation committee, federal and state scientists, and members of the commercial fishing industry to develop the survey design, strata design, temporal design, strata location, survey timing, cruise schedule, sampling design, survey platforms, survey gear, outreach, training, and data management procedures. Contract 0109 utilized the same information and protocols and therefore the description in the below sections is identical to that found in the contract 0010 final report.

2.1 SURVEY DESIGN

The strata and stations for the survey were established in cooperation with Northeast Fisheries Science Center (NEFSC), Maine Department of Marine Resources (MEDMR), New Hampshire Fish and Game (NHFG), participants from the commercial fishing industry, and a committee that was tasked with overseeing the implementation of the cod IBS - the IBS Implementation Committee during the previous contract. Given the hierarchy of objectives, the cod IBS utilized two types of grid systems as its design, the systematic grid and stratified random grid.

2.1.1 Systematic Grid

The IBS implementation committee selected the systematic sampling during contract 0010 because this design allowed for uniform coverage of a broad area, and it is a relatively simple design that has been extensively employed in biological surveys. The systematic grid used in the cod IBS is a 9-minute grid that extends from the Maine/Canadian border south to 41°30' north latitude and from a depth of 10 fathoms (Fm) out to 75 Fm (Appendix A). This includes the offshore areas of Platts Bank, Fippennies Ledge, Cashes Bank, Jefferys Ledge, and Outer Fall, but excludes Georges Bank. The grid does not extend inside Maine outer islands due to excessive fixed gear and extreme rock bottom. As recommended by NMFS personnel, the area within the western GOM specifically called 'the sliver' was incorporated into the strata design and was avoided during the survey due to the Benthic Habitat Monitoring Study in this area (Appendix A). The grid consists of 145 squares and sampling stations are located at the center of each square. All grid stations were attempted to be sampled on every cruise.

2.1.2 Stratified Random Grid

The IBS Implementation Committee adopted a stratified random grid during the previous contract for sampling areas of potential seasonally high aggregations of cod that fall within IBS strata. Over 30 commercial fishermen throughout the survey area identified 265 3-minute

squares (industry tows) as potential important areas of high abundance. All of the identified squares were incorporated into the design. However, due to the large number of industry tows and time constraints of the temporal design as described below in section 2.1.4, not all identified squares could be sampled every cruise. As a result, a randomized selection of stations was performed by dividing the 3-minute grid into 16 strata that were based on geographic location (Appendix A). Each stratum was weighted by the number of tows that it contained, and then using a random number selection feature in Microsoft Access software, the appropriate numbers of industry tows were selected from each stratum.

2.1.3 Strata Design

Some of the squares in both the systematic grid and the stratified random grid did not meet depths and/or bottom survey criteria as specified in section 2.1.1. To determine if a station would be included in the systematic grid, it had to meet the predetermined criteria that the longest axis of towable area, within the square, must equal a minimum distance of 1.0 nautical mile (nm) and 30% of the square must encompass towable bottom (e.g. depths between 10-75Fm, absence of extreme rock bottom, no land/island, etc.). To qualify for inclusion in the stratified random grid, the minimum towable bottom was increased to 50% of the square, and the longest axis of towable area within the square had to equal a minimum distance of 1.0 nm.

ARC/GIS software was used to help determine the acceptance or rejection of the individual squares in the grid. By studying bathymetric and backscatter layers, area of assumed towable bottom and/or estimated towable distance was calculated. Even though these conclusions were based on the best available data, ground-truthing was required.

The strata were reviewed by the contracted commercial fishermen, and once the survey commenced, each square was thoroughly assessed at sea by the vessels to determine the possibility of completing a valid tow inside the square. Squares that were visited three times and were deemed untowable due to bottom depth, hardness, and/or roughness were removed from the grid. This process increased survey time during the first year of the cod IBS, but was imperative in creating the survey strata.

2.1.4 Temporal Design/Survey Timing

Under contract 0010 each calendar year included five cod IBS cruises. A cruise consisted of a defined time period (Jan-Feb, Feb-Mar, Mar-April, April-May, and Nov-Dec) where all of the systematic grid tows and the randomly selected industry tows were sampled. Under contract 0109 only 4 cruises were funded starting in May 2006 ending in March 2007.

The first cruise was completed in May 2006, with the other three cruises being completed between December and March 2007. Although the strata and sampling design remained unchanged, each cruise was associated with a different goal. Goals for each of the cruises were developed by the IBS Implementation Committee during the initial stages of the study (Table 1). Note that cruise five is the last cruise of the calendar year, but the first cruise of the survey season.

Depending on the cruise, each vessel was assigned a certain number of sea days to complete their assigned tows. Sampling was standardized to be conducted from ½ hour before sunrise to ½

hour after sunset. To compensate for the difference in daylight hours throughout the survey season, the number of dedicated sea days per cruise varied from cruise to cruise. This design allowed the boats to better utilize their time and more efficiently sample the selected stations. Depending on weather, sea conditions, and length of daylight hours, an average of five tows per day were completed during each cruise. Approximately 225 stations were attempted to be sampled per cruise, totaling 1,125 stations each year. Total stations per cruise were allocated as 36% industry tows and 64% grid tows (Table 2).

Table 1. Temporal strata for the Industry-Based Survey for Gulf of Maine Cod

Cruise Number	Dates			Cruise Goal
1	January 1	–	February 12	to capture latest year class
2	February 13	–	March 17	to capture migrating and spawning cod in southern GOM
3	March 18	–	April 19	to capture migrating and spawning cod in mid-coast GOM
4	April 20	–	May 31	to capture migrating spawning cod in eastern GOM
5	November 14	–	December 31	to capture cod after redistribution of thermocline when spawning aggregations are forming

Table 2. Summary of attempted stations per cruise

Cruise number	Number of sea days	Number of grid tows	Number of industry tows	Number of stations
1	11	145 (64%)	80 (36%)	225
2	10	145 (64%)	80 (36%)	225
3[1]	9	145 (64%)	80 (36%)	225
4	8	145 (64%)	80 (36%)	225
5	12	145 (64%)	80 (36%)	225
Total # of stations attempted / year				**1125**

Number of attempted stations per cruise, total number of grid station (percent of grid stations attempted per cruise) and total number of industry tows (percent of grid stations per cruise).
[1]Note under contract 0109, only cruises 4,5,1, and 2 were completed.

2.2 SURVEY PLATFORMS AND GEAR

2.2.1 Survey Platforms

During contract 0010 four commercial fishing otter trawlers of similar size and horsepower were contracted to serve as the survey platforms. The vessels were contracted through the advertisement of a Request for Response (RFR) and a competitive bidding process. These vessels contracts were valid for the continuation of the study and therefore used during contract 0109. The process involved closely reviewing each proposal, interviewing captains and owners, contacting available references, and conducting dockside inspections of several vessels. The vessels were selected based on the following criteria:

1. Price. Bids were competitive and a relatively good value based on the vessel size.

2. Geographic location. The vessels selected were strategically distributed throughout the GOM coast, allowing access throughout the strata.

3. Vessel size. Vessels provided a stable, safe, and comfortable work platform that allowed sampling to be conducted in a wider range of adverse conditions ultimately increasing the probability of accomplishing the survey goals in the specified time frames.

4. Very similar in overall size and as a result fished similar size ground wire which simplified standardizing the gear.

5. Deck layout and space for working up the catch and storing additional gear was adequate.

6. Comfortable accommodations including spacious wheelhouse, galley, bunk room, and shower/head. Duties for the crew and scientific staff are very strenuous during the time

of year the survey is conducted. Comfortable accommodations are a valuable asset for extended trips.

7. Versatility. Vessels were willing to travel if additional sampling was needed.

8. Experience. The captains and owners had experience in cooperative research and were extremely interested and motivated to participate in this pilot study.

2.2.2 Gear to be Deployed

The trawl used in the survey is a product of many meetings and personal interviews held with participants from the commercial fishing industries from Rhode Island to Maine. The trawl is a two seam high-rise design that is specifically designed to catch a full range of cod year classes, while targeting the larger spawning size fish. This design also allows fishing over all substrate types that are anticipated to be encountered during the survey (i.e. soft mud to hard rocky ledge). The net has a 150-foot fishing circle, 87-foot sweep, and an 84-foot headrope. The wings and body of the net are made with 4.5-inch Euro twine, which tapers in the extension to a 3-inch codend that has a 2-inch mesh liner. The sweep is a 14-inch "Rockhopper" which has 14-inch disks in the belly that taper to 12 inches in the wings. The bridals and ground cables are each 15 fathoms. Both the bottom leg and ground cable are rubber cookie-covered to decrease wear and to improve the mud-cloud effect.

A detailed memorandum describing net description, rationale for net style selection, details of the net plan, and schematics of the sweep are provided in Appendix B.

2.2.3 Net Builder

Similar to the selection of commercial fishing vessels, the net builder was selected during the previous contract through a competitive bidding process that included the advertising of a RFR. The state contract for this vendor was still valid and therefore the same netbuilder was used during contract 0109. The criteria that were used to select the netbuilder were:

1. Bid price for nets and service was competitive.

2. Net design achieved all criteria of the survey trawl.

3. Excellent recommendations.

4. Extensive experience and knowledge of the New England groundfish fishery.

5. Shop size was large and well-staffed.

6. Shop was capable of manufacturing all components of the gear, including the rockhopper sweep, legs, and groundgear.

7. Could provide a one-ton truck with a crane for transporting, loading and unloading gear for the vessels.

8. Worked closely with Northeast trawl systems; a leader in the otter trawl manufacturing industry.

9. Staff, especially the lead net builder, was knowledgeable of survey design and the importance of standardization of the trawl nets.

10. Good working knowledge of computers and software, which assisted in the development of net plans and sweep plans.

2.2.4 Net Calibration

Before the nets were calibrated in the field during contract 0010, the net design was tested at The Centre for Sustainable Aquatic Resources of Memorial University of Newfoundland (CSAR) in St. John, Newfoundland Canada. CSAR is the largest flume tank in the world, and they have extensive knowledge and experience testing demersal trawls used in commercial and research operations (e.g. NEFSC bottom trawl survey, Department of Fisheries and Oceans (DFO) bottom trawl survey, DFO sentinel survey, *MarineFisheries* raised footrope trawl, etc.).

To test the trawl in the flume tank, a model of the net was required to be produced. The Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology (SINTEF) Fisheries and Aquaculture in Hirtshals, Denmark was contracted to develop and construct the model.

Testing the trawl in the flume tank allowed gear specialists to adjust the model to define its ideal geometric shape. The trawl's optimum fishing shape is important because it yields the highest fish retention. The angles, heights, spread, needed lift, and door sizes are measured and applied to the trawl when at sea. Having the known values was instrumental in net calibration and contributed to a more efficient and less time-consuming calibration process.

The net performance report developed from flume tank testing describes how minor changes to the rigging and towing speed affected the trawl's geometry. This assisted the scientists and captains in deciding where to increase attention on rigging parameters and towing. In addition, the flume tank test was recorded digitally and a DVD was produced. A copy of the DVD was provided in Appendix C of the final report for contract 0010 and the net performance report is provided in Table 3.

The survey vessel captains/owners, contracted net builders, in-house gear experts, and scientific personnel participated in flume tank testing. Having the survey members at the flume tank not only gave an excellent opportunity to train and familiarize participants with the survey gear, but allowed other industry and interested parties to observe the vigilant steps that were being taken to assure quality control throughout the survey.

Two net mensuration systems, produced by NorthStar Technical, were acquired under the previous contract to assist with the calibration of the survey trawl, and the two systems were to be rotated throughout the fleet during the cod IBS to assure net standardization. Members of the flume tank team received a tour of the NorthStar Technical production facility and were provided a demonstration of the performance of the equipment. In addition, prior to the sea trial and net

calibration, a separate training session was convened, and members of NorthStar Technical trained survey fishermen and scientists to install and deploy the equipment.

During the previous contract, sea trials were run on each vessel prior to the beginning of the first survey cruise. Using the net mensuration equipment, fishermen and scientific staff monitored the behavior of the trawl, ground gear, and doors in real time while towing. All nets were adjusted to optimal configuration by comparing flume tank measurements and the real-time data from the net mensuration system. The sea trials were conducted at various bottom depths and bottom substrate types. Nets were deemed standardized and ready for use in the survey when geometric configuration was similar to flume tank results.

During the first two years of the survey, an underwater camera was attached to the net in strategic locations to study fish behavior when encountered by the survey trawl and to observe performance of the net on various bottom types. The net's behavior in response to various factors, including speed, bottom type, and depth was documented. *MarineFisheries* provided the funds, staffing, and equipment to complete this task since this under water camera work was not included in the contract for the cod IBS pilot study. The underwater footage from this work is provided on the DVD included in Appendix C of the final report for contract 0010

Table 3. Flume tank test results for the Reidars 360, from the Memorial Institute in Newfoundland CA.

Rig #	1	2	3	4 *	5	6	7	8	9	10	11	12	13	14	15
Tow Speed (kts)	3.0	3.0	2.5	3.0	3.5	3.0	3.0	3.0	3.0	3.0	2.5	3.0	3.5	3.0	3.0
Door Spread (ft)	182	184	181	182	185	181	181				147	150	152	124	162
Upper Wing Spread (ft)	49.6	49.6	49.2	49.4	49.6	48.5	49.6				42.6	43.1	43.3	38.0	56.8
Lower Wing Spread (ft)	55.0	53.6	52.8	53.0	53.7	52.9	52.7				45.9	46.6	46.4	39.4	62.3
Headline Height (ft)	13.9	14.4	16.0	14.4	13.4	13.9	15.0	15.7	17.1	14.7	17.1	15.5	13.9	16.0	14.4
Wing Opening (ft)	9.4	10.0	11.0	10.2	9.7	10.2	10.8	10.5	10.8	10.5pt 10.0st	10.8	10.2	9.7	10.2	10.8
Bridle Length (ft)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90
Sweep Length (ft)	90	90	90	90	90	90	90	90	90	90	90	90	90	90	0
Upper Bridle Extension (ft)	0.0	1.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Port Tension (tonnes)			0.92	1.17	1.44	1.1	1.2	1.2	1.2		0.88	1.10	1.35	1.04	1.22
Starboard Tension (tonnes)			0.93	1.17	1.48	1.1	1.2	1.2	1.2		0.89	1.08	1.35	1.07	1.21
Total Tension (tonnes)			1.85	2.33	2.92	2.3	2.4	2.4	2.4		1.78	2.18	2.70	2.12	2.43
Mouth Area (sq. ft)	727.5	744.9	816.3	738.8	690.7	705.0	764.9				754.6	694.7	623.8	619.5	859.4
Mouth Drag (lbs / sq. ft)			5.0	7.0	9.3	7.1	6.8				5.2	6.9	9.5	7.5	6.2
# of 8" floats (6.83 lb lift)	58	58	58	58	58	50	58	66	76	58	58	58	58	58	58
Total Buoyancy (lbs)	393.3	393.3	393.3	393.3	393.3	340.9	393.3	448.0	516.3	393.3	393.3	393.3	393.3	393.3	393.3
Bridle Angle (degrees)	17.6	18.0	17.7	17.8	18.2	17.7	17.7			0.0	13.9	14.3	14.5	11.5	24.3

*** Rig 4:** design used for the cod IBS; Blank cells - not applicable

Rigging & Notes

Rig 1: Starting rig
Rig 2: 1" of upper bridle extension added, bridle endpoint where sweep is connected is 1.3' off seabed
Rig 3 – 5 : No set back, 50 lbs of weight at end of sweepline, sweeps making good contact
Rig 6: 8 floats removed, sweepline end weight removed, at 3 knots sweepline off bottom at endpoint by 12"
Rig 7: 8 floats reattached, delta plate and chain weight added (50 lbs) to end of sweepline and 1' upper bride extension added
Rig 8: Upper bridle extension removed, equivalent of 8 fullscale floats added to headline
Rig 9: 10 extra fullscale floats added (for a total of 18 extra), sweepline slightly raised off bottom
Rig 10: 2 fathom extra warp added to port side, 18 floats removed
Rig 11 – 13: Reduced door spread with standard number of floats (58), same as rigs 3 – 5 but with reduced door spread
Rig 14: Trawl underspread
Rig 15: Trawl overspread with sweepline removed

2.3 SAMPLING DESIGN

Four commercial fishing vessels were contracted as the sampling platforms for the survey. The four vessels visited assigned stations, conducted tows with the standardized gear, and processed catches. To assist in the standardization of the processing of catches and towing protocols, a Chief Scientist Guide was developed during the previous contract specifically for the cod IBS (Appendix C). This guide provided detailed descriptions of all procedures and protocols for scientific staff and crew and included a data field description list.

Figure 1. Sampling Catch

A crew member from the contracted survey vessel Lady Jane samples a catch of cod

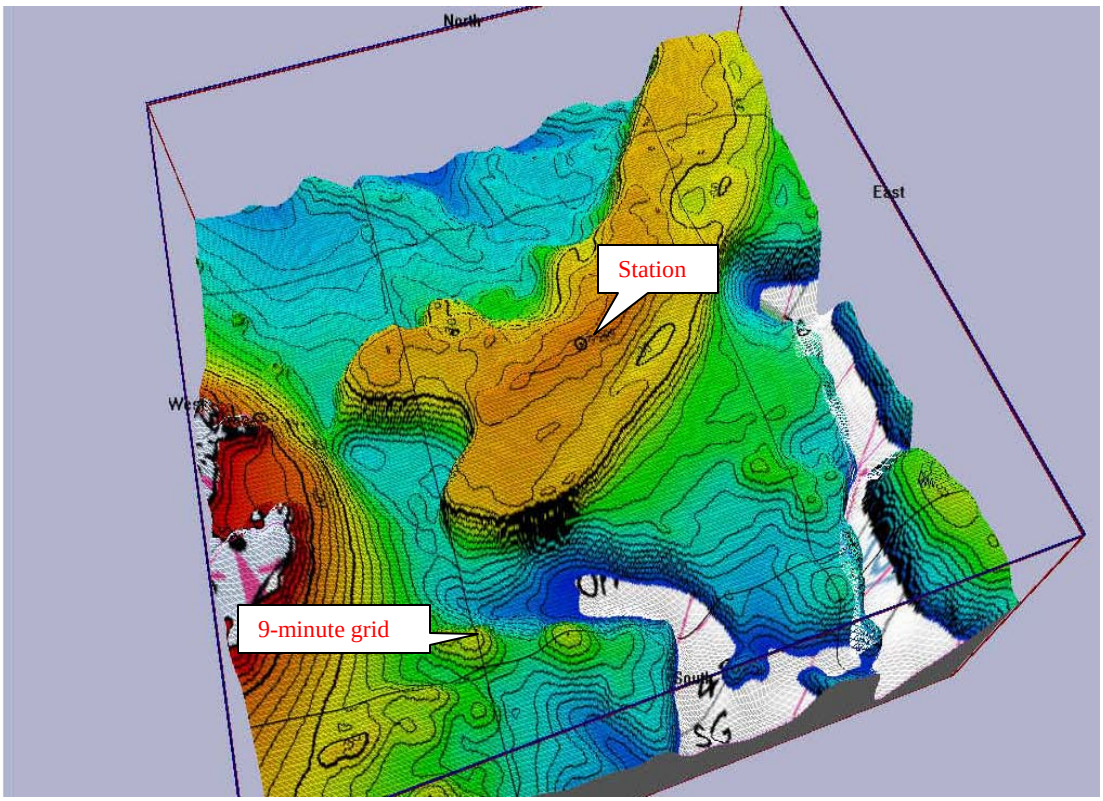
2.3.1 Data Collection

During each survey, data were collected manually and electronically by the scientific staff and vessel crew. Scientific staff recorded date, time, location, depth, weather, sea state, and specific gear characteristics at the start of each tow. During the tow, several parameters were monitored electronically. The bottom temperature data was collected using a StowAway TidbiT temperature logger. To ensure the measured bottom temperature was standardized among all of the vessels, the location of the data logger was consistently placed on the bracket of the port side trawl door.

To collect tow position and track line data, MaxSea Marine Plotting Software was utilized. The MaxSea software, which was installed on a notebook computer, was interfaced with each vessel's GPS device through a USB connection and was programmed to collect depth and position information in real-time. MaxSea is unique and powerful software due to its versatility and ability to display large amounts of detailed information in the survey area. The software also allows scientists to add "layers" of information that include survey strata, station location, historical tow information, wreck/tow hang information, and bathymetry data which are useful to both scientists and fishermen (Figure 2). The information created using this software could be retrieved and stored in tables and/or shared with other vessels participating in the survey.

Two NETMIND™ Trawl Monitoring Systems (net mensuration systems) were shared among the four sampling vessels. The NETMIND™ system collected information regarding net configuration including headrope height, door spread and bottom contact. Typically, each vessel utilized the NETMIND™ system at the start of each cruise to ensure that the nets were operating at the correct geometry. Once correct geometry was established, the systems were rotated throughout the sampling fleet to monitor trawl performance. Nets that became entangled with fixed gear, wrecks, or hard bottom and then retrieved were considered priority for net mensuration and were checked with the system as soon as possible. At the end of each day, all computer-generated data by the NETMIND™ system were downloaded to a laptop, and backed up on a USB memory key.

Figure 2. MaxSea software utilized during the IBS for GOM cod



A screen shot of a MaxSea 3-D image that is utilized during the cod survey. The software provides information such as the 9-minute grid (rectangular box stretched over bathymetry base map), station location (located in the center of the grid), strata boundaries (>10Fm and <75 Fm), and bathymetry.

During the survey only successful tows were sampled. In order to qualify as a successful tow, the following quality criteria had to be met: minimum of 20 minutes tow time, no more than 30% damage to trawl net; no large obstructions in the gear; and the tripper must have remained closed.

Tows were classified as three different quality tows and coded as such on the field log. This was necessary so the end users of the data could differentiate between the different quality tows and incomplete tows. Table 4 is the codes and criteria that were used to qualify each tow. A complete list of all codes used can be found in the Chief Scientist Guide (Appendix C).

Table 4. Haul values and gear condition codes used during the cod IBS.

Haul Value:	**1 =** Good tow. No gear/tow duration problems. **2** = Representative, but some gear/tow duration problems. **3** = Problem tow. May/may not be representative due to gear/tow duration. **4** = Not representative due to gear/tow duration.
Gear Condition:	**1** = No damage to insignificant damage. **2** = Wing twisted or tears in upper or lower wings not exceeding 10 ft; tear in square not exceeding 5 ft; tears not exceeding 3 ft in upper belly, or 6 ft in lower belly; cod-end or liner with tears not exceeding 2 ft; parted idler; liner hanging out of cod-end. **3** = Hung up with no to minor damage. **4** = Parted legs, sweep or head rope; cod-end liner untied; wire out slippage; other gear hung on door. **5** = Tear up exceeding limits for code 2, but not total. **6** = Significant obstruction in trawl, such as fixed gear, rocks, mud, coral, tires, old anchors, timber, etc. Problem with third wire; unmatched doors; strong current. **7** = Crossed doors. Net was not on bottom or did not perform due to currents or other factors. **8** = Open gear. **9** = Hung up with major damage; total tear up, rimrack; loss of all gear; loss of trawl; loss of 1or both doors.

All catch was removed from the net and sorted on deck by species. Spiny dogfish, crabs and American lobster were further sorted by sex. A total weight was recorded for all species using calibrated Marel shipboard 60 kg and Pesola 10 kg spring scales.

Biological sampling was conducted on a list of prioritized species. Atlantic cod biological sampling for all tows entailed recording individual length, individual weight, sex, stomach contents, and maturity stage. Otoliths were also removed and saved for aging.

Individual lengths were collected for other commercially-important species including American lobster, American plaice, Atlantic halibut, Atlantic wolffish, monkfish, Greenland halibut, haddock, pollock, redfish, white hake, winter flounder, witch flounder, and yellowtail flounder.

When catches of one or more species were significantly high for a tow, subsampling strategies were employed. Subsampling was generally used when total sampling of the particular species

was impractical and would impede the schedule. The subsampling guidelines used were developed by the NMFS, Northeast Fisheries Science Center Ecosystems Survey Branch and adapted to the cod IBS. The Chief Scientist Guide details the methodology used during the cod IBS (Appendix C).

2.3.2 Gear Condition

Maintaining the survey net and gear was essential to the integrity of the data and the standardization of the gear throughout the survey. Damaged gear or holes in the net can have a significant impact on the effectiveness of the trawl and therefore it was imperative that the trawl was kept in ideal condition. To accomplish this, the crew inspected the survey equipment after each tow and repaired any damage prior to the next deployment. If damage was severe, and the geometry or stability of the net was compromised, the trawl was removed from the vessel and returned to the net builder for repairs.

2.3.3 Towing Protocol

As recommended by the IBS implementation committee during the developmental stages of the study, the cod IBS utilized a commercial style survey tow rather than the more traditional straight line survey tow. A commercial style tow is simply the style tow that is typically used by the fishermen when on a commercial venture, and is usually influenced by depth, bottom type, substrate type, presence of fish, presence of fixed gear, presence of other fishing vessels, etc. Turns were conducted as gradual as possible during a survey tow to avoid affecting the geometry of the survey trawl. In order to avoid gear conflicts, and to determine how to conduct the tow, protocol required the survey vessels to assess the selected station for fixed gear, depth gradients, bottom roughness, and bottom hardness prior to deploying the gear.

The stations were located in the center of each square of the systematic and stratified grid. The vessels had the flexibility to complete the tow in any direction, but were required to tow as close as possible to the station. If fixed gear was present or if the bottom type prohibited the vessel from completing the tow, the vessel searched for open bottom, as close as possible to the station. The survey tow location was considered valid if two-thirds of it fell inside the station's square (which equals 20 minutes of tow time or approximately 1.0 nm).

Tow speed and duration are variables that are directly associated with catch rates and therefore were standardized. As mentioned above, the standardized survey tow utilized in the cod IBS was 30 minutes in duration with a minimum time requirement of 20 minutes. If the tow could not be completed, and the time duration was less than the required amount, the net was hauled aboard, thoroughly cleaned free of fish and debris, and the tow was attempted again in an area adjacent to the previous tow. The second attempt, or alternate tow, could not overlap or intersect with the previous tow. Tows were required to be completed at a fixed speed of 3.0 knots. To avoid any variables of tide and current, the tow speed was monitored using the vessel's Global Positioning System (GPS) and not the vessel's speedometer. Tow start time began when the winch stopped paying out wire and the tow ended when the winch was engaged to retrieve the wire.

The scope of wire set for each tow was standardized at 3:1 and is consistent with the scope ratio typically used by the New England commercial groundfish fishing fleet. Prior to deploying the net, the vessel's captain was required to estimate the average depth of the tow and then calculate

the amount of scope accordingly. In addition to the pre-tow assessment, digitized raster and vector Bathymetric charts, historical tow information, and local knowledge were resources used by vessel captains to determine the scope of wire. A scope chart was created to guide the vessel captains and chief scientists for the amount of wire to set (Table 5).

Table 5. Standardized scope of wire set for the IBS for GOM cod

Depth (fathoms)	Amount of Wire Set (fathoms)	Amount of Wire Set (meters)
10 – 12.5	25	46
12.6 – 20.8	50	91
20.9 – 29.2	75	137
29.3 – 37.5	100	183
37.6 – 45.8	125	229
45.9 – 54.2	150	274
54.3 – 62.5	175	320
62.6 – 70.8	200	366
70.9 – 79.2	225	411

Scope ratios are consistent with the scope rates used by the New England commercial groundfish fishing industry.

2.4 ADDITIONAL SURVEY COMPONENTS

2.4.1 Data Management

Data from contract 0010 in now in master data format and stored on the WHOI/SUN server in Woods Hole MA. Data for contract 0109 was processed using the exact protocols as the previous contract and is now in master data format and housed on the same server in the same database.

Post-cruise processing included converting the raw data collected at sea into master data files stored in the Oracle survey database (SVDBS) located at the NMFS, Northeast Fisheries Science Center (NEFSC) in Woods Hole, MA. This processing occurred over an 8 - 10 week period following the last day of each cruise. Processing began as raw data logs, biological samples, and computer-generated data files were returned to the *MarineFisheries* office in Gloucester, MA. Selected tow information was initially entered into a local Access database for a preliminary assessment of Atlantic cod catches and station completion rates for each cruise period.

Preliminary audit of the data continued at over a period of 2 - 3 weeks. The preliminary audit entailed reviewing all data logs for accuracy and completeness. Any questions regarding the raw data were resolved by direct interviews with the appropriate chief scientists. All biological samples collected were cross-referenced and logged onto the corresponding detail data logs, and individual species were coded to facilitate the data entry process.

Data entry was conducted by UNICOR / FPI, a contractor assigned for this task by the NEFSC. UNICOR was allowed five weeks for data entry from the date the data logs were submitted to them. Upon completion of the entry process, all data logs were returned to *MarineFisheries* in company with three electronic data files. These files were also submitted directly to the NEFSC for loading into the SVDBS raw data tables.

An audit of the cruise data was conducted using a remote access connection to the NEFSC database, the WHOI/SUN. The audit followed the standardized procedures presented in the SVDBS Auditing Manual version 2.20. Once the audit was complete, the NEFSC loaded the data into the SVDBS master data tables.

The computer-collected bottom temperature data strings, NETMIND™ gear configuration data strings, and vessel survey tow track line files were edited by eliminating data strings erroneously collected between hauls. The bottom temperature data was forwarded to the NEFSC for inclusion in the SVDBS master data table. Remaining files which have yet to be uploaded to the NEFSC database remain on file at *MarineFisheries*.

2.4.2 Sale of Catch / Project income

Instead of wastefully discarding the catch overboard, cod and other commercially valuable species that underwent sampling were sold. Proceeds from the sale of these fish were deposited into the *MarineFisheries* Research and Conservation Trust account, which was created to receive non-federal funds such as those from the sale of the survey catch. During contract 0010, the income generated from the survey was used to pay unexpected expenses, enhance the survey and, if income allowed, extend the survey to include the full spatiotemporal coverage. This use of funds was in accordance with the recommendations of the April 2002 Report, "Recommendations from the IBS Committee convened by NMFS". The April 2002 Report recommended this use of funds to "eliminate any incentive for participants to alter their research practices to increase their catch of fish."

During contract 0109, proceeds from the sale of the catch were used differently. Instead of using the funds towards enhancing or extending the survey, the generated funds were used to pay for the survey expenses. This decreased the amount invoiced to the federal government (NMFS/NCRPP) and resulted in the survey costing less money than what was budgeted for contract 0109. In addition, funds allocated for contract 0109 were less than what was needed for a complete year (5 cruises) of surveying, and the extra funds that were anticipated to be used to finish a fifth cruise, consistent with the use of funds in previous years, were instead used to pay for four cruises and the fifth cruise (which would have been a complete survey) was never done.

The total dollar amount of fish sold during the 06/07 survey was $102,014.43 (Table 6). All fish were sold at local dealers in Gloucester, MA with the one exception to a trip that was landed by the F/V Titan in Portland, ME. The F/V Jocka did not catch many legal sized fish and therefore never sold during the survey. The F/V Lisa Ann II caught and sold the most fish. The reason why the F/V Lisa Ann II had the most landings was due to the area that they surveyed (Ipswich Bay and Jefferies Ledge) and the fact that they had the most stations inside the fixed management area known as the Western Gulf of Maine closure. Because of the frequency of the

catch and the overall average price per pound, Atlantic cod earned $71,677.31 which was 70% of the project income (Table 7).

Table 6. Summary of the value of project income by species.

Species	Weight (lbs)	Avg. Price	Total
Atlantic Cod	36,680	$2.12	$71,677.31
Haddock	8,057	$2.17	$15,934.53
Pollock	11,001	$0.80	$5,754.70
Winter Flounder	1,570	$2.04	$3,144.93
Yellowtail Flounder	915	$2.01	$1,823.49
Redfish	1,573	$0.82	$1,068.64
Wolffish	464	$1.60	$784.95
American Plaice	247	$2.28	$579.64
Monkfish	132	$3.27	$448.27
Witch Flounder	129	$3.00	$383.97
Atlantic Mackerel	400	$0.40	$160.00
White Hake	84	$1.50	$157.42
Mixed Skates	70	$0.53	$43.35
Cusk	31	$1.11	$36.42
Lolligo Squid	84	$0.20	$16.80
Total	**61,437**	**$1.96**	**$102,014.42**

Table 7. Summary of value of project income by vessel.

Date Landed	Jocka	Lisa Ann II	Lady Jane	Titan	Total	Cruise Number	Invoice Number[1]
5/16/2006		$2,483.80	$4,517.40		$7,001.20	2664	1
5/20/2006		$46,639.11	$1,209.49		$47,848.60	2664	1
5/21/2006		$5,104.54			$5,104.54	2664	1
5/24/2006		$4,870.29			$4,870.29	2664	1
5/25/2006			$2,426.80		$2,426.80	2664	1
5/26/2006		$868.64			$868.64	2664	1
11/21/2006			$1,212.82		$1,212.82	2665	7
11/22/2006		$559.10			$559.10	2665	8
11/28/2006		$1,532.36			$1,532.36	2665	8
11/29/2006			$646.91		$646.91	2665	8
11/30/2006		$489.69			$489.69	2665	8
12/6/2006		$3,789.15			$3,789.15	2665	8
12/7/2006			$1,393.27		$1,393.27	2665	8
12/12/2006		$3,577.58			$3,577.58	2665	8
12/12/2006				$747.25	$747.25	2665	8
12/13/2006			$925.69		$925.69	2665	8
12/14/2006		$743.29			$743.29	2665	8
12/18/2006			$779.64		$779.64	2665	9

1/4/2007			$2,369.55		$2,369.55	2761	9
1/6/2007		$534.24			$534.24	2761	9
1/10/2007		$1,184.78			$1,184.78	2761	9
1/12/2007		$377.67			$377.67	2761	9
1/15/2007		$91.71			$91.71	2761	9
1/19/2007		$586.57			$586.57	2761	9
1/23/2007		$5,288.29			$5,288.29	2761	10
1/25/2007		$2,858.23			$2,858.23	2761	10
2/2/2007		$2.24	$177.42		$179.66	2761	10
2/23/2007		$1,457.33			$1,457.33	2762	11
2/27/2007			$939.11		$939.11	2762	11
3/2/2007		$1,346.27			$1,346.27	2762	11
3/22/2007		$284.20			$284.20	2762	11
Total		**$84,669.08**	**$16,598.10**	**$747.25**	**$102,014.43**		

[1]Invoice number is the number invoice that the project income was reported to NCRPP by *MarineFisheries*.

2.4.3 Outreach

Outreach was a key component to the cod IBS. The stakeholders of the survey were identified and divided into three groups: fishermen and industry from the New England groundfish fleet that would have an interest in or could assist the survey; fishermen and industry that would impact the survey and its activities; and the end users of the data (industry representatives/ scientists/managers).

The first group was included during all phases of the implementation of the survey project. Several industry members with non-qualifying vessels participated on the implementation team. Others shared local knowledge of cod "hot spots" or areas of concern during the survey design phase. During the gear development meetings, informative debates guided the selection of gear for the survey, and once on the water part-time fishermen assisted as scientific staff. The contracted net builders and vessels also proved to be valuable in conducting the survey, making sacrifices and vesting countless hours to assure that the survey was successful.

To keep this group informed and involved, several outreach outlets were utilized. Some of the outreach efforts included:

- Advertisements in local papers (Figure 3),
- Several pages dedicated to the survey on *MarineFisheries* website *http://www.mass.gov/dfwele/dmf/programsandprojects/ibsurvey.htm#ib*. Information included program description, maps of survey locations, coordinates, schedules, contact information, survey results, pictures and a short movie demonstrating age structure sampling, and
- Displays at trade shows – Working Waterfront Festival, New Bedford MA, Massachusetts Lobstermen's Association trade show.

Figure 3. Cod IBS sample advertisement

Advertisement was run monthly in the Fisherman's Voice and the Commercial Fisheries News, from October through May while the survey was being conducted.

The second group of stakeholders identified included the fishermen that had an impact on the survey and its activities, mainly fixed gear fishermen. Common with any survey that utilizes mobile gear as its sampling tool, interactions with fixed gear can potentially occur. Usually without intention, fixed gear fishermen set traps or nets in areas that have been randomly or systematically selected to be surveyed. This can cost both the fixed gear fishermen and the survey a considerable amount of inconvenience, time, and money. Most importantly, data quality can be impacted.

To address this potential conflict, an outreach plan was developed during the previous contract for the cod IBS. The plan was the product of a collaborative effort between state scientists and commercial fishermen. The IBS outreach sub-committee, comprised of both scientists and fishermen from Maine, New Hampshire, Massachusetts and Rhode Island, reviewed and approved the plan.

The outreach plan for the IBS of GOM cod included the following elements:

-Mailings

Maine:

Letters sent to representatives of the LZC, LAC, MLA, Downeast Lobstermen's Assoc., Commercial Fisheries News, Fishermen's Call, and Fishermen's Voice.

New Hampshire:

Letters, maps, coordinates, and schedules sent to all fixed gear fishermen. A copy of the letter was supplied to NH F&G for copying, envelop stuffing, and distribution.

- *MarineFisheries* Newsletter

An advertisement for the IBS for GOM cod was placed in *MarineFisheries* quarterly newsletter. This mailing reaches approximately 8,500 individuals that reside in

Massachusetts and throughout the New England region.

- Listserv

A memorandum summarizing the survey including, maps, coordinates, and schedules of the IBS for GOM cod was released on the *MarineFisheries* listserv. This electronic e-mail messaging system is one of the preferred methods for the distribution of immediate releases and emergency information. This distribution list reaches approximately 3,000 individuals that reside in Massachusetts and throughout the New England region.

- Website

A dedicated page on the *MarineFisheries* website was created to provide instant updates. Site includes general cod IBS information as well as maps, coordinates, and schedules. Site address: *http://www.mass.gov/dfwele/dmf/programsandprojects/ibsurvey.htm#ibs*

- VHF Announcements

New Hampshire:
Contracted vessels made general announcements on VHF channel 16 that included dates, location of sampling tows, and vessel contact information 48 hours prior to deployment.

Maine:
The morning of deployment, a general announcement was transmitted on VHF channel 16 for all stations that will be towed in or near the state of Maine territorial waters. The announcement included dates, location of tows that would be attempted to be surveyed, and vessel's contact information.

In addition to the outreach plan review, the IBS outreach sub-committee also developed alternative outreach methods. These methods were described in the minutes from the January 18, 2005 outreach sub-committee meeting (Appendix D).

One method that was implemented was the creation of an informational DVD about the NCRPP and the projects that it funded. Produced by NCRPP and NOAA, the DVD included a segment on the cod IBS that gave a brief overview of the study, its goals, and how it will benefit management of the Gulf of Maine cod stocks. This DVD was distributed to all groundfish stakeholders including industry, state and federal government, and the general public.

In February 2007 *MarineFisheries* presented and participated on a panel at the Maine Fishermen's Forum in Rockland ME. The purpose of the session was to discuss and inform the public about the cooperative research trawl surveys that were currently being conducted as well as how they differed from the federal trawl survey. *MarineFisheries'* gave a presentation that included details on the purpose and goals of the survey, why the survey was needed, a description of the vessels, survey methodology, contact information for both state scientists and vessels, scheduling of the survey, location of the tows, the potential benefit of the survey, a request for their assistance in keeping the survey tows free of fixed gear, what has worked and what were the challenges with cooperative research. Also included in the presentation was an industry perspective by Steve York, the captain of the contracted fishing vessel Jocka.

The third group of stakeholders that were targeted through outreach consisted of end users that would be using the data for research and management. Since this was a new data source, informing the group of the availability and how to retrieve the data through specific requests was important. To do this packets that included information about the survey, species distribution

maps, and length frequency information for ten commercially valuable species were created and distributed to the appropriate scientists.

2.4.4 Training

With the exception to hiring a new field coordinator in February 2007 and a new captain on the Portland-based fishing vessel, the staff and contracted vessels used to implement contract 0109 were virtually the same as those used under contract 0010. No formal training sessions were required prior to conducting the survey. Below is an overview of the training that took place prior to contract 0109.

Staff was trained prior to the initiation of the cod IBS via an in-house sampling design/training meeting held for dedicated program staff and members of the *MarineFisheries* Resource Assessment program. The Resource Assessment program conducts a standardized trawl survey twice a year with the goals to estimate abundance and distribution of estuarine and coastal species found within Massachusetts territorial waters. They utilize the same protocols and procedures used by the NMFS, Northeast Fisheries Science Center Ecosystems Survey Branch and have knowledge of the procedure for completing the survey trawl haul and species detail logs that were used during the cod IBS.

Training for the contracted vessels included one to two days of sea trials held prior to the start of the first leg. The sea trials entailed net calibration exercises while the catches were handled as mock work-up tows. Contracted scientific staff and vessel crew were instructed on proper biological sampling techniques including, but not limited to: species identification, collecting species weights and lengths, subsampling protocols, maturity sampling, and age structure extraction.

Other scientific staff training was provided for the following topics: NMFS logs while in situ, computer equipment, software, data loggers, net mensuration equipment, digital shipboard balances, and other equipment required to conduct the survey.

Captains and scientific staff tested and refined towing protocols and proper gear configurations, while decks and sampling stations were coordinated.

The chief scientists deployed throughout the first cruise of the cod IBS were dedicated program staff and in-house staff. During the first cruise, these individuals trained three contracted scientific staff on the duties of chief scientist. These individuals' responsibilities were later increased and in subsequent surveys they acted as chief scientists. Training material included detailed instructions for completing all survey data logs, techniques for accurate data collection, directions for all computer-generated data collection programs and guides for identification purposes. These identification guides included:

- NEFSC. Guide to Maturity Staging for Atlantic Cod *Gadus morhua.* National Marine Fisheries Service, Northeast Fisheries Science Center, Ecosystems Survey Branch. Woods Hole, MA.

- New Hampshire Sea Grant. 2002. Skates of the Western Gulf of Maine. NSGL#: NHU-H-02-002.

- Robins, C.R., G.C. Ray, J. Douglass and R. Freund. 1986. A Field Guide to Atlantic Coast Fishes (North America). Houghton Mifflin Company. New York. 354 p.

- Tomkiewicz, J., L. Tybjerg, N. Holm, A. Hansen, C. Broberg and E. Hansen. 2002. Manual to determine gonadal maturity of Baltic cod. DFU-rapport 116-02, Charlottenlund: Danish Institute for Fisheries Research. 49 p.

- Williams, A.B. 1974. Marine Flora and Fauna of the Northeastern United States. Crustacea : Decapoda. NOAA Technical Report NMFS 389. 50 p.

2.4.5 Safety Training

Conducting survey work, particularly during the time of year of the IBS for GOM cod, is hazardous work. Although some of the contracted professional observers, scientific staff and fishermen had varying degrees of safety training, a formal training session for the entire project was necessary. During contract 0010, the North East Safety Training Company (NESTC) was contracted to conduct a commercial fishing vessel safety training class. This safety class gave basic instruction in unintentional flooding, fire fighting, man overboard and abandoning ship procedures and was open to all program scientific staff, the contracted fishing vessel crews, and other in-house staff that were projected to participate in the cod IBS.

Figure 4. Safety training

A member of the cod IBS scientific staff igniting a handheld signaling flare during the safety training class, taught by NESTC in Gloucester, MA.

3 PROJECT MANAGEMENT

The cod IBS required a combination of dedicated hired staff, subcontractors, contracted professional fisheries observers, and in-house staff to conduct the survey. In addition, several volunteers and graduate students from local collages and universities assisted. In-house staff also contributed significantly to the implementation the survey. The majority of the support from in-house was donated by *MarineFisheries* and therefore did not impact the cod IBS budget.

3.1 Project Management

A schematic of the pool of staff and support is detailed in Figure 5. A brief description of the duties for the staff that were involved in implementing the IBS for GOM cod are below:

Program Manager: David Pierce, *MarineFisheries* Deputy Director, oversaw general operations, contracts, and budget.

Program Leader: Bill Hoffman, *MarineFisheries* full-time employee, dedicated to the cod IBS. Responsible for management and implementation of the survey including, budget, outreach, survey vessels, survey staff, design, scheduling, and training. Completed permitting, analysis, report writing. Chief Scientist.

Field Coordinator: Daniel Salerno/ Brant McAfee, contracted employee, dedicated to the cod IBS. Data management including editing, auditing, and data queries/requests. Coordinates vessel supplies, conducts biological and safety training, Chief Scientist.

Program income and expenditures: Kevin Creighton (Federal grants and contracts coordinator), Darlene Pari (accounting) *MarineFisheries* full-time staff. Responsible for submitting invoices to NMFS and paying project expenditures.

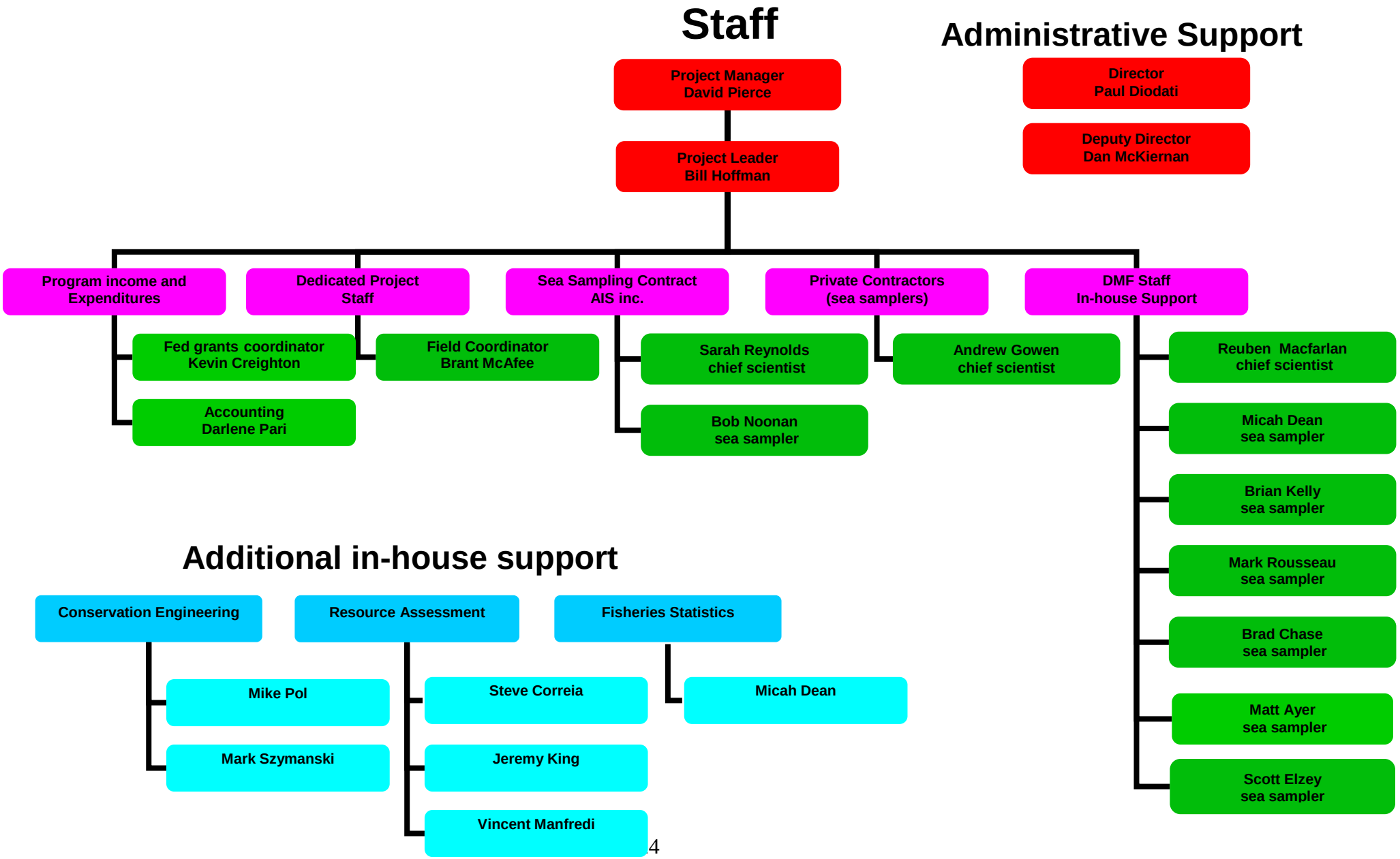
Sea Samplers (contract): AIS inc., AIS is an observer company that also currently holds the federal observer contract. Sarah Reynolds (Chief Scientist) and Robert Noonan (sea sampler/former commercial fisherman), sea sampling support, professional Federal Observer.

Contracted sea samplers (private): Andrew Gowen (Chief Scientist) privately contracted personnel, sea sampling support. Both have experience with cooperative research.

Data Analysis: Steven Correia/Micah Dean, *MarineFisheries* Aquatic Biologist III / Policy Management & Regulations. Assisted and provided guidance for survey design, sampling design, and data analysis.

DMF staff: Pool of in-house staff that assisted in the field with sea sampling and chief scientist support *MarineFisheries*.

Figure 5. Project management for the IBS for GOM cod



Additional in-house support: Several *MarineFisheries* projects and personnel were drawn upon to assist with the implementation of the cod IBS. In particular, the Conservation Engineering program for net development, calibration, and underwater videography; Statistics program for data analysis, database support, GIS mapping, survey design; and the Resource Assessment program for survey design, sampling design, and sea sampling/chief scientist support.

Commercial fishing industry participation: The four commercial fishing vessels that were selected to serve as the cod IBS sampling platforms were: F/V Jocka, F/V Titan, F/V Lisa Ann, and the F/V Lady Jane (Table 8). Reidar's Manufacturing Inc, Fairhaven MA, was contracted as the survey's net builder. In addition to building and providing the survey nets and gear, they also provided support throughout the survey. This support included maintaining the gear and nets (throughout the survey period, if major damage occurred Reidar's would repair nets. At the end of each survey, they would meticulously inspect each net to ensure top condition and standardization for the next year's survey), transporting nets and gear, and providing assistance with preparing the contracted vessels for survey work. The commercial fishermen that worked on a volunteer basis and provided local knowledge of vessels, gear, nets, and times and locations of local aggregations of GOM cod are too numerous to list.

Table 8. Contracted fishing vessels

Vessel	Homeport	Doc #	L.O.A.[1]	Owner	Captain
Jocka	Cundy's Harbor, ME	939745	67	Terry Alexander	Terry Alexander
Lisa Ann II	Newburyport, MA	1139403	58	Jim Ford	Jim Ford
Titan	Portland, ME	1051164	66	Michael Love	Russell DesJardins
Lady Jane	Gloucester, MA	608078	76	Russell Sherman	Russell Sherman

[1] L.O.A- length over all

4 FINDINGS

The first cod IBS cruise under contract 0109 began on May 13, 2006 and the final cruise finished on March 17, 2007. During that time four complete cruises were successfully conducted. All data are now in master data format and available to scientists and managers.

4.1 RESULTS

Biological, oceanographic, and meteorological information were collected in all of the cruises, entered in logs and computers, edited, audited and are now available for analysis on the WHOI/SUN database. Detailed spatiotemporal information by length and weight was collected for GOM Atlantic cod, as well as for several other species of interest. Biological sampling was expanded for cod to include maturity, age structures, individual weights, and food habits.

4.1.1 Species Caught

Total weight and number of species caught by cruise are provided in Table 9. The protocol for working up catches included weighing all species caught and measuring all commercially sought after species, but not all species that were caught by the trawl. If catches were too large to fully sample, catches were sub sampled according to the protocols described in Appendix C. As a general rule, catches were never estimated and only sub sampled if size of catch or time limitations required doing so. The exception to this rule was an estimation of a large catch of Spiny Dogfish that could not be hauled aboard due to the size of the catch. In this case, the amount of catch was estimated and then a sub sample was obtained to calculate sex ratios for sex/weight estimates.

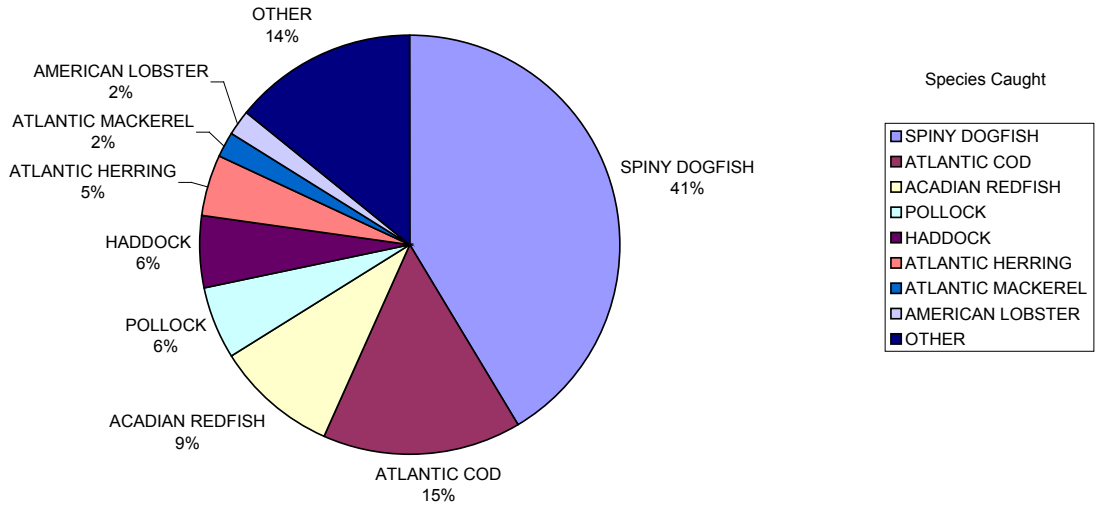
The top three species caught during the survey were Spiny Dogfish, Atlantic Cod, and Acadian Redfish. Spiny Dogfish are a migratory species and are most prevalent throughout the survey during the fall and are virtually absent during the winter months. During the fall November/December cruise, 73% of all the Spiny Dogfish landings were caught. This pattern in spatial temporal availability is a trend that is similar for all years that the cod IBS has been conducted.

Table 9. Total weight and number of species (where applicable) caught by the cod IBS by cruise.

Species Name	Cruise 2664		Cruise 2665		Cruise 2761		Cruise 2762		TOTAL	
	Weight	Number	Weight	Number	Weight	Number	Weight	Number	Weight	Number
ACADIAN REDFISH	6,185.9	45,112	5,832.3	42,077	3,561.1	23,399	5,011.5	32,722	20,590.8	143,310
ALEWIFE	942.7	0	1,985.4	0	478.4		262.2	0	3,668.7	0
AMERICAN LOBSTER	1,240.5	2,811	1,204.7	2,447	985.5	2,378	627.9	1,712	4,058.6	9,348
AMERICAN PLAICE	1,599.2	10,189	1,095.9	8,241	497.8	3,868	370.6	2,910	3,563.5	25,208
AMERICAN SHAD	35.9	0	258.4	0	194.4		9.6	0	498.3	0
ATLANTIC COD	19,309.6	8,280	6,790.6	7,070	4,704.7	6,563	2,345.1	4,928	33,150.0	26,841
ATLANTIC HALIBUT	205.3	65	44.7	25	136.1	71	57.1	55	443.2	216
ATLANTIC HERRING	1,650.5	0	4,705.2	1	2,055.8		2,290.7	0	10,702.2	1
ATLANTIC MACKEREL	97.0	0	1,815.8	0	1,422.8	1	1,040.4	0	4,376.0	1
ATLANTIC MENHADEN	4.3	0	0.0	0	0.0	0	0.8	0	5.1	0
ATLANTIC ROCK CRAB	7.3	0	6.9	0	4.7	1	1.7	0	20.6	1
ATLANTIC WOLFFISH	290.1	52	32.3	8	10.6	3	32.6	7	365.6	70
BARNDOOR SKATE	1.3	0	13.0	0	0.8	0	0.0	0	15.1	0
BLACK SEA BASS	2.1	0	1.8	0	0.5	2	0.0	0	4.4	2
BLUEBACK HERRING	4.6	0	50.8	2	27.0		33.2	0	115.6	2
BOREAL ASTERIAS	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
BUCKLER DORY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
BUTTERFISH	0.6	0	179.4	0	18.7	1	1.8	0	200.5	1
CUNNER	24.8	0	30.4	1	24.9		5.9	0	86.0	1
CUSK	27.7	23	67.3	7	25.0	18	18.2	12	138.2	60
FOURBEARD ROCKLING	0.9	0	2.2	4	0.6	0	5.4	0	9.1	4
FOURSPOT FLOUNDER	26.8	0	55.8	51	34.5	3	15.6	0	132.7	54
GOOSEFISH	255.4	235	298.4	215	100.3	134	28.5	85	682.6	669
GREENLAND HALIBUT	27.0	0	1.9	4	2.5	10	5.2	8	36.6	22
HADDOCK	4,690.7	4,272	3,076.5	4,218	2,547.0	3,074	1,732.6	2,463	12,046.8	14,027
JONAH CRAB	25.3	0	14.1	12	12.3	4	16.7	0	68.4	16
LITTLE SKATE	87.0	0	244.1	0	290.9		162.5	0	784.5	0
LOLLIGO SQUID	0.6	0	76.6	0	0.0	0	0.0	0	77.2	0
LONGFIN SQUID	16.8	0	301.7	4	79.2		14.0	0	411.7	4
LONGHORN SCULPIN	614.4	0	898.9	1	606.6	17	937.3	0	3,057.2	18
LUMPFISH	83.3	0	24.0	2	85.3	3	77.0	0	269.6	5
NORTHERN MOONSNAIL	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
NORTHERN SAND LANCE	0.4	0	0.0	0	3.0		0.0	0	3.4	0
NORTHERN SEAROBIN	0.8	0	1.4	0	0.0	0	0.1	0	2.3	0
NORTHERN SHRIMP	629.1	0	424.2	0	357.0		511.8	0	1,922.1	0
NORTHERN STONE CRAB	1.9	0	1.9	0	0.9		1.9	0	6.6	0
OCEAN POUT	682.0	0	70.9	5	123.2	9	63.2	0	939.3	14
OCEAN QUAHOG	0.1	0	0.0	0	0.0	0	0.0	0	0.1	0
OCTOPUS UNCLASSIFIED	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
POLLOCK	1,594.3	1,950	5,209.2	2,002	3,062.1	2,242	2,223.1	4,552	12,088.7	10,746
RAINBOW SMELT	0.1	0	4.2	110	13.3	9	12.4	0	30.0	119
RED HAKE	266.0	0	748.1	0	274.4		39.5	0	1,328.0	0
SCUP	1.3	0	4.5	27	3.6	9	0.2	0	9.6	36
SEA LAMPREY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0

SEA RAVEN	316.9	0	162.8	3	170.6	2	209.4	0	859.7	5
SEA SCALLOP	13.0	0	7.2	3	16.0	2	6.8	0	43.0	5
SHORTHORN SCULPIN	0.3	0	0.0	0	4.8		5.6	0	10.7	0
SILVER HAKE	180.7	0	520.2	0	260.0		128.8	0	1,089.7	0
SMOOTH SKATE	30.3	0	19.0	2	16.7		3.5	0	69.5	2
SNAKEBLENNY	0.2	0	0.1	0	0.0	0	0.0	0	0.3	0
SNOW CRAB	1.3	0	0.8	1	0.2	0	5.6	0	7.9	1
SPIDER CRAB UNCL	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
SPINY DOGFISH	3,679.9	0	65,500.5	14,431	20,686.8	2,959	356.3	0	90,223.5	17,390
STRIPED ANCHOVY	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
STRIPED BASS	78.6	17	0.0	0	0.0	0	0.0	0	78.6	17
SUMMER FLOUNDER	2.0	3	4.1	4	2.9	4	4.8	3	13.8	14
TAUTOG	1.7	0	0.0	0	0.0	0	0.0	0	1.7	0
THORNY SKATE	255.3	0	392.0	4	195.6		136.9	0	979.8	4
WHITE HAKE	67.4	409	295.1	892	128.0	702	25.4	226	515.9	2,229
WINDOWPANE	10.4	104	62.3	345	58.3	401	61.7	473	192.7	1,323
WINTER FLOUNDER	998.8	3,604	1,260.8	4,138	802.5	2,916	433.9	1,355	3,496.0	12,013
WINTER SKATE	115.0	0	900.9	2	334.1		131.3	0	1,481.3	2
WITCH FLOUNDER	145.7	595	185.2	1,289	66.4	591	36.3	289	433.6	2,764
WRYMOUTH	1.9	0	1.2	0	0.4	1	3.0	0	6.5	1
YELLOWTAIL FLOUNDER	522.5	1,477	731.3	2,704	911.3	3,821	480.5	2,127	2,645.6	10,129

Figure 6. Summary of species caught during the cod IBS May-April 2006/2007



4.1.2 Cod Spatiotemporal Distribution and Rolling Closures

The April 2002 Report identified that this study was needed to "obtain more detailed information about cod than is currently available from the existing surveys and help refine the description of future closures in space and time." However, note that the cod IBS was not specifically designed to study the rolling closures, and therefore it cannot be used for evaluating the "effectiveness" of closures in reducing mortality or to estimate the relative contribution of the rolling closures toward reducing GOM cod mortality, compared to other management measures. The rolling closures are only one component of a multi-faceted management plan and are used in conjunction with other management regulations (Days at Sea (DAS), trip limits, mesh-size, etc.), to achieve a goal of a targeted mortality rate.

For the purposes of this report, and to demonstrate the utility of the cod data compiled, analysis to display the spatiotemporal distribution of GOM cod by weight, number, juvenile fish, mature fish, spawning biomass, and pre-spawning biomass was performed. This analysis is the same that was performed and presented to the groundfish Plan Development Team (PDT) in August 2005. For analysis purposes, the cod IBS data were post stratified into a 30-minute strata comprised of six stratums. Each stratum was delimited using the same 30-minute lines of latitude that are used for the north and south boundaries of the rolling closures. These findings and a map of the 30-minute strata were updated and are attached in Appendix E.

4.1.3 Length Frequency Tables

The length compositions for several important species are shown in figures in Appendix F. These figures have both mean numbers per tow at length and mean number at length as a proportion of total number by strata and cruise for the 2003/2004, 2004/2005, and 2006/2007 surveys. Length distributions of different post-stratified strata can be examined by reading across rows. Temporal changes in length distribution within strata can be examined by reading down columns. Each figure includes a series of length frequency graphs that show average number at length throughout the entire survey period by post-stratified 30-minute strata. This type of analysis is unique because its format illustrates the general trends in distribution, stock demographics, and the co-occurrence of cod with other species.

4.1.4 Spatial-Temporal Distribution of Species

The distributions of catch per tow for cod, haddock, pollock, redfish, winter flounder, yellowtail flounder, American plaice, witch flounder, windowpane flounder, halibut, white hake, monkfish, American lobster, and rainbow smelt are shown in Appendix G. These data are equally as detailed and comprehensive as the cod data. Included in this appendix are ARC/GIS produced distribution maps of kilograms (Kg) per 30-minute tow. Also included are percent length frequencies, average number at length (where applicable), the average number at length as a percentage of total number, and a length frequency overview by species per cruise and strata.

Figure 7. Biological sampling

Scientific staff and crew collecting data from a survey catch

4.1.5 Cruise Completion Rates

Completion rates varied from area to area within the cod IBS strata. During the 2006/2007 survey, vessel completion rates ranged from 44% to 96%. Combined for all cruises the average completion rate was 77% (Table 10). Cruise number 1 (cruise code 2761), completed in January and February 2007, had an average completion rate of 44%, which was the lowest of all of the surveys. The reason for the low completion rate was twofold. First, typical for that time of the year, extreme weather plagued the northeast portion of the strata. This limited the contracted vessel to short windows of safe conditions, which did not allow the contracted vessel adequate time to venture offshore, survey areas and complete assigned stations. Second, a late lobster shed occurred in 2006 which resulted in an excessive amount of fixed lobster gear that obstructed potential lobster tows. During previous cod surveys, fall has been the most active time of year for the lobster industry, and fixed gear has consistently presented a major obstacle for the survey vessels. To add to the problem, the water off the Maine coast are limited by the amount of towable bottom due to hard and irregular bottom and depths outside the survey strata.

Table 10. Station completion rates.

		Downeast – Mid Coast ME	Mid Coast - Southern ME & Offshore	Southern Maine – Cape Ann MA	Cape Ann – Cape Cod MA	Total
2006/2007	**Cruise 2664 Apr – May**	34/58 (58%)	40/57 (70%)	47/54 (87%)	54/56 (96%)	175/225 (78%)
	Cruise 2665 Nov – Dec	31/57 (54%)	47/57 (82%)	46/55 (84%)	53/56 (95%)	177/225 (78%)
	Cruise 2761 Jan – Feb	25/56 (44%)	42/57 (74%)	60/67 (90%)	40/45 (89%)	1167/225 (74%)
	Cruise 2762 Feb – Mar	31/57 (54%)	47/57 (82%)	46/55 (84%)	53/56 (95%)	177/225 (79%)
	Totals for 06/07	***121/228 (53%)***	***176/228 (77%)***	***199/231 (86%)***	***200/213 (94%)***	***696/900 (77%)***

Station completion rates (# completed vs. # assigned) by region and cruise for the 2003/2004 and 2004/2005 surveys.

4.1.6 Comparison of Industry and Grid Tows

Although detailed analysis was outside the scope of work for contract 0109, a preliminary analysis was done for the comparison of catch rates of the industry selected stratified random grid stations verses the systematic grid stations. The purpose of the analysis was twofold. First, it can provide provided an example of future analysis that could be done if funding was made available. Secondly, it was preformed to give insight to the question that was asked during the 2006 technical peer review (see section 5.3): "is there a difference between the two types of stations?" Results for this analysis are located in Appendix H.

Catches in weight (kg) for industry and grid stations are summarized in Tables 11-13 and Figure 1 of Appendix H. The distributions of industry tows and grid tows are both highly skewed and are similar in range. The lower half of the data distributions are very similar, with only a slight increase (2-4 kgs) for industry stations compared to the grid stations (Table 12) in central location as measured by the median, trimeans, and trimmed means. A Wilcoxon rank sum test found no significant difference in location between the industry and grid stations (P=0.14).

Measures of spread are also similar for the two station types. The largest difference found is in the inter-quartile range, which is wider for the industry stations (42.7), than for the grid stations (28.6) (Table 13). This is largely driven by the 75th quantile for industry stations, which is about 14 kg higher than the 75th quantile for grid stations. The middle 75th range of the data (12.5th - 87.5th quantiles) is similar for both station types. The distribution and range of the outliers

(defined here as values greater than 75th quantile +1.5 inter-quartile range) are similar for both industry and grid tows.

Comparisons of the distributions of catch weight, catch in number of cod =>40 cm and catch in number of cod < 40 cm by year and strata are shown in Figures 2 through 6 in Appendix H. Differences between the stations types appear to be small relative to other factors such as strata and month.

Table 11. Comparison of summary statistics for catch weight for grid and industry tows

Station type	Number of tows	Minimum	12.5th quantile	25th quantile	Median	75th quantile	87.5th quantile	Maximum
Grid	880	0.1	1.8	3.4	9.9	32.0	82.2	12,060
Industry	642	0.1	1.6	3.5	12.2	46.2	85.2	6,804

Table 12. Comparison of various measurements of location

Station type	median	trimean	Trimmed mean (0.10 trimmed)	Arithmetic Mean
Grid	9.9	13.8	19.0	74.5
Industry	12.2	18.5	23.1	71.7

Table 13. Comparison of various measurements of spread

Station type	Range	Inter-quartile range	Middle 75% range	MAD	Standard deviation	CV
Grid	12,059.9	28.6	80.4	11.9	482.6	648.2
Industry	6,803.9	42.7	83.6	15.6	380.4	530.8

4.1.7 Net Mensuration Analysis

Using data collected with the NETMIND^{TM} Trawl Monitoring System, a net mensuration analysis was performed. The purpose of the analysis was to make inter-vessel comparisons to determine if the gear configuration and its performance was the same on all vessels at various depths. Because an in-depth analysis was outside the scope of the contract, a full complement of data that was necessary for the analysis was not available, and therefore results are preliminary in nature. It is recommended that if funding becomes available in the future the results from this analysis be used as a model for future analysis as well as be used to identify possible additional data elements that could be collected during future surveys.

The NETMIND^{TM} system records measurements, in real time, of the net and trawl doors geometry. Data elements that were used for this analysis included start and end depth (recorded off of the vessel's sounder), headrope height, and door spread. All headrope sensors were placed on the center line of the headrope, while all door sensors were shackled in the same location on the front of the trawl doors.

As described in section 2.2.4, the vessels rotated two net mensuration systems throughout the sampling fleet during the survey. Data was recorded during typical survey tows when time and conditions allowed. On occasion loss or malfunction of the equipment prohibited the collection of the data and therefore not all tows were recorded.. In general, net mensuration data contain a great deal of erroneous readings. Prior to analysis, all unrealistic values were censored from the data.

The distribution of depth fished by each vessel varied among the vessels. The majority of tows for the fishing vessel Lady Jane tended to be less than 75 meters, while the majority of tows for the fishing vessel Titan and Jocka were greater than 75 meters (Appendix I. Figure 1.). This difference in depth was attributed to the bathymetry of the locations that the vessels were assigned. The Lady Jane had stations in Massachusetts Bay and Cape Cod Bay which tend to encompass shallower depths, while the vessels that surveyed off of the Maine coast were exposed to underwater ledges and drop offs that quickly increase in depth once leaving the shore. This lack of balance of depth distribution among vessels complicated the analysis because it prevented the survey from obtaining an adequate number of data points for these vessels at all depths.

Also complicating the analysis was the methodology used to collect depth information. Depth was only collected at the start and end of the survey tow. Because the survey uses commercial style tows that tend to extend over different depths within one tow, the average depth used for this analysis may not be representative of the actual depth that was surveyed. *MarineFisheries* did work to resolve this flaw. During cruise number 2762, 12 Star-Oddi Data Storage Tags (DST) were loaned from *MarineFisheries* and deployed. These tags were capable of recording depth and time of measurement at a pre-programmed interval. By using these tags, an accurate depth could be synched with net mensuration data giving the true geometry of the trawl at depth. Unfortunately, due to fiscal constraints under this contract, the survey stopped earlier than anticipated and this work (which was not a deliverable of the contract) was not finished.

Common for all vessels, the average door spread at depth increased as depth increased (Appendix I. Figure 2.). This is typical in all trawling as it is directly related to scope and the amount of wire that is available. The more wire set out the further the doors can spread the gear. Door spread did tend to have more variance at depth (Appendix I. Figure 3.). Door spread on the Lisa Ann II showed to be slightly greater in shallower depths, but because an insufficient amount of data was collected on all of the vessels, this data were not conclusive.

An average headrope height during the survey was typically 4.4 meters. On all vessels headrope height decreased at depth. A variance in the headrope was observed on the Lady Jane in shoal water, however, after further investigations this variance was contributed to the depth data set rather than a significant difference in the vessel (Appendix I. Figure 4).

4.2 SURVEY PROBLEMS

Several unforeseeable obstacles were encountered during all years of the cod IBS, including the 2006/2007 cruises completed under contract 0109. Although cooperative research is not a new concept, using multiple commercial fishing vessels as sampling platforms in a standardized survey in the GOM is. The development and implementation of the survey was a unique collaborative effort that included New England state and federal scientists, managers, and commercial fishermen working together to produce a cod survey. Some of the problems encountered during the first two years of the cod survey are detailed below.

4.2.1 Fixed gear

As mentioned above, the presence of fixed gear was the most significant problem that the survey encountered. Despite numerous outreach attempts, the removal of fixed gear from the areas to be surveyed was not significantly successful. Comparing the completion rates to the 2003/2004 and 2004/2005 , which were 74% and 76% respectively, to the 2006/2007 completion rate there was no significant improvement. Within the survey season, rates did improve from fall to spring, but this was attributed to the differences in fishing effort, rather than a response to cod IBS outreach. The areas of the survey that were impacted the greatest were from the ME / NH border east to the Canadian / ME border.

The most successful method to obtain stations free of fixed gear was by working tow-by-tow and one-on-one with fishermen. However, given that the strata covered such a large area, hundreds of fixed gear fishermen needed to be contacted, and it was logistically impossible to do so. Therefore, the areas with the highest concentrations of fixed gear (e.g., Mohegan island, southern Maine, and Massachusetts Bay) were the primary areas of focus for one-on-one contact.

4.2.2 Federal Contract Scheduling

Conducting the survey is a major undertaking and commitment for both the primary contracted state agency, and the sub-contracted survey vessels. In order to be successful in achieving the targets for each cruise and the overall goals of the survey, the vessels are required to be fully committed to the survey and have flexible schedules during the times of the year that the survey is conducted. To do this, the vessels must know well in advance (usually in the beginning of the groundfish management fishing year, May 1st) of their required commitment for the following survey period beginning in November.

During the contract period, information about contract extensions and /or new contracts, or lack there of, was given ‘last minute’, causing serious scheduling problems for the fishermen. Not being able to plan the fishing year in advance can cost the vessels a considerable amount of money and this potential loss results from how they are managed. Because they are given a set amount of days that they are allowed to fish (Days at Sea (DAS)), they must plan in advance how they are going to use their DAS so to ensure that they have a steady source of income year round, as well as how to maximize their return. Also, because the amount of DAS is limited, the vessels often require additional income through participation in other fisheries (i.e. lolligo, silver hake, sea scallop, etc.) or alternative cooperative research projects. Not knowing in advance the

required commitment to the study can complicate this necessary planning or prevent them from meeting cooperative research application deadlines.

The processing time to award the new contract was unfortunately overdue. Granted that *MarineFisheries* was merely a contracted organization that was hired to implement a project for NOAA/NMFS, they still had a vested interest and wanted to ensure that the study was completed to the best of its ability and it accomplished the studies original goals. Because contract 0109 was not awarded until 5/12/06, a data gap was created between the end date of contract 0010 and the start of 0109. This included 3 cruises that would have sampled inside the March April, and May rolling management areas known as the "rolling closures". This unfortunate gap breaks up the continuity the data and increases the difficulty in analysis. It also decreases its utility to be used to evaluate current management practices.

Uncertainty of the future of the project and confusion with the project's end dates complicated the management of the project as well. This impacted *MarineFisheries* ability to effectively manage the program and the ability of the vessels to properly plan, costing them funds.

4.3 ADDITIONAL WORK NEEDED

The cod survey is a pilot program and remains "work in progress". This study has enormous potential and if developed into a long-term study, managers, scientists, and fishermen would be anticipated to benefit from the data collected during the survey. Some of the potential additional work that could be undertaken is discussed below, while some recommended survey improvements are described in section 5.4.

4.3.1 Food Habits for GOM Cod

Collection for prey composition and energetic information was initiated the final cruise of the 05/06 survey and continued in 2006/2007. Because the collection of stomachs could provide a good basis for future studies, sampling was continued. At this time, it is not known exactly how many stomachs have been collected, but it is estimated that over 500 samples are available. If funding is available, the stomachs have been preserved and could be analyzed by *MarineFishieries* staff Although this process was not included in the original scope of work, this task was incorporated into the samplers' workload and did not compromise daily station completion rates.

4.3.2 Individual Weights for GOM cod

Measuring individual weights (whole and eviscerated) for the development of a length-weight relationship and condition factor for Atlantic cod was continued during contract 0109. Although preliminary, the work could be expanded upon.

4.3.3 Increase Resolution in Areas of Abundance

The cod IBS was designed to measure spatial/temporal changes in cod distribution in the inshore waters of the GOM. However, the survey does not have sufficient stations to characterize cod in

some localized areas of high abundance. Enhancement of resolution in these areas during times of historic abundance would facilitate comparing these areas throughout the strata.

4.3.4 Habitat Information

As mentioned in the final report for contract 0010, having the ability to correlate catch rates to habitat type and unique physical features is valuable information for both fishery scientists and managers. An advanced seabed classification system is capable of collecting this information. Once initiated, the system is capable of electronically collecting data in the background while survey tows are conducted. The unit is interfaced with the vessel's sounder (if compatible) and a personal computer (PC) that is capable of quantifying substrate and bottom type. The system uses Roxanne technology and analyzes the second echo of the vessels sounder. Each substrate and bottom type is assigned a value that is stored both graphically on plotting software and numerically in a log. These data can be analyzed spatially or in correlation with trawl catch rates throughout the survey area. Preliminary work was done during the 2005 survey and demonstrated one aspect of the survey that could be enhanced. This data collection was continued during the 2006/2007 and is available for analysis.

4.3.5 Fisheries Scientific Computing System

Fisheries Scientific Computing System (FSCS) is a state-of-the-art digital data collection and information management system that can capture all critical data as survey catches are processed (i.e. species identification, catch weight, fish length, fish weight, sex ratio, reproductive maturity, and stomach content data), thereby providing near real-time stock assessment input data. The advantages to using the system in the cod IBS could be the elimination of the need to record information on paper logs which is inefficient, includes transcription errors, and expensive. The system is designed to improve efficiency on deck, data quality, tracking fish sampling protocols, and minimize data processing time. The initial set-up cost is high, but would significantly enhance survey data collection and processing.

During the summer of 2007, *MarineFisheries* staff, including the cod IBS project leader and field coordinator, participated on the Northern Shrimp resource assessment cruise (shrimp cruise). Besides the fact that the project leader acted as the "shrimp biologist" for that leg of the cruise, the purpose was to obtain "hands on" experience using the portable FSCS system. Also on the cruise was NMFS personnel Paul Kostovick, one of the creators and experts of the FSCS. After 6 days working with the system it became apparent that the cod IBS could significantly benefit from the use of the system. It was also noted that significant training in the installation, operation, and troubleshooting of the system would be required for the chief scientists. This training would take several days (including training days in the field) and would have to be incorporated in the cost of the survey. Also, because of the investment in training, it would be important that staff turnover be low. This would require several dedicated cod IBS personnel be hired rather than temporary contracted help. This change would increase the cost of deploying the system and the overall cost of the survey.

4.3.6 Survey Trawl Reference Manual

A survey trawl reference manual is an invaluable tool that could be developed for the cod IBS. Creating a manual would entail survey participants, scientists, and the survey's contracted net

builder to work with subcontracted gear specialists that have extensive knowledge of survey trawls and access to technical equipment. Below is a description of a manual that was supplied from Marine Institute/CSAR, Department of Fisheries and Oceans Canada:

> Collecting data for population abundance surveys in a harsh environment, where the survey tool is away from direct visual observation, is often a difficult task. Added to this task, is the bias and variance that may be attributed to the survey trawl from human, environmental and gear performance issues. Knowing that the survey trawl is constructed in the same manner and out of the same material consistently is essential, thus the calibration and standardization of survey trawls is essential.
>
> A *Survey Trawl Reference Manual* is used by the fisheries scientific community to ensure that from one tow to the next, from year to year the survey trawl that is used for resource stock assessment has not been altered.
>
> A survey trawl reference manual is made up of three sections: a) trawl plans, b) a parts list and c) checklist.
>
> **Trawl Plans**
>
> Trawls plans can be further broken down into four smaller sub sections, 1) trawl profile and rigging, 2) trawl body, 3) footgear and 4) component drawings. Detail drawings are used in each section to elaborate on construction techniques used in trawl manufacture and footgear fabrication.
>
> **Parts List**
>
> A parts list is used to identify each component that is used in the survey trawl and it's rigging through the use of a part number. The parts list provides a means of allowing the research vessel's crew to communicate effectively to the purchasing department, whose knowledge of survey trawls is usually limited. The list will indeed be useful in the procurement of the individual trawl parts.
>
> **Checklist**
>
> A checklist provides a means of ensuring the specifications of the trawl and its rigging are maintained throughout the survey. The checklist fills two valuable functions: it provides the measurer with a systematic guide ensuring nothing is overlooked and that a record of mensuration is kept. It is most useful for the vessel crew in maintaining survey gear standardization.

During the cod IBS fishermen and net builders were heavily relied on to inspect, rig and repair the nets to ensure net standardization. To enhance the ability to standardize the survey trawl nets, the development of a survey trawl reference manual would be beneficial for the cod IBS. This would not only add more credibility to the survey data, but will facilitate scientists, fishermen, and net builders before, during and after the survey.

This recommendation was made in the final report for contract 0010, but funding in contract 0109 did not allow for the creation of the trawl reference manual. Because there is no longer any intent to continue the cod IBS and this study may be “shelved” for many years before it is initiated again, the creation of this document would be invaluable in storing the survey gear configuration so that it could be duplicated in the future.

5 EVALUATION

5.1 OBJECTIVES THAT WERE ATTAINED

To summarize, the primary objective of the survey was to provide information on the seasonal distribution of cod within the GOM within 5 periods (November-December, January-February, Late February-early March, late March-April, and early April-May) and to characterize the length distribution and age structure of GOM cod during these periods, with the latter two objectives as secondary. The first was to provide information on the age/length structure during current rolling closure areas (November, April-May) when fishery-dependent data are unavailable, and the second was to provide information on the seasonal distribution of other groundfish within the GOM and to provide length frequency information where data was sufficient. As evident with the results that were presented in Section 4, the above three objectives were accomplished during the contractual period where funding allowed.

5.2 ADDITIONAL OBJECTIVES THAT WERE ATTAINED

During the IBS Technical meeting on July 19, and 20, 2005, several "secondary objectives" or additional objectives were identified. These objectives were not new to the cod IBS, but more a clarification of the purpose of the survey. Note the distinction between primary, secondary, and additional objectives described in Section 5.1 and objectives listed above. The survey design was based on the primary objectives and the secondary or "additional" objectives were only addressed as resources allowed.

IBS workshop additional objectives:

To collect information or provide data for other purposes including:

- Help in the identification of Habitat Area of Particular Concern (HAPC) for cod,
- To assist in the review of Experimental Fishing Permits (EFP) relative to other research on cod spawning,
- Identification of other species composition (e.g. GOM haddock),
- Provide biological samples for other species at special requests, and
- Provide information regarding marine-protected areas (e.g., Stellwagen Bank Sanctuary).

Although the survey was a single species survey directed towards cod, it took advantage of the opportunity to sample the entire catch collecting information that supported the above additional objectives. The additional objectives have been met and, where it applies, data are in master data within the SVDBS database on the WHOI/SUN server. The objective to provide biological samples for other species at special requests has also been met. Several individuals and organizations have utilized the survey to collect ancillary information and biological samples (Table 14).

Table 14. Ancillary data collection

Institution	Principal Investigator	Sample	Purpose
Boston University	Les Kaufman	tissue samples and fin clips	Stable isotope analysis and DNA and RNA/DNA ratios on Atlantic cod and haddock
NOAA / NEFSC	Paul Nitschke	winter flounder	Fecundity study of Massachusetts / Cape Cod Bay winter flounder
Mass. Div. Of Marine Fisheries	Brad Chase	rainbow smelt	Fecundity study of rainbow smelt
University of New Hampshire	David Berlinsky	cod fin clips	Atlantic cod DNA population study
UNH, SMAST / UMASS, NE Cod Tagging Program, American Littoral Society	Hunt Powell	cod tag recapture information	Migratory patterns of Atlantic cod

5.3 SURVEY MODIFICATIONS AND PROPOSED IMPROVEMENTS

On August 29 – 30, 2006 the cod IBS received a technical peer review in Portsmouth. NH. At the end of the session, a report was written by the review team that included several recommendations for modifications. Although most were outside the scope of this contract these modifications are discussed below. Some of their concerns were already stated in the final report for contract 0010 and were addressed by the IBS technical committee. This report revisits these points to identify areas of possible survey improvements for future surveys. For reference, the technical peer review report is included in Appendix J.

5.3.1 Strata Enhancement

Regarding extending the survey strata, the peer review team stated:

> "some concern to the lack of sampling of cod in water deeper that 75 fathoms may not provide a complete picture of cod distribution particularly during winter months".

During the development of the survey design, industry recommended that the depth be limited to 60 fathoms, thus covering the "inshore" GOM. During the first year of the survey, cod catch rates of adults were low during the winter period within 60 fathoms and adult cod were presumed to be distributed outside the survey sampling area. The survey was revised to sample to 75 fathoms by reallocation of survey tows. It was acknowledged that the survey may not cover the entire range of cod in the GOM during the February cruise. The IBS design subcommittee examined this issue and concluded in a report that was submitted to the IBS technical committee on June 26, 2005 that:

> "The prospect of extending the cod IBS to deeper water was evaluated. The additional number of tows required to increase the depth coverage of the cod IBS was examined. In 2004-2005, approximately 20 grid tows were added and 30 industry tows to increase the depth limit from 60 fathoms to 75 fathoms, but cod IBS cannot go deeper without increased funding or at the cost of industry-selected tow locations. The table below shows the additional number of grid tows by cruise needed to expand the survey to deeper water. The number of additional grid tows is proportional to the area of additional depth strata. The number of expected industry tows is based on the difference between the fixed 225 tows per cruise and the expected number of grid tows. Industry tows are presented as percentage of industry to total tows. Increasing the spatial coverage of the survey to 90 fathoms, while limiting each cruise to 225 total tows, requires reducing the number of industry tows to approximately 19%. The benefit of increasing spatial coverage needs to be evaluated against the cost of reducing industry tows by the design and implementation committees."

Extending the range of the survey beyond 75 fathom would provide more comprehensive coverage of the cod distribution, but would require more funding or a change in the current allocation of stations (less density of samples). If the survey resolution was decreased, the ability to compare data from a consistent survey design across years would be negatively impacted and compromise the high-resolution objective of this survey.

5.3.2 Vessel Calibration, Depletion Tows

Another main finding and conclusion by the 2006 peer review committee stated:

> "It is assumed the efficacy of the four commercial vessels providing data (are) the same; however, inter-vessel comparisons would be desirable."

They were also asked if these data could be useful for determining relative indices of abundance and they stated:

> "Inter-vessel comparisons would be desirable before using data for this purpose. Should funding be limited, side-by-side comparisons between vessels could be performed in an area of high abundance and varied depths in lieu of obtaining samples from a low productive stratum such as in the east where both station completion and cod distribution was low."

Accepting that vessel "comparison" and "calibration" is merely a difference in terminology, and are the same thing, it was presented during the peer review that this area of improvement was evaluated by the IBS design committee during the contract 0010 period. The committee was tasked to evaluate the plausibility of vessel calibration and the need for depletion tows. They reported the following in the June 26, 2005 report:

> "Tasks: a) Evaluate the number of tows necessary for vessel calibration. Identify variables that can be standardized to minimize vessel effects. b) Evaluate the number of necessary for depletion studies. Also consider the limitations of not including calibration or depletions tows."
> "a) All vessels within each IBS survey have similar horsepower and tonnage. Gear mensuration for the cod IBS suggests little difference in net behavior among vessels. Similarly, Alaska surveys use multiple commercial vessels, but focus on standardized protocols rather than calibration. One idea proposed at the workshop was to compare the three cod IBS vessels to one standard vessel rather than all six pair-wise comparisons. Given the main objectives of the IBS (distribution and demographics), the subcommittee considered this issue to be important (e.g., spatial analyses will assume constant sampling efficiencies), but not a priority issue. Therefore, quantitative analyses were not completed for this report.
>
> b) There was general consensus at the workshop that neither calibration nor depletion tows would be cost-effective (i.e., would take away from vessel time for survey tows), but the Workshop requested a cost-benefit analysis. The committee felt that this issue could best be addressed with a review of sample sizes and effectiveness of previously conducted depletion and calibration studies.
>
> The catchability issue is important if the goal is abundance estimation, either relative or absolute; but if our goal is more biological relative to differentiating distributions of cohorts with respect to closure areas, then net mensuration is cost effective. In the absence of depletion or calibration studies, the cod IBS data cannot be used to estimate absolute stock size."

If abundance estimation was to be obtained by using the cod IBS, a vessel calibration study would have to be designed and implemented. This study would have to be separate from the cod IBS and done independently. During the survey season there would not be adequate time to do both. If this study was to be implemented, due to logistics and the number of tows required, it would be very costly.

5.3.3 Temporal Strata/Rolling Closure

As described in the final report for contract 0010, the cod IBS was designed to assist cod management, specifically in characterizing cod within the groundfish rolling closures and therefore some of the primary utilities of the survey were:

- To describe and compare relative abundance of mature and juvenile cod within identified blocks with respect to seasonal closures,
- Provide information on the distribution of cod with respect to seasonal closures, and
- Describe the spatial-temporal distribution and maturity condition of cod within the constraints of the survey design (by 30-minute rolling block for the 03/04 survey and by station after the sampling protocol was improved for the 04/05 survey (Section 5.3.2)).

Unfortunately, the survey had limitations when being used to evaluate the rolling closures because the months of the survey did not directly correspond with the timing of the rolling closures, which have changed since the design of the survey. The rolling closures in the GOM when the survey was designed are shown in Table 15, and rolling closures in effect when the survey was implemented are shown in Table 16.

Table 15. Rolling closures in effect during the design of the survey

Block Number	Months
121-123:	March/April, October/November
124-125:	January (if triggered), February/March/April, October/November
129-133:	April/May
136-138:	May
139-140:	May/June
141-147, 152:	June
Cashes Ledge:	July/August/September/October, November (if triggered)

Table 16. Rolling closures in effect just prior to implementation of the survey

Block Number	Months
121-123:	March/April
124-125:	April/May, October/November
129-131:	April/May
132-133:	April/May/June
136-138:	May/June
139-140:	May/June
141-147, 152:	June
Cashes Ledge:	Year round

Contract 0010 sampled closures occurring in November, January, February, March, April and May and contract 0109 only sampled the closures in November and May. Neither contract sampled the October and June closures and therefore data that could be used for evaluation of the rolling closures are not available for this time period.

Note that fishery independent sampling occurs in October (NEFSC survey, Maine-New Hampshire trawl survey) and June (Maine-New Hampshire trawl survey). Sampling coverage in June does not occur in the southern part of the inshore GOM; however, based on the surveys that cover the remaining portion of the GOM, sufficient information may be able to make inferences on the distribution/demographics of cod in June and October.

As recommended in the final report for contract 0010, to meet the objective of sampling during the June and October rolling closures, a sixth cruise would have to be incorporated into the temporal strata design. This improvement to the strata would allow the survey to cover the full span of the rolling closures (October, November, January, March, April, May, and June). Adding a sixth cruise would accomplish the secondary objective of sampling during the rolling closures without compromising the current sampling intensity or spatiotemporal strata. Comparisons with previous surveys, cruises and areas would allow for an evaluation of all rolling closure areas. The disadvantage of this option would be the financial encumbrance of

adding another cruise to the survey. In Table 17, the temporal strata, number of calendar days, and sea days are shown as an example of a six-cruise survey.

Table 17. Temporal strata and number of sea days for a six-cruise survey

Cruise Number	Start Date	End Date	Calendar Days	Sea Days[1]
1	10/7	11/18	43	44
2	11/19	12/31	43	48
3	1/1	2/12	43	44
4	2/13	3/27	43	40
5	3/28	5/9	43	36
6	5/9	6/21	43	32
		Totals	**258**	**244**

[1]Number of allocated sea days vary to compensate for the amount of daylight available during each cruise.

5.3.4 Additional Analysis

The report generated by the review committee stated:

> "The data presented provide a qualitative spatio-temporal view for a number of parameters: however, further statistical analysis are required to determine if there are significant differences"

The scope of work under contract 0190 did not include analysis. Because *MarineFisheries* had a vested interest in the study some analysis for this report was performed, using in-house resources and using in-house funds. These are submitted in section X.X. If funding became available *MarineFisheries* would be available for statistical analysis to determine if there are significant differences. However this topic was addressed in section X of this report and was also included in the 2006 report.

5.4 DISSEMINATION OF PROJECT RESULTS

As described in detail in Section 2.4.3, an outreach plan was developed for the survey, not only to make commercial fishermen aware of the survey activities, but to provide all interested parties (state and federal managers and scientists, commercial fishing industry, and general public) with results of the survey. Data are available via state and federal websites. Mailings and list-serv e-mails have been sent with details of the survey and information regarding where survey results can be found. Presentations have also been given to regulatory and industry related groups Section 4.1.1.

5.4.1 GIS-Based Website

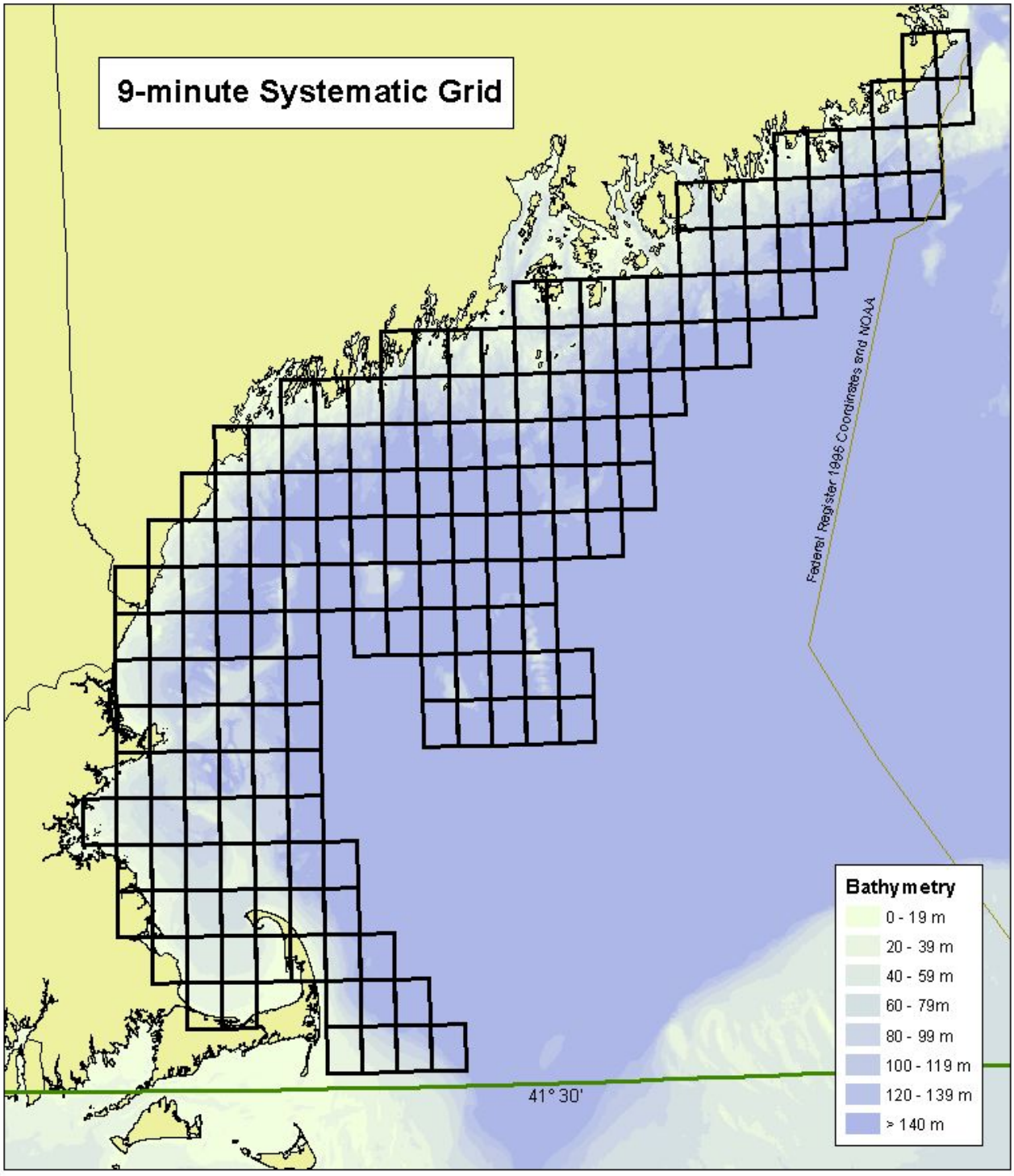
The GIS-based website is a useful tool that was created for the purpose of dissemination of information about the cod IBS and its results. The website was originally developed under a contract held by ME DMR and is now managed by the NOAA/NMFS in Woods Hole, MA. The website was designed to allow fishermen, managers, scientists, and the general public to access specific summary data and create maps for the industry-based surveys. The website provides the

public an opportunity to view and categorize survey data by species composition, length frequency, and location and year of survey tows. Data from 11 cruises (i.e. both the 2003/2004 and 2004/2005 survey and the additional cruise that was completed in the fall of 2005) is in master format and currently available by the website. It is anticipated because the four cruises completed during contract 0109 are in master data format that they will be added to the website and made available to the public. The website can be found at: *http://www.nero.noaa.gov/StateFedOff/coopresearch/*.

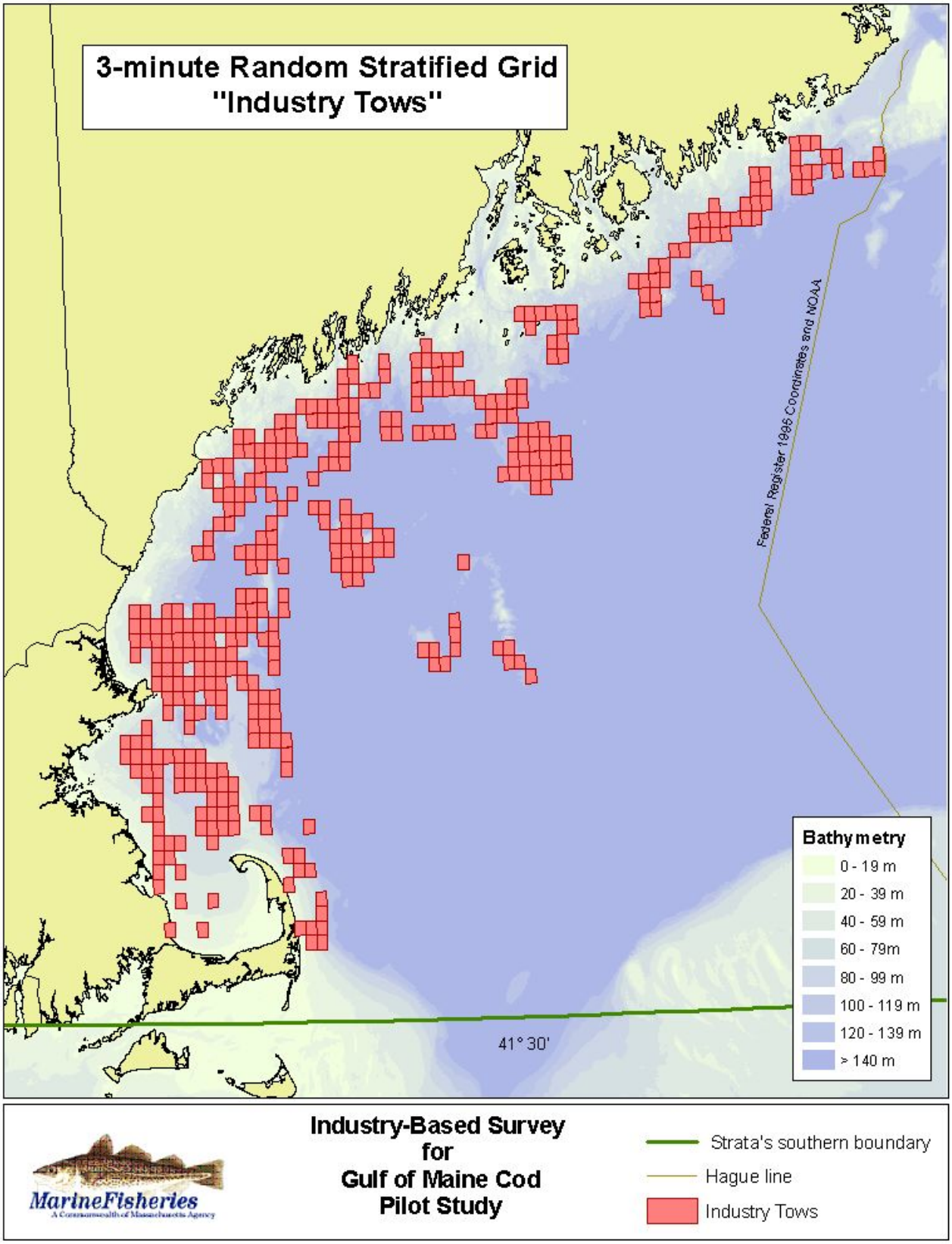
Appendix A

Industry-Based Survey
for
Gulf of Maine Cod
Pilot Study

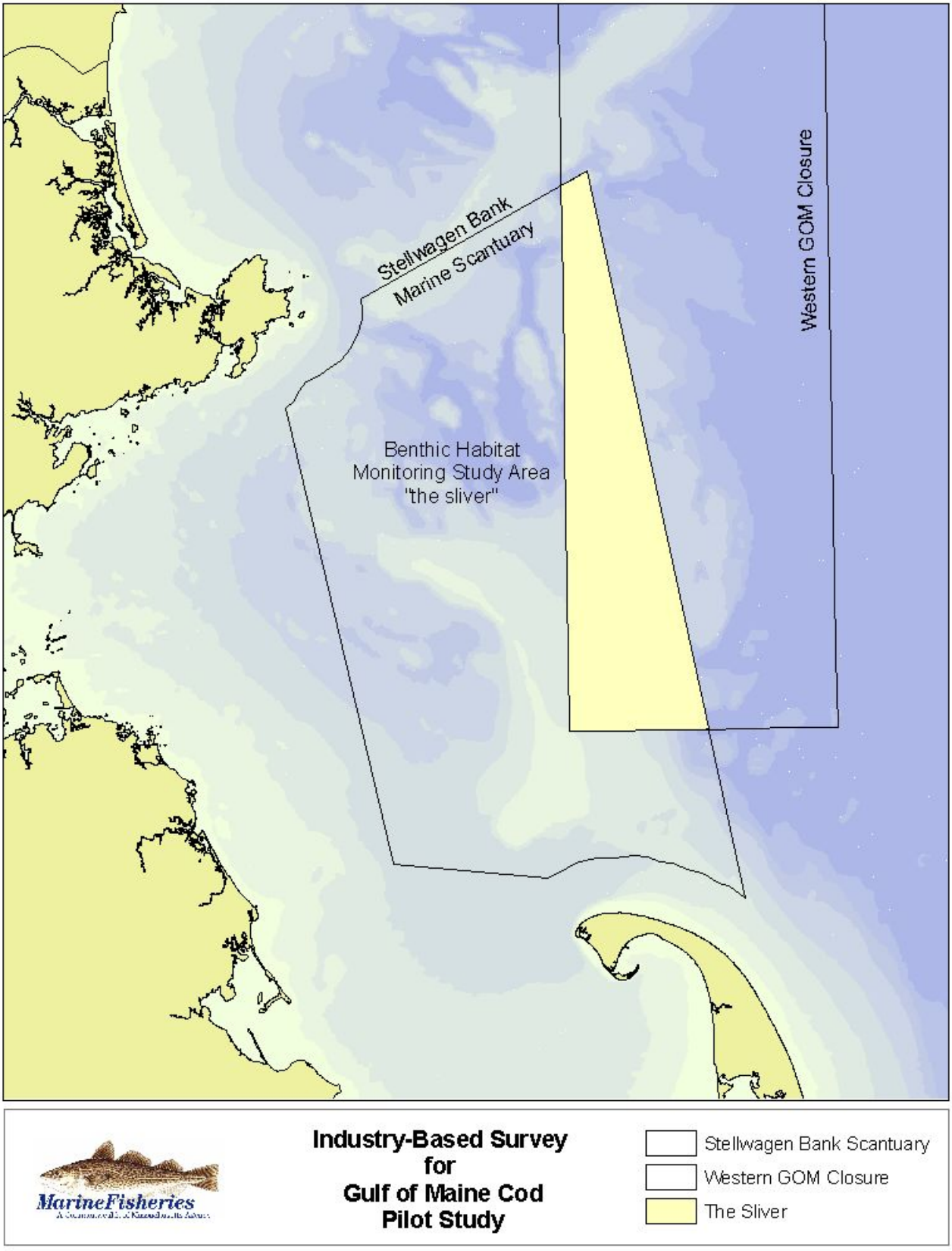
9-minute systematic grid, 3-minute stratified random grid, 3-minute stratified random grid strata, and the area closed due to benthic habitat monitoring study known as “the sliver”


9-minute Systematic Grid
Federal Register 1996 Coordinates and NOAA
41° 30'
Bathymetry
0 - 19 m
20 - 39 m
40 - 59 m
60 - 79m
80 - 99 m
100 - 119 m
120 - 139 m
> 140 m
MarineFisheries
Industry-Based Survey
for
Gulf of Maine Cod
Pilot Study
Strata's southern boundary
Hague line
9-min grid

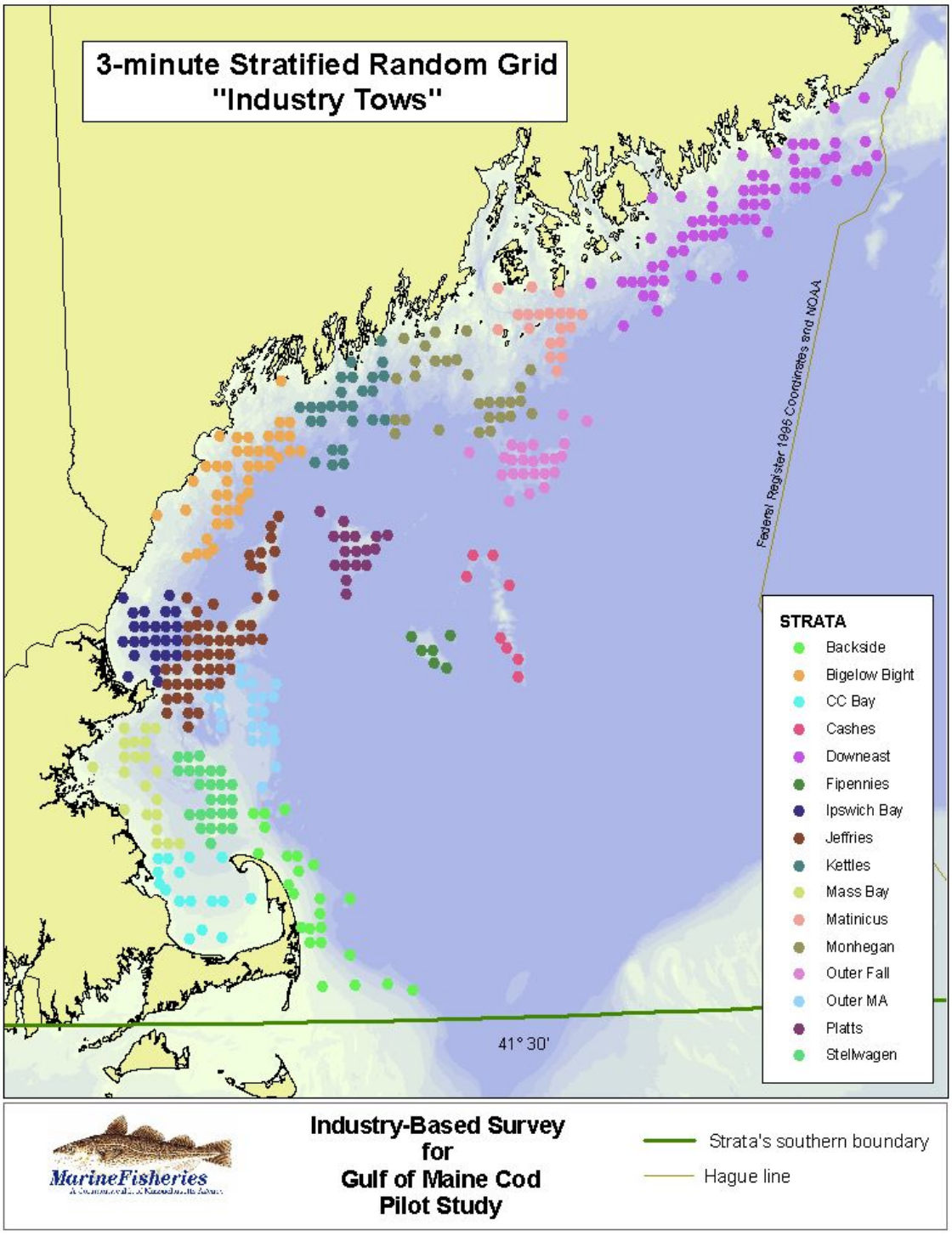
3-minute random stratified grid



Benthic Habitat Monitoring Study Area, “the sliver”



Strata for the selection of industry tows for the IBS for GOM cod



Appendix B

Industry-Based Survey
for
Gulf of Maine Cod
Pilot Study

Survey net selection memorandum, net plan, sweep schematic, and door end detail schematic

MEMORANDUM

TO: Earl Meredith, Linda Mercer, Cheri Patterson

FROM: Bill Hoffman

CC: David Pierce, Thomas Moth-Poulsen

DATE: May 4, 2003

RE: Division of Marine Fisheries trawl net recommendations for the Industry-Based Survey

During the months of March and April of this year, the Division of Marine Fisheries *(MarineFisheries)* has been collecting advice and information to determine the trawl net specifications that should be adopted as the standardized gear that will be deployed for the Industry–Based Survey (IBS) pilot program. Representatives from the New England commercial fishing industry, The Centre for Sustainable Aquatic Resources of Memorial University of Newfoundland (CSAR), and Canadian Department of Fisheries and Oceans (DFO) have been consulted. Most of these consultations have been in the form of telephone interviews; however, in response to a suggestion by the IBS implementation committee, a gear workshop was also held on March 18th, 2003 with industry representatives, National Marine Fisheries Service (NMFS), and *MarineFisheries*. As expected, there was a variety of opinions on which style trawl should be used in the survey, and what characteristics this trawl should have. After sorting through the compilation of information, *MarineFisheries* has determined that the following trawl net specifications should be adopted in the final design.

Net size:

At the gear workshop the group decided that the fishing circle, which is the circumference measurement of the opening of the trawl starting just behind the sweep, is the most common parameter when selecting the trawl. It is recommended that the fishing circle should be approximately 150'. This size was agreed upon by industry as a mid-sized commercial trawl that could be towed by all involved vessels and would be capable of producing a representative sample while not catching too many fish.

Mesh size and material:

As suggested by the implementation committee, 4.5" mesh should be used in the body of the trawl with 2" mesh used in the codend. During our discussions it was agreed this size is appropriate for two reasons. First, it is not so small that it would cause a backflow at the mouth of the trawl, which is believed to alert larger fish

allowing them to avoid being caught, as well as blowing smaller fish out of the trawl at the end of the tow. Second, 4.5" mesh is large enough to allow water to flow through the trawl resulting in a reduction of drag. Reduced drag is important because it allows vessels to tow more efficiently. It also will allow the trawl to be towed at quicker speeds (e.g. 3 knots, which is a component of the towing protocol) while still maintaining its geometric shape and bottom contact. Mesh diameter and material were also considered, and it was decided that 3mm Euroline would be the most appropriate for the trawl. This material is more robust and has a higher tensile strength than a traditional 3mm polyethylene twine. This twine is anticipated to withstand the rigors of the survey and, due to its tight cylindrical weave, will be more hydrodynamic, thus further reducing drag and the possibility of a backflow effect. Adding larger meshes in the square and the wings was considered to reduce drag, but changing mesh sizes throughout the trawl would complicate the design. It was agreed that for the ease and speed of repairs the trawl should be as simple as possible. Therefore, it is recommended that the 4.5" mesh be used throughout the body of the trawl, including the wings and square, and continuing down through the extension to approximately one fathom before the codend. In front of the codend it will be necessary to taper the mesh from 4.5" to 2", therefore it is recommended that a brief section 3" twine be incorporated before the codend. This twine will not only make a smooth transition to the codend, but will prevent the backflow effect in front of the codend.

Sweep and ground gear:

Because many of the sample sites will be over unknown bottom structure, it will be important that the sweep be able to tow over adverse bottom types while maintaining constant contact with it. To accomplish this it is recommended that a standard commercial "rockhopper" sweep be utilized including 14" rockhopper disks in the belly of the trawl tapering out 8" on the wings. They should be mounted on a rubber covered cookie wire with 6" disks staggered in between the rockhopper disks to act as suction breakers.

Cables, trawl doors, and floats:

These three elements of the trawl are highly contributing factors that affect how the trawl fishes. Through adjustments and alterations of the above, the trawl can be made to optimally fish. It was a consensus through our consultations, that the best way to establish the final configuration of these items will be through tests performed at a flume tank. As discussed below, results will allow us to adjust and alter the cables, trawl doors and floats, to optimize the trawls fishing potential. One characteristic that will be tested is a cookie cutter covered leg. It was recommended by industry that these legs, ranging from 1/2"-5/8" in diameter, be deployed in the survey. This is a common configuration that is often used in commercial dragging operations, and it is believed that this style leg creates an enhanced mud cloud and is more resilient over time.

Trawl Style:

It has been discussed and agreed the trawl that is selected for the survey must be: 1) designed to specifically target cod, 2) have a sound design and construction that would be recognized and accepted by industry and scientists, 3) capable of fishing on all bottom types (e.g., hard, soft, mixed, gravel, mud, sand, etc.), 4) easily repairable either on the vessel or on shore, 5) rigid, such that the trawl is resistant to being distorted or collapsing under different variables, (e.g. excessive strains, picking up debris on ground gear, etc.), and 6) an elevated head rope height, to ensure that cod higher in the water column, be captured.

Through our consultations, 2-seam and 4-seam trawl designs were identified as the two styles of trawls that would meet the set criteria. Both styles are commonly used today throughout the Gulf of Maine by New England groundfishermen. A 2-seam trawl is made out of two panels of mesh, a top and a bottom, which are laced along the two sides known as the gore line, selvage, or lastridge. A 4-seam trawl, commonly called a box net, has four panels of twine (top, bottom, and two sides) that are laced together to form 4 gore lines. Each trawl has its advantages and disadvantages, but both are proven commercial designs that will catch cod.

One of the strengths of a 4-seam trawl is its advantageous geometric shape. The trawl tends to maintain a gradual taper, round opening, and a high head rope height. A gradual taper down the belly and extension is important for catching cod because the fish aren't forced into a tighter space when dropping back into the trawl, allowing them to be caught more easily. Headrope height is desirable because it covers a greater percentage of the vertical water column therefore increasing its ability to capture cod that may be hovering above (e.g. spawning or feeding aggregations) the sea bed floor. A 4-seam trawl generally has good vertical lift. This lift keeps the belly of the trawl up off of the bottom where it could be damaged by obstructions or hard bottom, and as a result allows the trawl to be towed over variable bottom types. If damage does occur, it is usually limited to the bottom belly of the trawl. Gore lines are the strength of any trawl as they carry much of the weight of the catch. Having four gore lines makes the 4-seam robust and will hold up well when making large catches. The four gore lines also allow fishermen to have more control to tune the gear.

One disadvantage of the 4-seam trawl is its complex design. Dealing with four panels can be confusing for fishermen when working on a deck of a boat. If damage occurs, repairs can be more time consuming resulting in loss of valuable survey time. Its design allows more options to control the trawl, but as a result it compromises its stability. This trawl will not maintain its perfect shape if obstructions (e.g. old or lost fishing gear, logs, boulders, or other debris) become lodged in the trawl or ground gear. If areas of the trawl are altered (e.g. stretched headrope or footrope, uneven wires, etc) this, too, will have a negative impact on its ideal shape and, ultimately, its effectiveness.

The 2-seam trawl is reportedly the most commonly used commercial trawl style in New England, and is for several reasons. The main advantage to the 2-seam trawl is its stability. It is a very tolerant trawl to the prior mentioned obstructions and alterations and will maintain its geometric shape under these circumstances. Its two-panel construction uses a reduced amount of material. The trawl requires less labor to build, and therefore the overall cost of the trawl is less. For the same reasons, if damage occurs, the 2-seam trawl is generally quicker to repair. It is very versatile, as the trawl's headrope can be shortened to make a low profile trawl (commonly used to capture flat fishes) or can be lengthened into a "balloon top" to give it a high profile (which is used to catch gadids or small pelagics). Some industry representatives mentioned that they believed the 4-seam trawl had a higher headrope height, but after researching this topic we found that this was not necessarily the case. In a report that was produced by the MIT Sea Grant Program and the Center for Fisheries Engineering Research titled: Report No. 10 Standard Series Trawl Tests by Cliff Goudey, seventeen 4-seam and 2-seam trawls were tested and compared at the David Taylor Naval Ship R&D Center flume tank. It was shown that 4-seam and 2-seam set at the same parameters, and, towed, under the same conditions, maintained similar geometric dimensions.

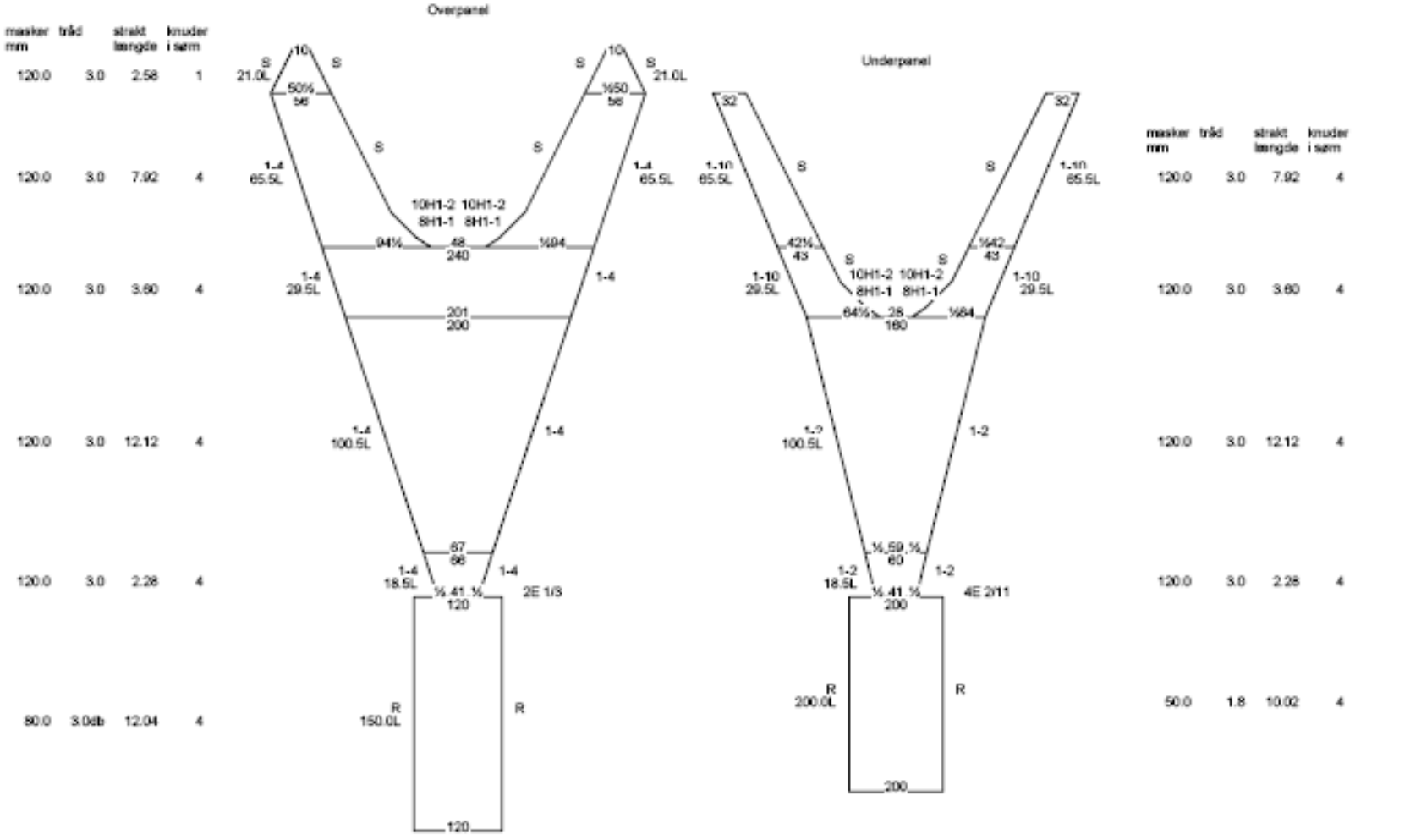
During consultations, fishermen, scientists, and trawl builders, all agreed that the selected trawl design is not as important as the ability to standardize the gear and document that it is operating properly. Because of the survey design, the selected gear will be used on many different vessels and by many different fishermen. Therefore, a key to the success of the survey will be the ability to quickly and easily calibrate the gear as well as maintain the optimal fishing shape from each tow and vessel. The 2-seam trawl offers the best opportunity to achieve this and therefore *MarineFisheries* believes this is the best trawl design for the IBS.

Flume Tank:

Once the final trawl design is selected, *MarineFisheries* intends of to have a model of the trawl manufactured and tested in a flume tank at (CSAR) in St. John's, Newfoundland. This is the largest flume tank in the world and they have extensive knowledge and experience testing otter trawl trawls used in commercial and research operations (e.g. NEFSC bottom trawl survey, DFO bottom trawl survey, DFO sentinel survey, *MarineFisheries* raised footrope trawl, etc.). While testing the trawl at this facility, gear specialists will be able to make adjustments to the trawl until it is operating at an ideal geometric shape. This shape is the trawls optimum fishing shape, and is important because it yields the highest fish retention. The recorded angles, heights, spread, needed lift, and door sizes that were measured can then be applied to the trawl when at sea allowing the gear to be calibrated quicker and easier. Another benefit from the flume tank tests will be the production of a "report" for the captains for the selected trawl. This report will describe what effect minor changes to the rigging and towing speed will have to the trawl geometry and tell the captains where to increase attention on rigging parameters and towing. If financially feasible, *MarineFisheries* hopes to invite operating

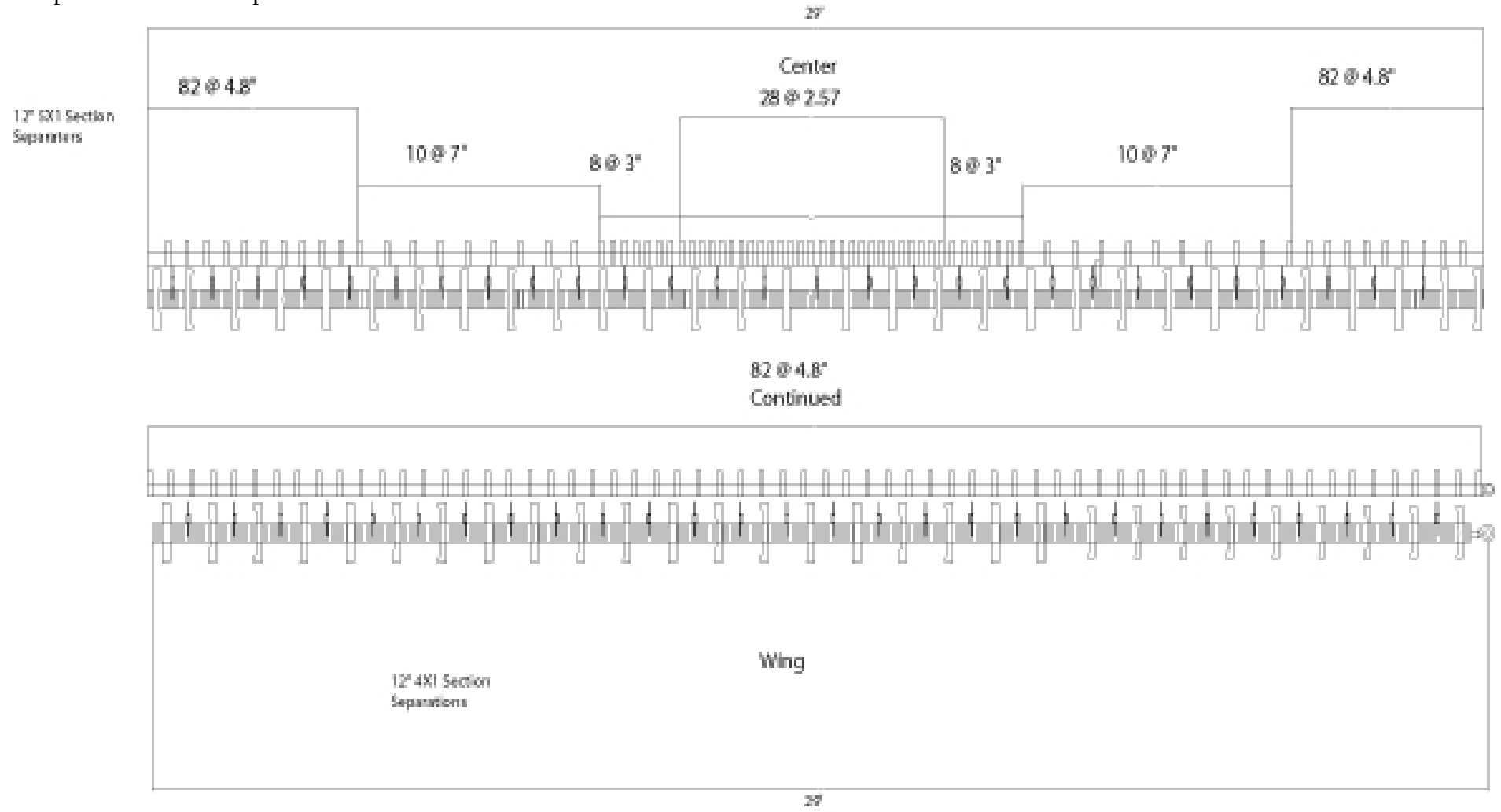
vessel captains/owners and other industry representatives to attend the testing of the trawl. This will not only give an excellent opportunity to train the fishermen that will be using the standardized gear, but will allow other industry and interested parties to observe the vigilant steps that are being taken to assure quality control throughout the survey.

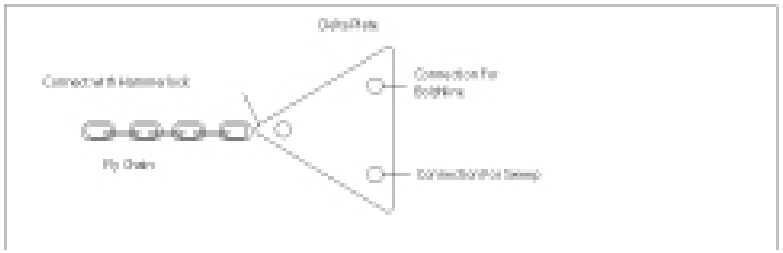
Appendix B (cont). Net plan for the IBS for GOM cod survey net, the Reidar's 360



Sweep schematic

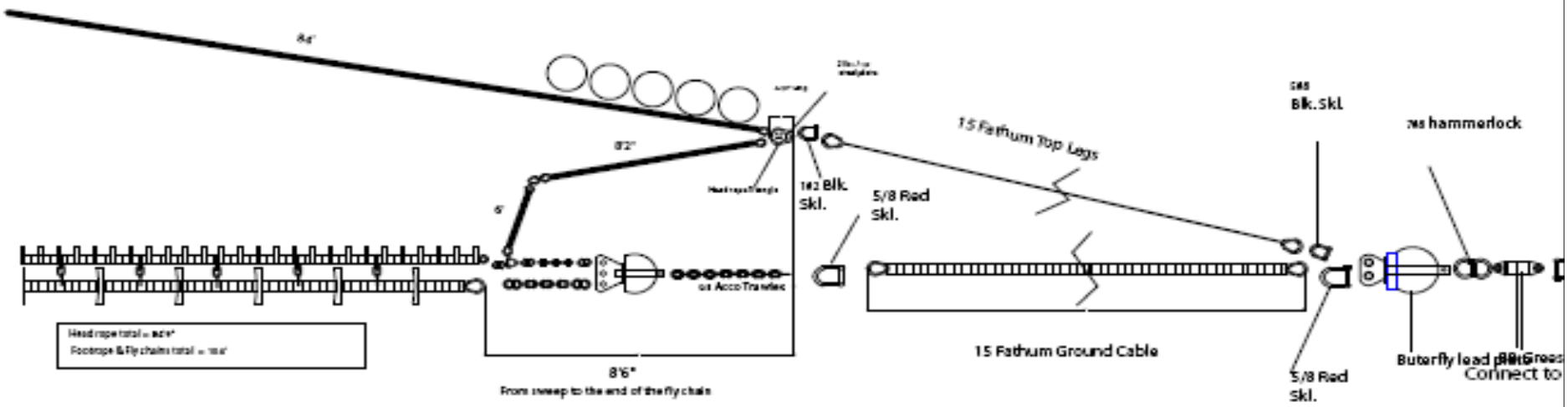
Sweep schematic and tri-plate detail





Door end detail

Door End Detail



Hans Bendiksen ©}

Reidar's Manufacturing Inc. ©}

Appendix C

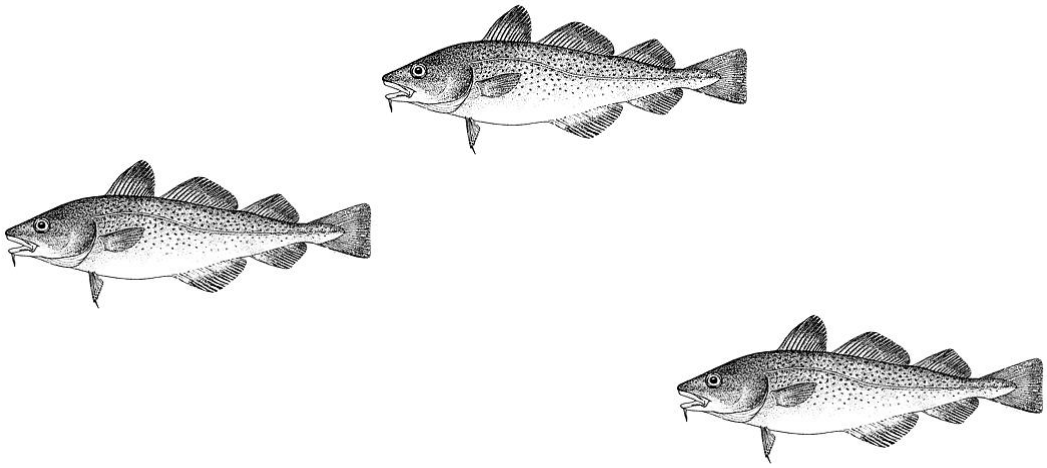
Industry-Based Survey
for
Gulf of Maine Cod
Pilot Study

Chief Scientist Guide

Massachusetts Division of Marine Fisheries
Industry Based Survey

For

Gulf of Maine Cod



Chief Scientist Guidelines

2005 - 2006

MarineFisheries
A Commonwealth of Massachusetts Agency

Table of Contents

1. PRIOR TO DEPARTURE:

1.1 MaxSea Marine Software (Appendix B)

Laptop computer should be turned on and set up so it is ready for the first haul of the day. Attach GPS cable to USB port of computer and open MaxSea to make sure the computer and GPS interface is working.

1.2 StowAway TidbiT Temperature Logger (Appendix C)

The temperature tidbit recorder should be initialized with the DESCRIPTION:

VCMMDDYY (vessel code, month, day, year)

Ex: **JK030505** (Jocka, March 5th,2005)

In order to initialize the tidbit, the Optic Base Station cable must be connected to the laptop through the serial port. After initialization, the tidbit is to be secured in a baitbag and attached to the inboard side of the port door prior to the first haul of the day. Make sure it is out of the way of the door arm.

1.3 NETMIND Trawl Monitoring System (if onboard) (Appendix D)

Detach the Optic Base Station cable and attach the NETMIND Trawl Manager System cable to the laptop serial port and attach the cable from hydrophone into the NETMIND Trawl Manager System. Charged NETMIND sensors should be attached to the net & doors before leaving the dock, as this is an easier process than attaching the sensors at sea. For the door sensors, the master goes on the starboard side and the slave goes on the port side of the gear. The hydrophone should be set up off a block from an outrigger. **Remember to leave the hydrophone inboard during steaming.**

1.4 Marel Shipboard Scale

Marel scale should be plugged in and allowed to warm up. Calibration of the scale is to be conducted before the first tow of the day but it **cannot** be done while the vessel is tied to the dock or while the vessel is still in the harbor.

To calibrate the scale:

- Confirm that the platform is empty and clean.
- Press MENU and ZERO simultaneously
- When display shows: **"*Put 20 kg*"**, place calibration weight on the center of the platform.
- Press PRINT and wait for message: **"*Fit XX*"**.

A good calibration should have a Fit Number (***XX***) of 25 or less. If higher, then recalibrate.

2. BEFORE THE START OF A TOW:

2.1 Survey Area

Upon arrival at the station, ensure that the tow path is free of fixed gear and untowable bottom. This may require the captain to make at least one pass along the planned tow path to ensure that the tow can be completed successfully and with no fixed gear interactions. **All attempts should be made to avoid all fixed gear.** It would be extremely helpful to the captain if the chief scientist remains in the wheel house during this time period to assist in sighting fixed gear.

Confirm that the captain surveys the area and attempts to cover the entire tow area for that station before dropping and moving on to the next station. If time and/or safety are a factor, consult with the captain and make a decision on how long to spend searching for a tow.

If a station is not going to be completed, indicate in the 'Stations Done.xls' file the reason for not attempting the tow. Remember to be specific as to why the tow was not completed. For example, a tow was not completed because of hard bottom. Did the whole survey area have hard bottom or did the only area left because of fixed gear have hard bottom? Scenario #1 is hard bottom; scenario #2 is fixed gear.

2.2 Gear Identification

Check and record the door and net numbers on the Trawl Haul Log. The net number will be welded on the tri-plate on the lower leg. The door numbers will be welded on the interior of the door.

2.3 NETMIND Trawl Monitoring System

Turn on NETMIND Trawl Manager System and open NETMIND on the laptop. Have the sea sampler or vessel crew stand-by for hydrophone deployment.

3. START OF THE TOW:

3.1 Start of tow protocol:

The survey tow begins when the brake on the winch is locked.

Upon **"winch break lock"**:

- Start the Egg timer (located on the desktop of the laptop. Make sure it is placed on the screen so both you and the captain can clearly see it.
- Begin vessel tracking in MaxSea. (Appendix B)
- Deploy the NETMIND hydrophone. Make sure the excess hydrophone cable is secured and will not be pulled overboard.

3.2 During tow

The chief scientist should remain in the wheel house unless the catch work up from the previous station needs to be finished.

4. END OF TOW:

The survey tow ends once the brakes on the winches are disengaged and the winches begin haul back. The required tow time should be 30 minutes in duration. Tow durations between 20 and 30 minutes are acceptable; less than twenty minutes is not acceptable and should be redone.

4.1 MaxSea Marine Software (Appendix B)

- Stop vessel tracking on MaxSea.
- Convert vessel track to a route and save.
- Use track route to determine start and end latitude / longitude coordinates (**DD MM.MMM**) and track line length (**x.xx** nm).

4.2 NETMIND Trawl Monitoring System

Haul aboard the NETMIND hydrophone. This may be done just before the end of the tow in order to prevent the hydrophone cable from becoming entangled in the survey gear or vessel propeller. Neatly stow the cable and deployment line so that is out of the way from deck activities.

4.3 Haul Value

Determine if the haul was a successful tow or not ((HAUL VALUE) based on:
- Time (tow must be a minimum of 20 minutes)
- Gear Condition (large or many holes in the net is probably not a successful tow)
- Interaction with large amounts of fixed gear (NETMIND may help here)
- Captains discretion

If it is determined that the haul was not successful (HAUL VALUE = 4), then the catch is not recorded, legal size fish (see section 9.1) should be collected for sale, and the remainder of the catch returned overboard. The tow should be repeated if possible. Indicate on the Trawl Haul Log that there is a second attempt and add detailed comments explaining the reason why the tow is being attempted for a second time. Save the initial vessel track for future reference.
If the haul can't be completed again, then fill in the Trawl Haul Log as necessary, do not record any species information and record the # CODED SPECIES as 0 even if there was a catch.

4.4 Gear Damage

If there is any gear damage, record the appropriate gear condition code. Also, please record in the 'GEAR LOG.xls' file the date, the net or door number, a detailed explanation of the damage, and any attempts made to repair/fix the problem.
**** Please Note: IF ANY NET DAMAGE IS PRESENT, IT MUST BE REPAIRED PRIOR TO DEPLOYMENT FOR THE NEXT HAUL.** If the damage is too severe to be repaired at sea, contact the project coordinator to arrange for delivery of a new survey net.

4.5 Fixed Gear

All fixed gear that comes up in or on the trawl net should be indicated on the Trawl Haul Log along with any detail information such as buoy color, numbers or names on buoy, or trap tag information along with the total number to traps entangled with the survey gear. All gear should be returned to the sea with minimal cutting of lines if possible. If a line or warp is needed to be cut in order to release the fixed gear, then all attempts should be made to retie it together after untangling it from the survey gear. If traps come up in the net without warp lines, then the traps should kept onboard and returned to Massachusetts Division of Marine Fisheries, Gloucester Office.

5. CATCH WORK UP:

When the gear comes aboard, all species must be removed from the net. This may require the crew to back down the net on deck and shake all fish down into the cod end. When the catch is dumped on deck, take a moment to assess how you will sample the catch – is it a small or relatively easy catch to sample or do you need to subsample? Are there species that should be quickly dealt with and returned overboard alive? Will you need baskets or will fish totes be required?

5.1 Photographs

Photographs and movie clips should be taken as time permits. Subjects should include the catch, unique or unidentifiable species, vessel operations, gear damage, and sampling.

5.2 Scales

The Marel Shipboard Scale is to be tared with a clean, empty orange basket before each tow. If fish totes are needed make sure the Marel Shipboard Scale is tared with a fish tote and not an orange basket. The Pesola 10 kg Spring Scale should be zeroed with an empty small bucket before each tow. The Pesola 10 kg Spring Scale is to be used when weights are 3 kg or less.

5.3 Sorting and Weighing the Catch

All species are to be separated into individual baskets. Dogfish and crab species are to be separated by sex. American Lobsters are to be separated by male, female and female egg bearers. All species are weighed to the nearest 0.1 kg. Small amounts should be weighed in the small buckets with the Pesola 10 kg Spring Scale; however, make sure that all water has been drained out of the bucket before weighing.

There are a few species that should be pulled out of the pile, weighed and measured and returned to the water as quickly as possible. These include Atlantic sturgeon, Atlantic halibut and lumpfish.

5.4 Sampling

Refer to the Species Sampling Priorities List (Appendix E) and Supplementary Sampling List (Appendix F) for information on which species is to be sampled and for what data is to be collected. Sampling should be conducted on all species of priority as time permits but keep in mind that this is an Atlantic cod survey; therefore, this species will always be sampled whenever it appears in the catch. All supplementary samples will need a water proof label which will include cruise number, station number, species and sample type.

5.5 Length Frequencies

Length frequencies are initially recorded as stroke tallies on the Trawl Haul Log and then each line is totaled when you are done recording lengths. Make sure you leave yourself enough room on the Trawl Haul Log so all sizes can be recorded in numerical order.

If there are only a small number (12 or less) of fish, lengths can be recorded in the LENGHTS OF INDIVIDUAL FISH column. Please **do not** try to cram 20 – 30 individual lengths in this box as it is difficult to read for the data entry process.

5.6 Age Structure and Envelopes

Age structure envelopes are to be filled in for each tow with the corresponding cruise code, station number and individual detail number. Two otoliths should be retained for each fish, even if they break during extraction. When binding the envelopes together, try to prevent crushing the otoliths by using a paper clip or using rubber bands as loosely as possible. Do not use electrical or duct tape. Allow envelopes to dry before sealing them in a plastic bag.

5.7 Subsampling

If the catch is large or there is a large quantity of a single species, subsampling may be easier and more time efficient. Subsampling techniques will generally vary depending on the species and circumstance but the following scenarios should help the work up of large catches.

Remember to record all subsample weights in the SAMPLING box of the Trawl Haul Log or circle the subsample basket weights recorded in WEIGHED PART OF CATCH column. Also, show all work used to calculate subsampling expansion factors.

1. Discard by Count Subsample Method:

Large amount of dogfish: Fill four to six baskets by sex and record a weight for each basket. Count the number of individuals per basket to calculate an average weight per fish in the subsample. Have the crew and sea sampler discard the remaining dogfish while counting the number of each by sex. You now have a total number of dogfish discarded. Multiply this number by the average weight per dogfish from the subsample to calculate an estimated weight of dogfish discarded. The discarded weight is then added to the subsample weight for a total catch weight of dogfish.

Example: Female Spiny Dogfish

	additional #'s counted:		avg. 2.26 kg/dog
Basket 1: 30.2 kg = 14 dogs			
Basket 2: 25.5 kg = 12 dogs	125		* 491 dogs
Basket 3: 32.7 kg = 15 dogs	148	(est disc wt)	1109.7 kg
Basket 4: 45.2 kg = 18 dogs	218	(sub wt)	+ 133.6 kg
subsample totals: 133.6 kg = 59 dogs	491	(est total wt)	**1243.3 kg**
133.6 kg ÷ 59 dogs = 2.26 kg/dog		(total num)	**550 dogs**

2. Mix Subsample Method

Large mix species that would take a long time to separate: Fill only the mix of species into the baskets and record a total weight for the mix. Take random samples out of each basket and put into an empty basket and fill at least a third full. This is your subsample; record the weight of the subsample. Sort the subsample by species and record a subsample weight for each species. Use these weights to determine the percentage of each species in the mix catch. Multiply each species percentage by the total mix weight for a total catch weight of each species in the mix.

Example: mix of Atlantic herring, silver hake, alewife

total weight = 126.2 kg

subsample weight: 25.4 kg		total species weight
Atlantic herring:	12.5 kg → 49.2 % * 126.7 =	**62.3 kg**
silver hake:	11.8 kg → 46.5 % * 126.7 =	**58.5 kg**
alewife:	1.1 kg → 4.3 % * 126.7 =	**5.4 kg**

3. Straight Weight Subsample Method

Large amount of a single species in which lengths will be recorded: Fill all fish into baskets or totes (remember to tare for tote) and record a total weight. The subsample should be representative in lengths of the catch; therefore, try to obtain it from different portions of the pile or from a random mix of the weighed baskets. Record the weight of the subsample. Divide the total catch weight by the subsample weight to determine the length frequency expansion factor. Record the length frequency of the subsample and use the subsample total number to calculate an estimated total number of fish.

Example: total weight of redfish = 226.4 kg

subsample weight of redfish = 55.4 kg

LF expansion factor = 226.4/55.4 = 4.09

subsample number of redfish = 218

estimated total number of redfish = 4.09 * 218 = 892

4. Single Species by Length Subsample Method

Single species with distinct size categories and one or more size categories can be subsampled. This method is similar to the Straight Weight Method because each size category will be initially treated as separate species until the data is expanded. While sorting the catch, fill baskets according to a definitive length separation point and record as large and small fish. Record a total weight for each size category. Obtain a representative subsample from each size category and record the weight. Divide the total

weight by the subsample weight to determine the length frequency expansion factor for each size category. Record the length frequency of the subsample in separate columns of the Trawl Haul Log and use the subsample total number to calculate an estimated total number of fish for each size category.

Example 1: small and large haddock

	small haddock	large haddock	**total haddock**
weight	45.2 kg	457.2 kg	45.2 + 457.2 = **502.4 kg**
subsample weight	15.3 kg	266.9 kg	
L/F expansion factor	$\frac{45.2}{15.3}$ = **2.95**	$\frac{457.2}{266.9}$ = **1.71**	
subsample number	65	320	
total number	65 * 2.95 = 192	320 * 1.71 = 548	192 + 548 = **740**

Example 2: mostly large but some small pollock

	small pollock	large pollock	**total pollock**
weight	10.9 kg	3217.2 kg	10.9 + 3217.2 = **3228.1 kg**
subsample weight	none	306.9 kg	
L/F expansion factor	none	$\frac{3217.2}{306.9}$ = **10.48**	
subsample number	none	84	
total number	36	84 * 10.48 = 880	36 + 880 = **916**

6. AFTER CATCH IS WORKED UP:

6.1 Deck Clean up

After weighing, measuring and sampling all of the catch, the sea sampler should help clear the deck. If the crew is still processing the portion of the catch that is to be sold, assist them as best as possible. If help is not required, then proceed to hosing down the work station, removing fish guts and blood from the sampling equipment, baskets, table, and work area. If there is an exceptionally large catch, the watch chief should also assist in clearing the deck after finishing with the data logs.

6.2 Log Clean Up

Unless needed on deck, the watch chief should finish and clean up the data logs before the next tow. All fields must be completed before the logs are turned in. If you plan to code the logs please us a **red pencil** to fill in the species and sex codes. This is to aide in the data entry process. All length frequencies should be tallied up and the total number is to be recorded in the TOTAL CATCH NUMBER column and the total weight for each species is to be recorded in the TOTAL CATCH WEIGHT column. The total cod weight for each tow, the date, station number and any comments should be entered into the 'Stations Done.xls' file on the desk top of the laptop.

6.3 Expansions

If the tow was shortened or a subsample was taken, an expansion factor must be calculated.

* Time Expansion Factor (EF_{time}) = 30 / xx.x, where xx.x = length of tow

* Subsample Expansion Factor (EF_{sub}) = total weight / subsample weight

* Subsample on a shortened tow, expansion factor = EF_{time} * EF_{sub}

A. Rules for Expansions:

1. Do not expand the recorded length frequency data on the log.

2. Record the calculated expansion factor in the LF EXPAN FACTOR column.

3. Record the calculated expanded total number in the TOTAL CATCH NUMBER column. Use the 'AUDIT.xls' spreadsheet file (located on the desk top of the laptop) to obtain the expanded total number.

B. Additional Rules for Time Expansion:

1. If there are no lengths or number of species recorded then total weight is expanded by time expansion factor.

2. If only **1** animal, then there is **no expansion** of weight or length frequency, **regardless of expansion factor.**

3. If more than **1** animal, weight is expanded **only** if the length frequency will be expanded.

C. Exception to expansion rules:

When using the Single Species by Length Subsample Method., the size categories are initially treated as separate species and the length frequencies are collected in separate columns. The 'Audit.xls' spreadsheet file should be used with the appropriate length frequency data and corresponding expansion factor to obtain the expanded length frequency distribution for each size category. The expanded length frequency distributions must now be combined and recorded as a single length frequency distribution on the data log for the data entry process.

7. END OF THE DAY:

7.1 Gear

All deck equipment is to be cleaned. Scrub any dried blood or fish guts off the table, length boards, baskets and anywhere also as needed. The calipers and Pesola Spring Scale should be rinse with fresh water (if available) and given a coating of WD-40.

7.2 StowAway TidbiT Temperature Logger

The tidbit temperature logger needs to be removed and the data downloaded onto the laptop. All temperature data is to be saved in the **2005-2006** folder.

7.3 NETMIND Trawl Monitoring System

If the vessel is tying up for the night at the dock, please remove the NETMIND door sensors and stow them inside the vessel for the night. Also, remove any NETMIND sensors that need to be charged. These should be rinsed off with fresh water and placed on the chargers overnight. Disconnect the hydrophone cable from the NETMIND Trawl Manager System and stow the hydrophone and cable inside the vessel for the night.

7.4 Marel Shipboard Scale

Rinse and clean off the platform. If possible, leave the scale plugged in, replace the cover back on the scale box and place a large ziplock over the digital readout screen. If the scale is to be broken down for the night, make sure all components are dried and the scale is wiped down with WD-40.

7.5 Electronic Data Backup

At the end of each day, all electronic data should be backed up onto the USB memory key. This included all NETMIND files, the bottom temperature data file downloaded from the tidbit logger, the current cruise MaxSea layer file, Stations Done.xls and Gear Log.xls files.

7.6 Call In of Stations Done

A daily report for all stations completed should be called in to the program manager. This is to include both stations completed and those not completed.

8. END OF THE TRIP:

8.1 Gear

All equipment that is going to be left onboard the vessel must be thoroughly cleaned, packed up and stowed out of the way for normal vessel operations. Take an inventory of all supplies and include a list of needs for the next survey cruise with the package of data logs.

8.2 NETMIND Trawl Monitoring System

All sensors must be removed from the fishing gear. Neatly, pack the sensors and hydrophone cable into fish totes. Leave the sensor bags on the net.

8.3 Return to the Office

The following equipment must be return to the Massachusetts Division of Marine Fisheries Office:

- data sheets
- age structures
- specialty samples
- laptop computer
- USB memory key
- digital camera
- briefcase with all miscellaneous equipment and files
- complete NETMIND System (sensors, hydrophone, trawl manager computer, shackles, sled, chargers, voltmeter, adjustable wrenches)

9. REFERENCE TABLES

9.1 Legal Fish Sizes

American Plaice (dab)	35.6 cm (14“)
Atlantic Cod	55.9 cm (22“)
Atlantic Halibut	91.4 cm (36“)
Black Sea Bass	30.5 cm (12“)
Goosefish (monkfish)	43.2 cm (17“)
Haddock	48.3 cm (19“)
Pollock	48.3 cm (19“)
Redfish	22.9 cm (9“)
Scup	22.9 cm (9”)
Summer Flounder (fluke)	35.6 cm (14“)
Tautog (blackfish)	40.6 cm (16“)
Windowpane Flounder (sand dab)	30.5 cm (12“)
Winter Flounder (blackback)	30.5 cm (12“)
Witch Flounder (grey sole)	35.6 cm (14“)
Yellowtail Flounder	33.0 cm (13“)

9.2 Seconds to Tenths of Minutes

Seconds	Minutes
0 – 2	0.0
3 – 8	0.1
9 – 14	0.2
15 – 20	0.3
21 – 26	0.4
27 – 32	0.5
33 – 38	0.6
39 – 44	0.7
45 – 50	0.8
51 – 56	0.9
57 – 59	1.0

9.3 Wire Out Chart

Fathoms	Meters
25	46
50	91
75	137
100	183
125	229
150	274
175	320
200	366
225	411

9.4 Scope Chart

Depth (Fa)	Wire Out (Fa)
10 – 12.5	25
12.6 – 20.8	50
20.9 – 29.2	75
29.3 – 37.5	100
37.6 – 45.8	125
45.9 – 54.2	150
54.3 – 62.5	175
62.6 – 70.8	200
70.9 – 79.2	225

9.5 Fathoms to Meters

Fathoms	Meters
10.0 - 10.1	18
10.2 - 10.6	19
10.7 - 11.2	20
11.3 - 11.7	21
11.8 - 12.3	22
12.4 - 12.8	23
12.9 - 13.3	24
13.4 - 13.9	25
14.0 - 14.4	26
14.5 - 15.0	27
15.1 - 15.5	28
15.6 - 16.1	29
16.2 - 16.6	30
16.7 - 17.2	31
17.3 - 17.7	32
17.8 - 18.3	33
18.4 - 18.8	34
18.9 - 19.4	35
19.5 - 19.9	36
20.0 - 20.5	37
20.6 - 21.0	38
21.1 - 21.5	39
21.6 - 22.1	40
22.2 - 22.6	41
22.7 - 23.2	42
23.3 - 23.7	43
23.8 - 24.3	44
24.4 - 24.8	45
24.9 - 25.4	46
25.5 - 25.9	47
26.0 - 26.5	48
26.6 - 27.0	49
27.1 - 27.6	50
27.7 - 28.1	51
28.2 - 28.6	52
28.7 - 29.2	53
29.3 - 29.7	54
29.8 - 30.3	55
30.4 - 30.8	56
30.9 - 31.4	57
31.5 - 31.9	58
32.0 - 32.5	59
32.6 - 33.0	60
33.1 - 33.6	61
33.7 - 34.1	62
34.2 - 34.7	63

Fathoms	Meters
34.8 - 35.2	64
35.3 – 35.8	65
35.9 – 36.3	66
36.4 – 36.8	67
36.9 - 37.4	68
37.5 - 37.9	69
38.0 - 38.5	70
38.6 - 39.0	71
39.1 - 39.6	72
39.7 - 40.1	73
40.2 - 40.7	74
40.8 - 41.2	75
41.3 - 41.8	76
41.9 - 42.3	77
42.4 - 42.9	78
43.0 - 43.4	79
43.5 - 44.0	80
44.1 - 44.5	81
44.6 - 45.0	82
45.1 - 45.6	83
45.7 - 46.1	84
46.2 - 46.7	85
46.8 - 47.2	86
47.3 - 47.8	87
47.9 - 48.3	88
48.4 - 48.9	89
49.0 - 49.4	90
49.5 - 50.0	91
50.1 - 50.5	92
50.6 - 51.1	93
51.2 - 51.6	94
51.7 - 52.2	95
52.3 - 52.7	96
52.8 - 53.2	97
53.3 - 53.8	98
53.9 - 54.3	99
54.4 - 54.9	100
55.0 - 55.4	101
55.5 - 56.0	102
56.1 - 56.5	103
56.6 - 57.1	104
57.2 - 57.6	105
57.7 - 58.2	106
58.3 - 58.7	107
58.8 - 59.3	108
59.4 - 59.8	109

Fathoms	Meters
59.9 - 60.4	110
60.5 - 60.9	111
61.0 - 61.4	112
61.5 - 62.0	113
62.1 - 62.5	114
62.6 - 63.1	115
63.2 - 63.6	116
63.7 - 64.2	117
64.3 - 64.7	118
64.8 - 65.3	119
65.4 - 65.8	120
65.9 - 66.4	121
66.5 - 66.9	122
67.0 - 67.5	123
67.6 - 68.0	124
68.1 - 68.6	125
68.7 - 69.1	126
69.2 - 69.7	127
69.8 - 70.2	128
70.3 - 70.8	129
70.9 - 71.3	130
71.4 - 71.9	131
72.0 - 72.4	132
72.5 - 72.9	133
73.0 - 73.5	134
73.6 - 74.0	135
74.1 - 74.6	136
74.7 - 75.1	137
75.2 - 75.7	138
75.8 - 76.2	139
76.3 - 76.8	140
76.9 - 77.3	141
77.4 - 77.9	142
78.0 - 78.4	143
78.5 - 79.0	144
79.1 - 79.5	145
79.6 - 80.1	146
80.2 - 80.6	147
80.7 - 81.2	148
81.3 - 81.7	149
81.8 - 82.2	150
82.3 - 82.8	151
82.9 - 83.3	152
83.4 - 83.9	153
84.0 - 84.4	154
84.5 - 85.0	155

9.6 Selected Species Code List

Code	Sex	Species
015	1	spiny dogfish, male
015	2	spiny dogfish, female
022		barndoor skate
023		winter skate
026		little skate
027		smooth skate
028		thorny skate
032		atlantic herring
033		alewife
034		blueback herring
035		american shad
036		atlantic menhaden
045		rainbow smelt
072		atlantic cod
074		haddock
075		pollock
076		white hake
077		red hake
078		spotted hake
083		4 beard rockling
084		cusk
099		greenland halibut
101		atlantic halibut
102		american plaice
103		summer flounder
104		4-spot flounder
105		yellowtail flounder
106		winter flounder
107		witch flounder
108		windowpane flounder
112		buckler dory
113		atlantic silverside
121		atlantic mackerel
131		butterfish
139		striped bass
143		scup
155		acadian redfish
162		shorthorn sculpin
163		longhorn sculpin
164		sea raven
168		lumpfish
171		northern searobin
172		striped searobin
176		cunner
177		tautog
181		northern sandlance
191		wrymouth
192		atlantic wolffish
193		ocean pout
197		goosefish

Code	Sex	Species
301	0	lobster, unsexed
301	1	am. lobster, male
301	2	am. lobster, female
301	3	am. lobster, female, egger
305		shrimp unclassified
306		northern shrimp
310	0	deepsea red crab
312	0	jonah crab, unsexed
312	1	jonah crab, male
312	2	jonah crab, female
313	0	rock crab, unsexed
313	1	rock crab, male
313	2	rock crab, female
324	0	stone crab
325	0	snow crab
348		moonsnail
401		sea scallop
502		illex squid
503		loligo squid
510		octopus

Appendix A. Trawl Haul Log Instructions, Front

1-4 Cruise Code:	**2565** (leg 5)**, 2661** (leg 1)**, 2662** (leg 2)**, 2663** (leg 3)**, 2664** (leg 4)
5-8 Station:	**[*Assigned Station #*]**
9-13 Stratum:	**01010**
17 Station Value:	**2** = industry tow **7** = grid tow
18 Haul Value:	**1** = Good tow. No gear/tow duration problems. **2** = Representative, but some gear/tow duration problems. **3** = Problem tow. May/may not be representative due to gear/tow duration. **4** = Not representative due to gear/tow duration.
19 Gear Condition:	**1** = No damage to insignificant damage. **2** = Wing twisted or tears in upper or lower wings not exceeding 10 ft; tear in square not exceeding 5 ft; tears not exceeding 3 ft in upper belly, or 6 ft in lower belly; cod-end or liner with tears not exceeding 2 ft; parted idler; liner hanging out of cod-end. **3** = Hung up with no to minor damage. **4** = Parted legs, sweep or head rope; cod-end liner untied; wire out slippage; other gear hung on door. **5** = Tear up exceeding limits for code 2, but not total. **6** = Significant obstruction in trawl, such as fixed gear, rocks, mud, coral, tires, old anchors, timber, etc. Problem with third wire; unmatched doors; strong current. **7** = Crossed doors. Net was not on bottom or did not perform due to currents or other factors. **8** = Open gear. **9** = Hung up with major damage; total tear up, rimrack; loss of all gear; loss of trawl; loss of 1or both doors.
20–22 Stat Area:	**467, 511**, **512**, **513**, **514, 515, 521** (from MaxSea stat area layer file)
Vessel (on line)	**LE** = Lady Jane **L2** = Lisa Ann II **TO** = Titan **JK** = Jocka
23–24 Cruise:	**[*Assigned Leg #*]** (05, 01, 02, 03, 04)
27 EST/EDT:	**1** = Eastern Standard Time **2** = Eastern Daylight Time
28–33 YR-MO-DA:	**[*YY, MM, DD*]**
34–35 Gear Type:	**18**
36–39 Time:	Set time using 24 - hour clock

40-42 Min Out: Actual tow time, to 0.1 minutes (see section 9.2)

43-46 Depth Start: Depth @ start in meters (see section 9.5)

47-50 Depth End: Depth @ end in meters (see section 9.5)

Latitude/Longitude both start and end positions are to recorded in **SHIP OPERATIONS** Box
DD MM.MMM (from MaxSea track line)

99-102 Cable in Water: Wire out from block in meters. (see section 9.3)

115-117 Doppler Bottom: Actual tow length from track line created (from MaxSea Planning Route).

121-122 DSGN SPD: **3.0**

123-124 Gear ID: **01, 02, 03, 04, 05, 06** (Check for number welded on lower wing tri-plate.)

125-126 Door ID: **01**, **02**, **03**, **04** (Check for number welded on door.)

137-138 Cloud:
00 = clear
01 = 10 % coverage
02 = 20 – 30 % coverage
03 = 40 % coverage
04 = 50 % coverage
05 = 60 % coverage
06 = 70 – 80 % coverage
07 = 90 % coverage
08 = 100 % coverage
09 = Obscure (cannot be estimated)

147-149 Wind Dir: **000-359** (if no wind = **999**)

150-151 Wind Speed: Wind speed in knots (if no wind = **00**)

152-153 Weather:
00 = clear
01 = partly cloudy
02 = continuous layer of clouds
03 = blowing snow, sand/dust storm
04 = fog, thick dust or haze
05 = drizzle
06 = rain
07 = snow or snow / rain mix
08 = showers
09 = thunderstorms
99 = can't be determined

154-155 Wave Ht: Wave height to 0.1 meters

156-158 Swell Dir: **000-359** (confused seas or no swell = **999**)

159-160	Swell Ht:	Swell height to 0.1 meters
161-163	Ref Surf Temp:	Sea surface temperature to 0.1°C (from bucket thermometer)
183-184	Coded Species:	Number of species recorded on log (Male, female, eggers are considered separate species.)
185-188	Trash:	Amount of trash in liters

Trawl Haul Log Instructions, Back

Special Sampling:
* Leave this column blank.

Lengths of Individual Fish:
* Record individual lengths of fish in centimeters when only a few are present (less than 12).
* Lobsters are recorded in millimeters.

Species:
* Record species name.
* Spiny dogfish, crabs and lobsters are recorded by sex on separate lines.
* Additionally, female lobsters with eggs are recorded on a separate line.

Sex:
* Record the appropriate sex code for species to be sexed.
* 1 = male, 2 = female, 3 = eggers.
* These codes **must** be filled in with **red pencil**.

SPP Code:
* Record the species code. (see section 9.6)
* These codes **must** be filled in with **red pencil**.

Weighed Part of Catch:
* Record all bushel and bucket weights in these columns.
* Remember to circle the weights that are used when subsampling.

Portion Discarded:
* Leave this column blank.

LF Expansion Factor:
* Record the time or subsample length frequency expansion factor.
* If you expand the length frequency by hand on the log, **do not** record the expansion factor .

Total Catch Weight:
* Record the total weight of each species to the nearest 0.1 kg.
* If a time expansion is used, record the expanded weight.

Total Catch Number:
* Record the total number of each species.
* If a time or subsample expansion is used, record the expanded number.

APPENDIX B: MaxSea Marine Software

*** To turn on/off layers**: - click the **[Layer zone]** button 

- check/uncheck the layers needed.

*** To set active layer**: - click the **[Layer zone]** button 

- select **[Set active file]**
- click the layer file you wish to activate.

*** To turn on Tracking**: - click: 

- Before Tracking is initiated, make sure you have the correct layer active. This should be the layer with the corresponding present cruise number (2565.ptf for cruise 2565).

*** To save track line**: - click off Tracking 

- You will be prompted to select a file to save the track in. The active layer (current cruise layer) will already be highlighted; hit enter to save to the active file.

*** To establish start / end positions**: - use the **[Select Point]** tool 

- double left click the start / end position
- record latitude / longitude positions on Trawl Haul Log
- enter the appropriate label for position (**station# S/E**)

*** To determine length of a track line**: - use the **[Select Point]** tool 

- right click on the line to get the larger dialogue box
- select **Convert to Planning Route**
- left click on last point

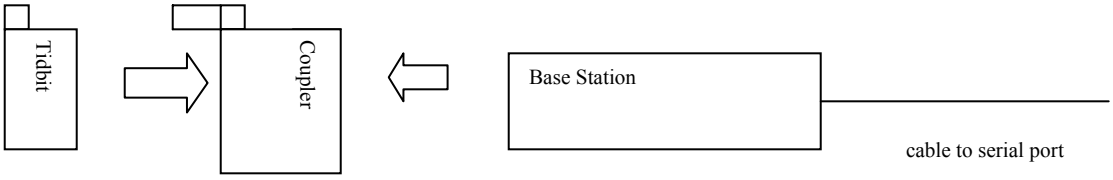
*** To save route**: - under **Routes**: click **Save Planning Route As**

- save in **My Documents** => **Planning Routes**
- save as Vessel Code Cruise # Station # (ex. **JK 2465 345**)
- double click  to delete the route (it will still be saved in **Planning Routes** Folder)

APPENDIX C: StowAway TidbiT Temperature Logger

* Connect cable into serial port (Comm1, detach NETMIND cable).

* If you encounter troubles with the Optical Connection, check to make sure all the physical connections are attached in the following manner:



* To launch logger:

  - double click BoxCar 3.7

  - click **Logger** => **Launch**

  Settings are: Description: **Vessel Code Month Day Year** (ex**. L2112505**)
  Interval: **30 sec (11 Days 7 Hrs)**
  Meas. Units: **Temperature (°C)**

  - click start and follow prompt

  - ok light on recorder should be blinking green when ready

* For consistency between vessels, always place the logger in a bait bag and attach to the port door.

* The temperature recorders are programmed to record for 11 + days. However, it should be downloaded at the end of everyday to prevent data loss.

* To download data:

  - double click BoxCar 3.7

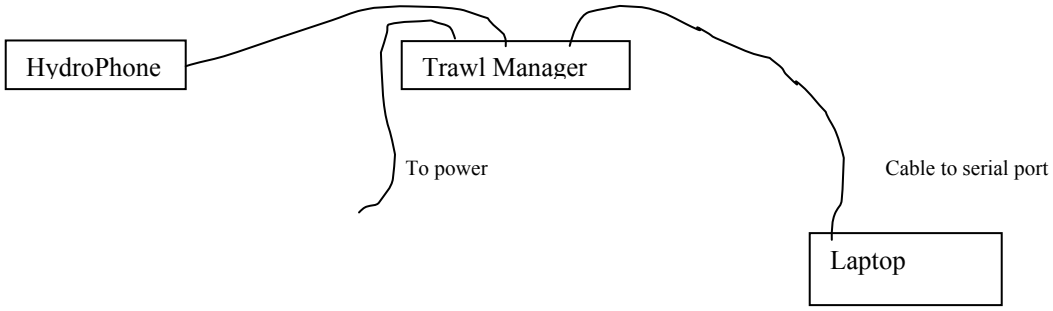
  - click **Logger** => **Readout**, follow prompt

* Save As: **Vessel Code Month Day Year.dtf** (ex. L2112505.dtf) in **2005-2006** folder

MUST RELAUNCH LOGGER AFTER EVERY DOWNLOAD

APPENDIX D: NETMIND Trawl Monitoring System

* Attach computer connecting cable to the laptop serial port (Com1).



* Hydrophone must be inboard while steaming.

* Sensor Placement:
  - Headrope sensor is placed in the sensor bag on the inside of the net at the center of the headrope with the rounded end facing the vessel and the **Sonar** mark facing downward. There should be at least two shackles attaching the sensor through the lug to the net. Line of sight positioning to the sea floor can be adjusted with heavy cable ties.
  - Door sensors are shackled to the links welded to the inside of the door. The Master Sensor is attached on the starboard door and the Slave Sensor is attached to the port door. The rounded ends must face towards the vessel and the **Sonar** marks facing each other.
  - Bottom Contact sensor is bolted into its casing and chained to the center of the ground gear with the rounded end facing the vessel.

* Settings: these settings should already be in place and not changed.

- System => HydroPhone Type => Single
ComPort => COM1
Scheduling => Auto
SystemNumber => 8

- Sensors => Headline
Transducer => Primary

√ **Enabled**	Minimum	Maximum	
Delay Time	**5000**	**6905**	mSec
Measured Value	**2.20**	**13.70**	Meters
Status Delay	**0**	**0**	mSec
Alarm Limits	**0.00**	**0.00**	Meters
Alarm State	• **Disabled**		

√ **Data Logging Enabled**
Transducer Log File Name: *VC*HR.CSV *

Doorspread

Transducer => DoorSpread

√ **Enabled**	Minimum	Maximum	
Delay Time	**12000**	**14000**	mSec
Measured Value	**0.00**	**150.00**	Meters
Status Delay	**11850**	**11950**	mSec
Alarm Limits	**0.00**	**0.00**	Meters
Alarm State	• **Disabled**		

√ **Data Logging Enabled**
Transducer Log File Name: *VC*DS.CSV *

Grid

Transducer => Tilt

√ **Enabled**	Minimum	Maximum	
Delay Time	**7230**	**8770**	mSec
Measured Value	**3.00**	**93.00**	°
Status Delay	**0**	**0**	mSec
Alarm Limits	**0.00**	**0.00**	°
Alarm State	• **Disabled**		

√ **Data Logging Enabled**
Transducer Log File Name: *VC*T.CSV *

* where ***VC*** = vessel code (JK, TO, L2, LE)

* Can create a real time display for each sensor by clicking **CREATE HISTORY DISPLAY**
(double click the display screen to change units & values)

* Turn on NETMIND Trawl Manager System before the first tow. This unit can be left on during the day but should be turned off at night.

* Charging
- The sensors should hold their charge for 3 – 4 days.
- Test senor charge: red voltmeter wire to S lug; black voltmeter wire to negative lug
- Charging sensors requires removing them from the gear, rinsing with fresh water and drying before proceeding. Attach the red cable to the positive lug and the black cable to the negative lug. The charger status LED will go from amber to green when done (max charge ~9 + volts).

Appendix E. Species Sampling Priority List

1	Atlantic Cod:	fork length
		sex & maturity – 1 fish / 3 cm <= 40 cm, 3 fish / 1 cm => 41 cm
		otoliths – 1 fish / 3 cm <= 80 cm, 3 fish / 1 cm => 81 cm
2	American Lobster	carapace length by sex
	American Plaice (dab)	total length
	Atlantic Halibut	fork length
	Haddock	fork length
	Pollock	fork length
	Winter Flounder (blackback)	total length
	Witch Flounder (grey sole)	total length
	Yellowtail Flounder	total length
3	Atlantic Wolffish (catfish)	total length
	Goosefish (monkfish)	lower jaw to tip of tail length
	Greenland Halibut (turbot)	fork length
	Redfish	fork length
	White Hake	total length

Appendix F. Supplementary Sampling List

1. Winter Flounder — Paul Nitschke (NOAA/NEFSC)

what: frozen whole samples; 12 fish per cm in the 19 – 42 cm range
where: Massachusetts Bay and Cape Cod Bay
when: Leg 1 and Leg 2

Samples separated by date and region

2. Atlantic Cod — Mass DMF CCZ Study

what: whole stomachs; 1 sample per 3 cm interval (with otolith)
where: Ipswich Bay, Jeffreys, Outer MA, Mass Bay; Stellwagen; CC Bay
when: Leg 5 and Leg 1

Individual samples with cruise code, station and individual ID number

Appendix D

Industry-Based Survey
for
Gulf of Maine Cod
Pilot Study

Outreach Materials and Minutes from Subcommittee Meeting

Appendix E. An article that was published in a local news paper

Gloucester Daily Times -- *Monday December 19, 2005*

Cod numbered

Bill Hoffman, an aquatic biologist for the Division of Marine Fisheries, heads the Industry Based Cod Survey.

By Patricia Cronin
Staff writer

Editor's note — Fisheries reporter Patricia Cronin joined researchers from the Massachusetts Division of Marine Fisheries and the crew of the Gloucester fishing vessel Lady Jane for a 12-hour cod survey Friday. Scientists hope the data collected during the Industry Based Cod Survey will hold the key to rebounding Gulf of Maine cod.

ON MASSACHUSETTS BAY — As the boat pulled away from the wharf at Rocky Neck, Capt. Russell Sherman turned the wooden wheel in the predawn darkness and mumbled under his breath.

"Sometimes you look like a jockey riding a race horse, and sometimes you look like a stumbling, old drunk," he said, shimmying the boat's rear back and forth in the low tide and finally squeezing her free from a tight spot between another vessel and the wharf.

A kettle of water had already begun to boil when researchers boarded the 76-foot steel dragger just before 4:30 a.m. It was 16 degrees outside, but the metal boat had already been warming for several hours. Along with Division of Marine Fisheries biologist Bill Hoffman and two other state researchers, Sherman and his three-man crew waited for the ship to reach the first spot where they would drop a specially designed net in hopes of catching cod.

"We're looking for distribution of fish," Hoffman said. "We're trying to figure out if they are here to spawn, feed or leave and then spawn."

The Industry Based Cod Survey, launched in 2003, teams up fishermen and scientists on trawl surveys of the waters off Massachusetts and Maine. Researchers hope their data will provide scientists with a way to save the dwindling number of cod thought to be reproducing in the Gulf of Maine in late December and January.

Last year, a large number of spawning cod were common just one mile offshore. This year, cod have been few and far between.

Cod Conservation Zone

The inshore area researchers had set out to explore lay within the Cod Conservation Zone, established by the DMF to protect spawning clusters of cod. The zone runs from Marblehead to Boston and ends to the east at the 3-mile nautical line, where federal waters begin.

Any gear capable of catching cod is prohibited within these waters from Dec. 1 to Jan. 15, except for the ship's 4- to 3-inch mesh nets with specially designed 2-inch cod ends.

Fishermen helped design the nets used on board the locally owned fishing boat, rather than a research vessel. For those whose livelihoods depend on the study's results, the fishing boat lends additional credibility to IBCS data, Sherman said.

"If we do the right job, then the truth will be known and let the cards fall where they may," he said. "I have every bit of faith in this survey."

There has never been a survey of the zone during winter months, and Hoffman said scientists hope the data collected will help fill gaps in federal and state trawl surveys conducted in the past.

The first haul

Daylight had finally broken over the horizon as the crew reached its first drop. Hoffman said the survey spots were picked using a grid of Massachusetts Bay. Each square in the grid represented one haul.

With orange slickers on over sweat shirts and thermals, Mike Ragusa, Joe Parisi and Steven Cambria made their way onto the slush-covered deck and lowered the nets. A layer of sea smoke over the icy water soon swallowed the orange buoys, and the boat lurched forward. We had caught something other than fish, a wreck or old lobster traps perhaps, and Sherman had to back up the boat to free the tangled net. Finally, the net was freed and, after a 20-minute tow, hauled back onboard. There were no cod. "It's just been that kind of season," Hoffman said. "I don't

know if the cod are just late. That's what some fishermen have been saying. They say (the cod) haven't shown up yet."

Sampling the cod

The second tow yielded 17 pounds of cod. Hoffman, marine biologist Dan Salerno and sea sampler A.J. Macfarlan got to work, separating the cod from other fish and crustaceans recovered in the tow, such as yellowtail flounder and lobster. The cod were weighed together and individually before they were measured, sliced through the middle and examined. The researchers checked the sex and maturity level of each fish, removed its stomach and then sliced down its head from behind the eyes to remove ear bones called otoliths. When baked, tiny rings form on the bones, Salerno said. Similar to the rings on a tree, they reveal a fish's age. Using tweezers, the crew performed the delicate work quickly, placing the bones into tiny envelopes. But it soon turned competitive for Hoffman and Ragusa.

"Yeah, by one second you beat me," Ragusa said, accusing Hoffman of cheating after he lost a race to slice and remove the ear bones from five cod.

In search of more data

After recording survey results on paper, researchers will store the information in a large database within 40 to 60 days. The New England Fishery Management Council, working on additional cod regulations in a document known as Framework 42, has already agreed to use the data in its 2008 Groundfish Benchmark Assessment.

"We're at a time when we really need to enhance the survey or expand it," Hoffman said. "It's just not enough, in my eyes, to mean significant results. You would need five years, at a minimum, for a better picture." Now entering its third year, the survey lacks additional funding for 2006.

In the pilothouse, where computer screens surrounded the old, wooden wheel and medallions of St. Peter hung on the wall near Hoffman's laptop, Sherman steered the Lady Jane back to port after six hauls and little cod.

"If there has to be a fish that has to be surveyed, it's Gulf of Maine cod," he said. "The whole industry has been regulated to the tune of Gulf of Maine codfish for the past 10 years."

With the sunset hours behind and the light of a full moon dancing on the water ahead, the boat pulled back into its spot beside the dock and the men prepared to go home.

They will survey additional spots during five more scheduled trips in 2006.

Where have the cod gone?

The IBCS is recording data on cod thought to be spawning in the Cod Conservation Zone during the winter months. But recent assessments show Gulf of Maine cod are already in trouble.

* Gulf cod numbers have declined 21 percent since the last assessment in 2002.

* A larger than normal number of cod were thought to have been born in 2003, known as the '03 year class. Conservationists have stated that if the '03 year class is not protected from overfishing, Gulf of Maine cod might not rebound.

* In 2007, the same year the '03 year class would be large enough to be caught, the total allowable catch targets for Gulf cod will nearly double.

Appendix E (cont).

IBS Outreach Subcommittee
Draft Meeting Minutes
January 18, 2005

Attendees: Chris Moore, MAFMC, Marla Trollan, NMFS, Terry Alexander, Industry, F/V Jocka, Bill Duffy, Northern Geomantics, Bill Hoffman, MADMF, Dan Salerno, MADMF, Sarah Pierce, RIDMF, Cheri Patterson, NHFGD, By phone: April Valliere, RIDMF, Pat Fiorelli, NEFMC. Absentees – Azure Westwood (NMFS) and Robert Johnston (NMFS)

Action Items to address:

- Further public outreach of all IBS-Addressed
- General information (overview of all projects)-Addressed
- Fixed gear interactions, other type of communication problems-Addressed
- Message out to constituents/industry/public/Congress ($)-Addressed with the exception of Congressional outreach. See
- Consult with Bill Duffy on methods to link websites, etc…

Agenda:

10:00 Welcome/Introductions
10:15 IBS Website – Bill Duffy – Northern Geomantics
11:00 NMFS Cooperative Research Partners Initiative (CRPI) Outreach Program – Marla Trollan – NOAA/NMFS Regional Outreach Coordinator
12:00 Lunch
12:30 Discussion of IBS Outreach Subcommittee Action Items from IBS meeting – August 2004
Develop protocol of notification to industry regarding IBS trawl activities.
Develop general information of IBS projects (Yellowtail flounder and GOM Cod Trawl surveys).
Other communication needs – constituents, industry, public, congress, etc..
Linking Agency/Industry websites to IBS website.
2:00 Adjourn

1) Overview of IBS Website: Bill Duffy – Northern Geomantics

Bill Duffy gave an overview of the IBS Cod Trawl Survey website (http://projects.northgeo.com/trawl). The IBS website currently includes data from IBS Cod Trawl Survey, Yellowtail Flounder Survey and Cod Tagging Survey. Bill reviewed the GOM Cod Trawl survey.

Features include but not limited to:

1) GIS map of GOM cod survey range.
2) Circles on map indicate where cod inshore trawl surveys where conducted and how many fish where caught.
3) If click on circles, can obtain species, species weight, length frequencies, etc. As well as, date and location (longitude and latitude) of actual trawl. This information can be printed.
4) Can show graphs (bar, line, etc..) of species composition of a single leg.
5) Currently is available for administrative changes to the following: Linda Mercer – Maine DMF, Bill Hoffman – MADMF and Bill Duffy and other Northgeo design personnel.

Bill Duffy would like to can get final comments, concerns, etc so he can move the website out of development stage and into production. Bill Duffy brought up the concern that now the website is close to production an agency needs to be available to host the IBS website. Currently, Maine DMF has volunteered to host this site temporarily as early as next week until NMFS or another state/council entity can host. NOAA/NMFS will look into hosting this site permanently and will be in contact with Bill Duffy for maintenance costs and site specifics. The requirements to host this developed website are in Appendix 1.

A "wish list" of what the Outreach Subcommittee would like to see for changes, additions and improvements in the future is outlined below:

Request From	Requested change, addition and/or improvements to website
Industry (fishermen)	Produce a single sheet for basic information on how to move around website easily.
Industry, science and management (state, councils, etc…	Add a descriptive cover page introducing the various surveys and CRPI, IBS, etc.. to website.
Science and Management	Add surface temperature as a field in database and data collection requirements to allow website access for both cod and yellowtail surveys. Ultimately have both bottom temperature and surface temperature available on website.
Industry	Add date to screens currently not showing date of trawls.

2) Overview of outreach funding applied to Cooperative Research Partnership Initiative (CRPI) through NOAA/NMFS – Marla Trollan, Outreach Coordinator.

NOAA/NMFS is already working from an approved spending plan for outreach towards all the CRPI programs in an integrated and coordinated approach through all the related committees. Marla outlined that outreach funding ($65,000 – $70,000) was provided to the CRPI program in 2005. The projects being addressed under the CRPI program are the Cod Tagging surveys, Industry-Based Surveys (GOM Cod Trawl and SNE Yellowtail Flounder surveys) and Study Fleet surveys. NOAA/NMFS will be meeting with media producers on January 21, 2005 to initiate the development of a 20-30

minute video with loop feed for trade shows, various interested organizations, etc... This video will introduce the CRPI program and current programs/projects. Marla will also be developing displays, brochures and handouts of the CRPI program and for the individual programs/projects housed under CRPI.

The CRPI logo that was developed will no longer be used, as there was concern of perception that CRPI is separate from NOAA fisheries. Whereas, it actually is a program funded through the NMFS/NOAA. Therefore the CRPI logo will not be used any longer and the NOAA logo will be on all developed media materials.

Marla will be coordinating with Bill Hoffman (GOM Cod Trawl Survey coordinator) and April Valliere (SNE Yellowtail Flounder Survey coordinator) to obtain and/or schedule photos, video footage and interviews with fishermen on the vessels.

Bill Hoffman explained that he has already developed media material for the IBS GOM Cod trawl survey and has already displayed this information at trade shows and distributed information through mailings. He also has developed maps and coordinates of the survey sites for distribution through these media. He will be sharing these developed media materials with Marla.

Conversation developed, at the prompting from Chris Moore, MAFMC, on how to best reach the audience who will be most interested in the data from the various CRPI programs/projects. The audience was defined by the Outreach Subcommittee as industry (fishermen and fishing organizations) and the various state and federal agencies, stock assessment and private organizations concerned with the science and management of the surveyed species. Other questions that Chris would like clarified is whether this data will be used, in what capacity and the timing of data availability? Who has requested data from these surveys to date? Chris will be developing a white paper that will track the data used for management and/or researchers.

Some of the outlets to best reach interested parties through media that were discussed for Marla to work with, as well as, some that have already been used for specific IBS project were:

Outlets that have been used:

1) Trade shows (Bill Hoffman, MA).
2) Article written in GIS newsletter by Bill Duffy. *Please send to Cheri as informational material for the next meeting for the IBS Committee.*
3) State website links and public notices/press releases (MA and RI).

MA: http://Mass.gov/marinefisheries
To access GOM Cod Trawl Survey from website -
Programs and Projects
RI: http://www.state.ri.us/dem
To access SNE Yellowtail Flounder Survey from website -
Programs
Fish and Wildlife
Marine Fisheries
"Fall Industry-Based Surveys" – bottom right

Outlets to access:

1) Atlantic Offshore Lobstermen's Association, Bonnie Spinazzola, Executive Director – (603)483-3030.
2) Actual person-to-person contact in downeast Maine at local stores, gathering spots for local fishermen, etc... At a minimum deliver posters, etc… to these areas of concern for specific outreach for this program in an area that has been a large problem with fixed gear conflicts for both GOM Cod survey and ME/NH inshore trawl survey. – Suggestion by Industry.
3) Further networking by:
    a. Hanging posters at industry gathering points,
    b. Develop display for booth at trade shows,
    c. Presentations/displays at council meetings where industry is present,
    d. Presentations at local commercial fishermen meetings,
    e. Presentations to law enforcement so they may pass information on to industry.
    f. Ad's provided to commercial fishermen magazines, etc…
    g. Distribute media and information through email lists that partners may have available. (NEFMC has extensive email list).
    h. Committee industry members become involved in promoting projects in more personal fishermen interaction relating to area projects.
    i. Get informational home page of CRPI at the host site (NOAA/NMFS?) with links to the states currently coordinating projects and have information on their home web page.

Summarize how to distribute and address outreach media discussed and which partner involved (yellow highlight is priority):

Partner	Outreach Effort
Industry	Obtain a list of fishermen that would be interested in personal contact to help advertise IBS, CRPI, etc…, get a video loop for upcoming local fishermen meetings, distribute posters and brochures.
NOAA/NMFS	Design poster as priority and then get brochure out. (~500 posters). Include MA and RI websites in media distribution.
NOAA/NMFS	Half page/Full page ad in commercial fishermen media outlets.
NOAA/NMFS	Get general CRPI informational web page set up that will link with IBS website no matter where it is hosted. NOAA/NMFS CRPI website has recently undergone a redesign.
NOAA/NMFS	Design brochures for individual studies (IBS, Study Fleet, Cod Tagging) and CRPI.
NOAA/NMFS	Video of ongoing pilot projects– by using current video footage from MA, and working with MA and RI to get videographers on vessels conducting surveys.
States	Informing fixed gear fishermen or other conflict gear where and when IBS trawls occur.
States, Council, NOAA/NMFS	Distribute posters to local fish exchanges and fishing gear stores and appropriate meetings (council, trade, commercial fishermen

and Industry	meetings, etc..)
States, Council, NOAA/NMFS and Industry	Distribute information through email lists. (Pat – Council and has extensive email list to use).

Other items addressed prior to Chris Moore and Marla Trollan leaving:

- MA is concerned that there has been no indication from NOAA/NMFS that the IBS GOM Cod Trawl survey is funded for 2005. MA does not have the ability to spend forward. Will need to get information about budget ASAP. Chris Moore will address this soon.
- Get poster and display finalized for Maine Fisherman's Forum – Samoset, ME for NOAA/NMFS booth. Possible use MA video loop of GOM Cod Trawl Survey. Bill Duffy and Bill Hoffman may help represent IBS website and GOM Cod Trawl Survey.

3) Discussion of IBS Outreach Subcommittee Action Items from IBS meeting – August 2004

Develop Protocol of notification of surveys to industry:

Timing for GOM Cod Trawl Survey: Start in November 1

- See Appendix 2 for GOM Cod Trawl survey notification/outreach from Bill Hoffman, MA.
- Letters sent to NH, ME and MA by GOM Cod Survey coordinator to distribute to fixed gear fishermen prior to survey (Appendix 3). ME, *Linda Mercer – how best should Bill deal with this with ME and would program outreach be able to be posted on ME website? Subcommittee Chair, Cheri - Check with MA/NH inshore survey partners to see how they would like outreach to complement IBS GOM Cod Trawl survey - not interfere/overwhelm industry.*
- Terry Alexander (Industry) will call industry members to communicate with downeast fixed gear fishermen. *Bill Hoffman, MA, will send downeast problem areas to Terry. Terry will call lobster zone council presidents that are in downeast ME affected areas to obtain names, emails and/or phone numbers of "Independent Industry Outreach members". Get outreach information to Terry for him to distribute.*
- Mail reminder cards as survey legs approach time within each individual states waters.
- Send radio communication on VHF of trawling activity on appropriate marine radio channels as vessels are trawling in specific areas.
- Send trawl activity timing to Coast Guard and state's law enforcement. Can be done with same letter sent to industry.

Timing for SNE Yellowtail Flounder Survey: March 1st

Not sure what needs are currently –fixed gear is not a problem as with GOM Cod survey. Suggestions from subcommittee are as follows:

- Yearly informational card or CRPI's brochure developed on SNE Yellowtail Flounder survey and send out with RI mass mailings (i.e. license renewals). The brochure should contain CRPI and RI website addresses for further reference for industry.

Agenda Items (see above) Addressed:

1. Develop general information of IBS Projects: Addressed above - NOAA/NMFS - will be doing this with funded outreach initiative for CRPI, which IBS is housed under.

2. Other communication needs –
   a. Constituent – Addressed above. In addition, keep contact with NEFMC members (Pat Fiorelli). GOM Cod Trawl survey and SNE Yellowtail Flounder survey coordinators will be sending what they mass mail to the industry or other outreach materials so she can send out with her email/mailing lists.
   b. Industry – Addressed above – All involved partners will be working as described above.
   c. Public – Addressed above – See NOAA/NMFS CRPI outreach initiative.
   d. Congress – NOAA/NMFS (Marla Trollan) and NEFMC (Pat Fiorelli) to determine. *Please send suggestions to subcommittee chair for discussion during conference call in February.*

3. Linking Agency/Industry websites to CRPI/IBS website. Addressed above - NOAA/NMFS will be working on this if they host the designed IBS website.

Summarization of tasks:

Linda Mercer, ME – Will this process work within ME and would program outreach be able to be posted on ME website?

Cheri Patterson, NH - Check with MA/NH inshore survey partners to see how they would like outreach to complement IBS GOM Cod Trawl survey - not interfere/overwhelm industry.
Develop template of mass mailing reminder cards of GOM Cod Trawl Survey to industry.

Bill Hoffman, MA - Send downeast problem trawl areas to Terry Alexander (Industry).
Get outreach information to Terry for him to distribute to the "Industry Outreach members".
Get outreach materials and letters of notification of trawl survey to Pat Fiorelli for NEFMC distribution.

Terry Alexander, Industry - Terry will call lobster zone council presidents that are in downeast ME affected areas to obtain names, emails and/or phone numbers of "Industry Outreach members".
Help Bill and ME distribute letters of notification of trawl survey and outreach of IBS to downeast ME problem areas.

Marla Trollan, NMFS – Develop CRPI and IBS outreach media materials as presented and discussed above as part of funded initiative. Supply posters, brochures, etc.. to coordinators of projects and state's involved to distribute with mass mailings.
Check into having IBS Website hosted at NOAA/NMFS (work with Bill Duffy).
Work with Pat Fiorelli to arrive at suggestions for congressional outreach methods for CRPI (IBS, etc..) if NOAA/NMFS has not already addressed this in-house. If have addressed this in-house please send the information for the IBS Outreach Subcommittee conference call.

Pat Fiorelli, NEFMC – Work with Marla Trollan, NMFS, to arrive at suggestions for congressional outreach methods for CRPI (IBS, etc..) if NOAA/NMFS has not already addressed this in-house.
Work with Bill Hoffman, GOM Cod Trawl Survey and NMFS to help distribute outreach media as appropriate to NEFMC.

April Valliere – Let Subcommittee know if there is any other media outlets that RI would like to reach for IBS (CRPI) to industry or science and management.

Bill Duffy - Please send GIS article to Cheri as informational material for the next meeting for the IBS Committee.

Appendix E

Industry-Based Survey
for
Gulf of Maine Cod
Pilot Study

Evaluation of the Gulf of Maine Rolling Closures

Industry-Based Survey for Gulf of Maine Cod

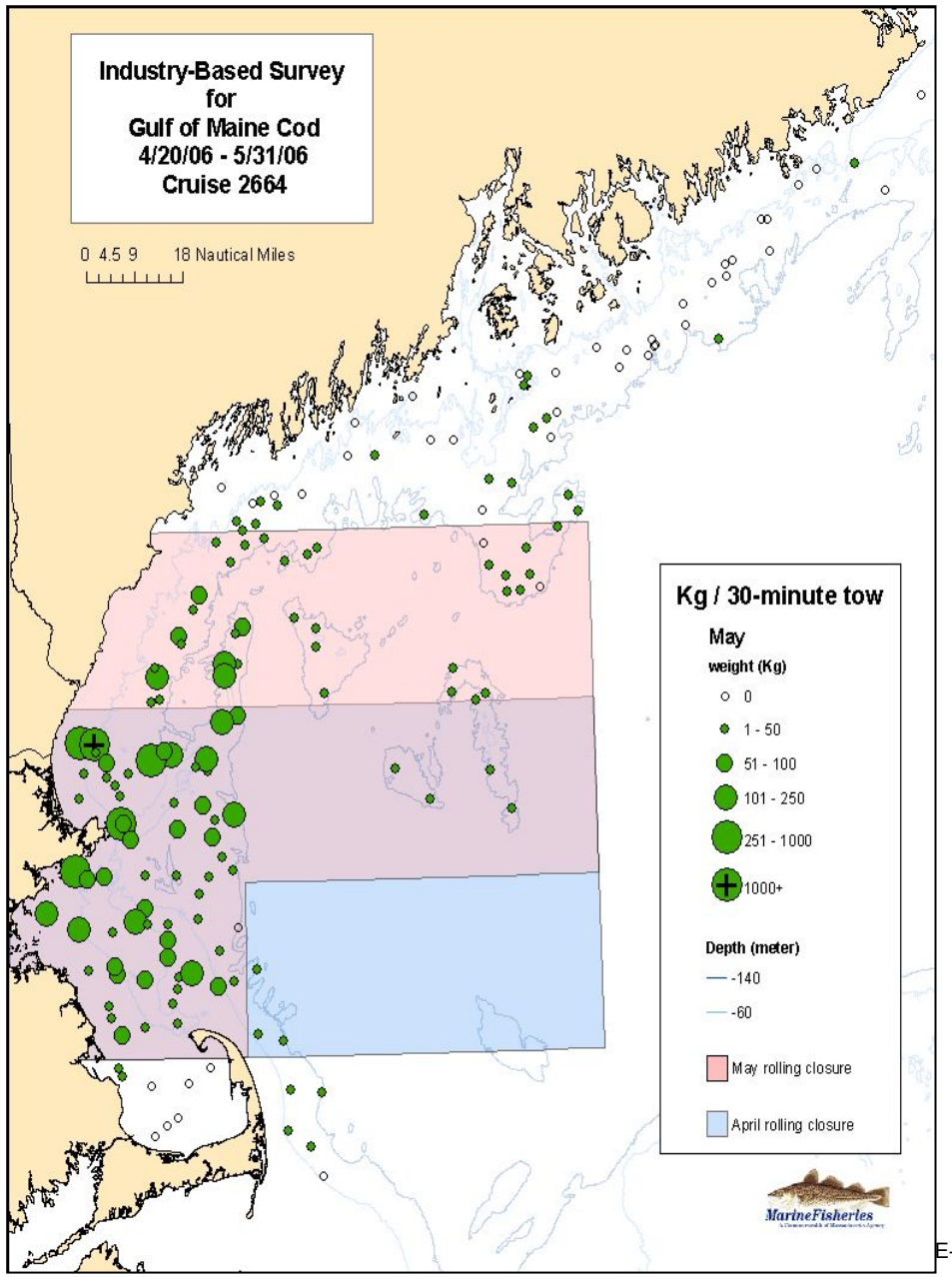
2006 - 2007 Survey Results

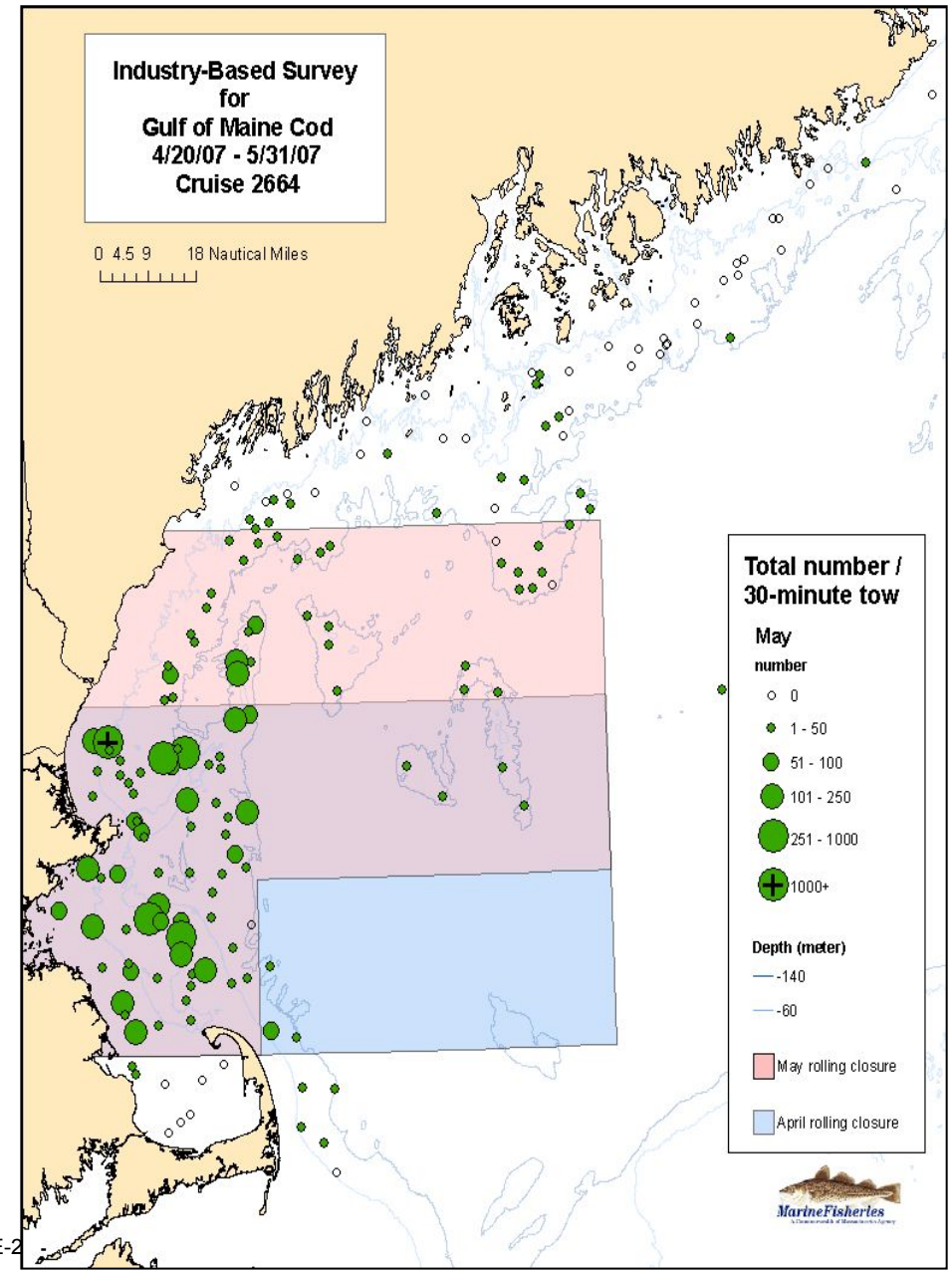
Atlantic Cod

Spatial and temporal distribution of total weight and total number

Catch Weight (kg) and Number per Tow

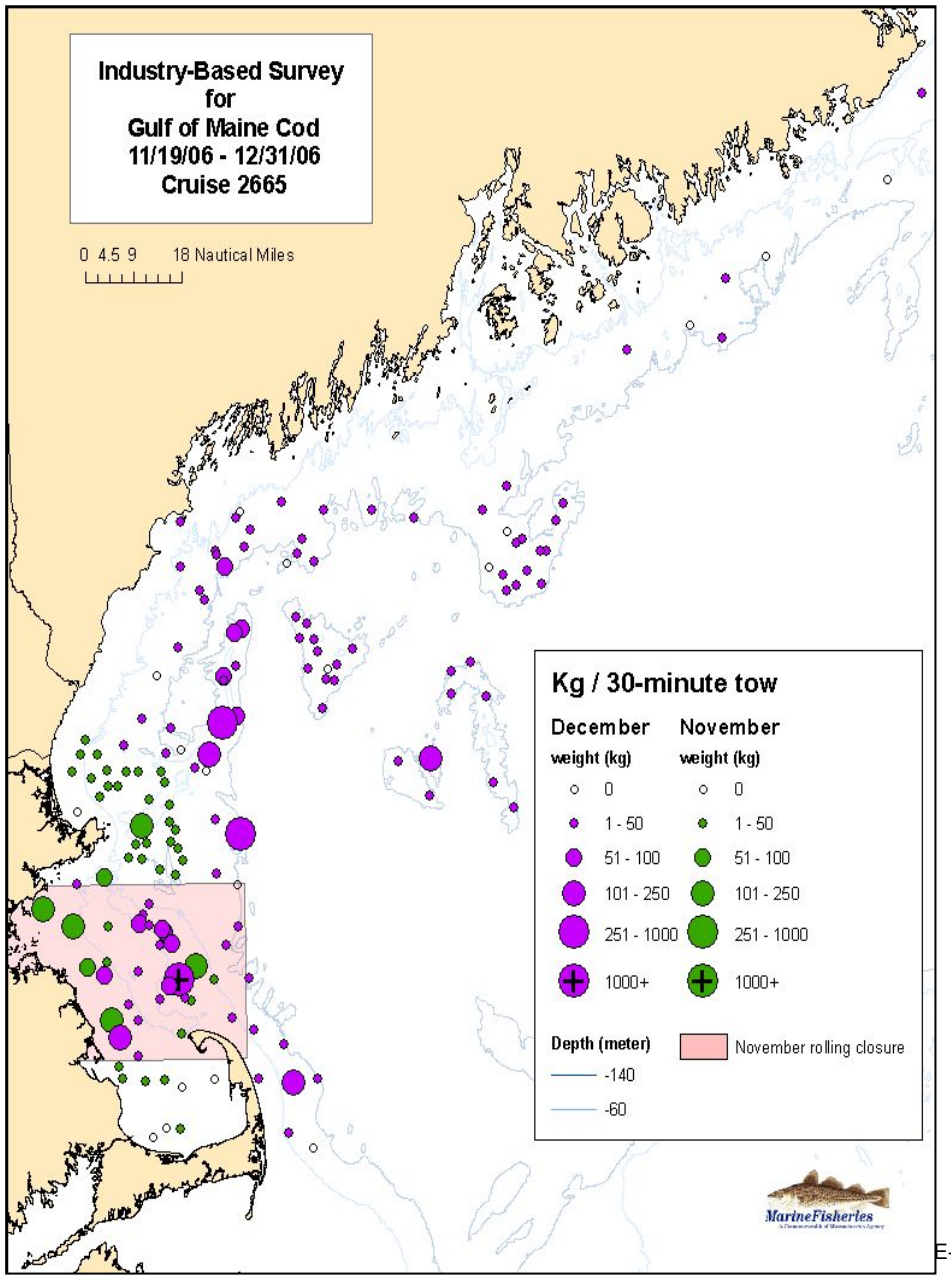
Survey results during April and May rolling closures. Weights and number standardized to 30 minutes in duration.

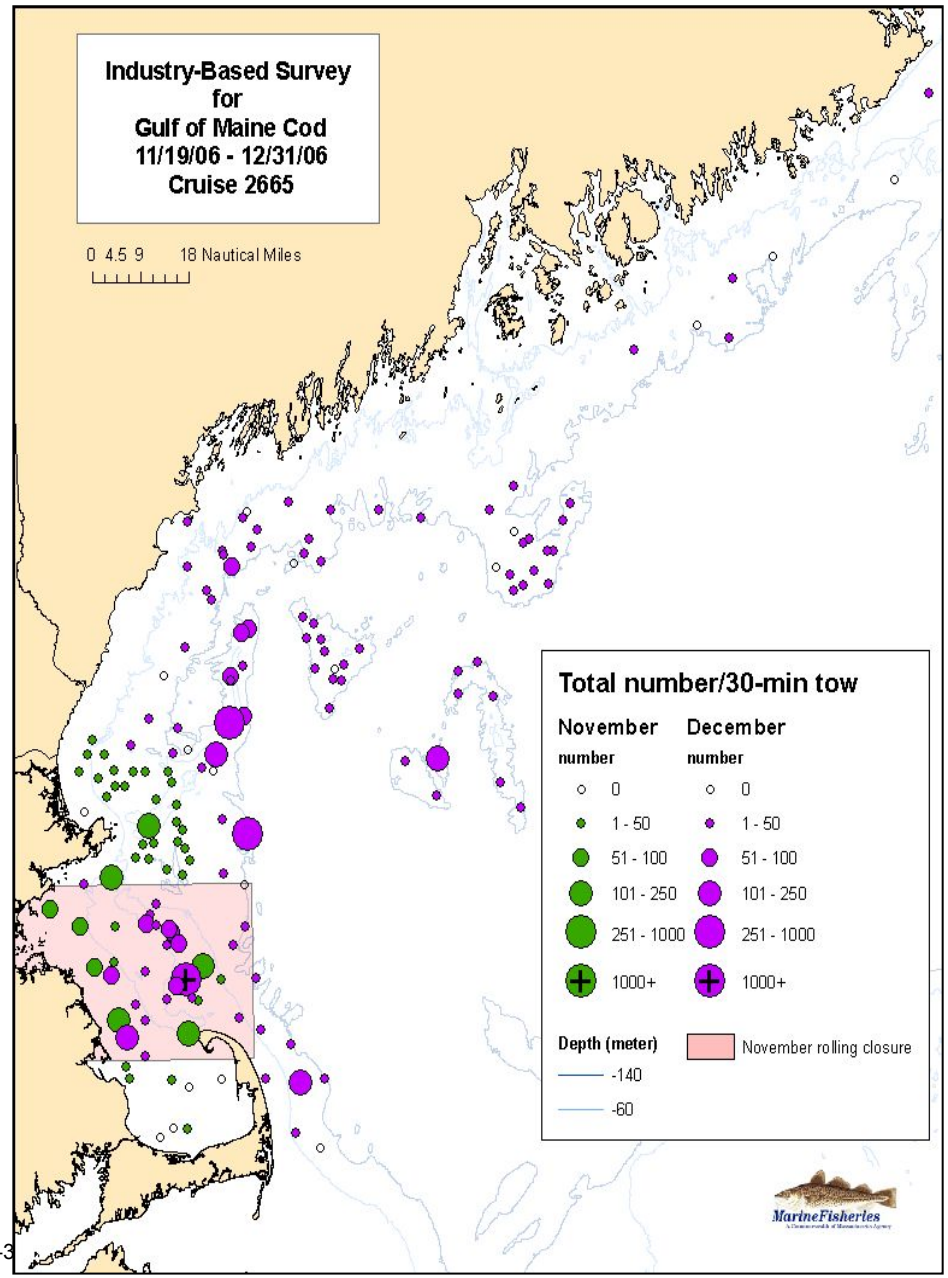




Catch Weight (kg) and Number per Tow

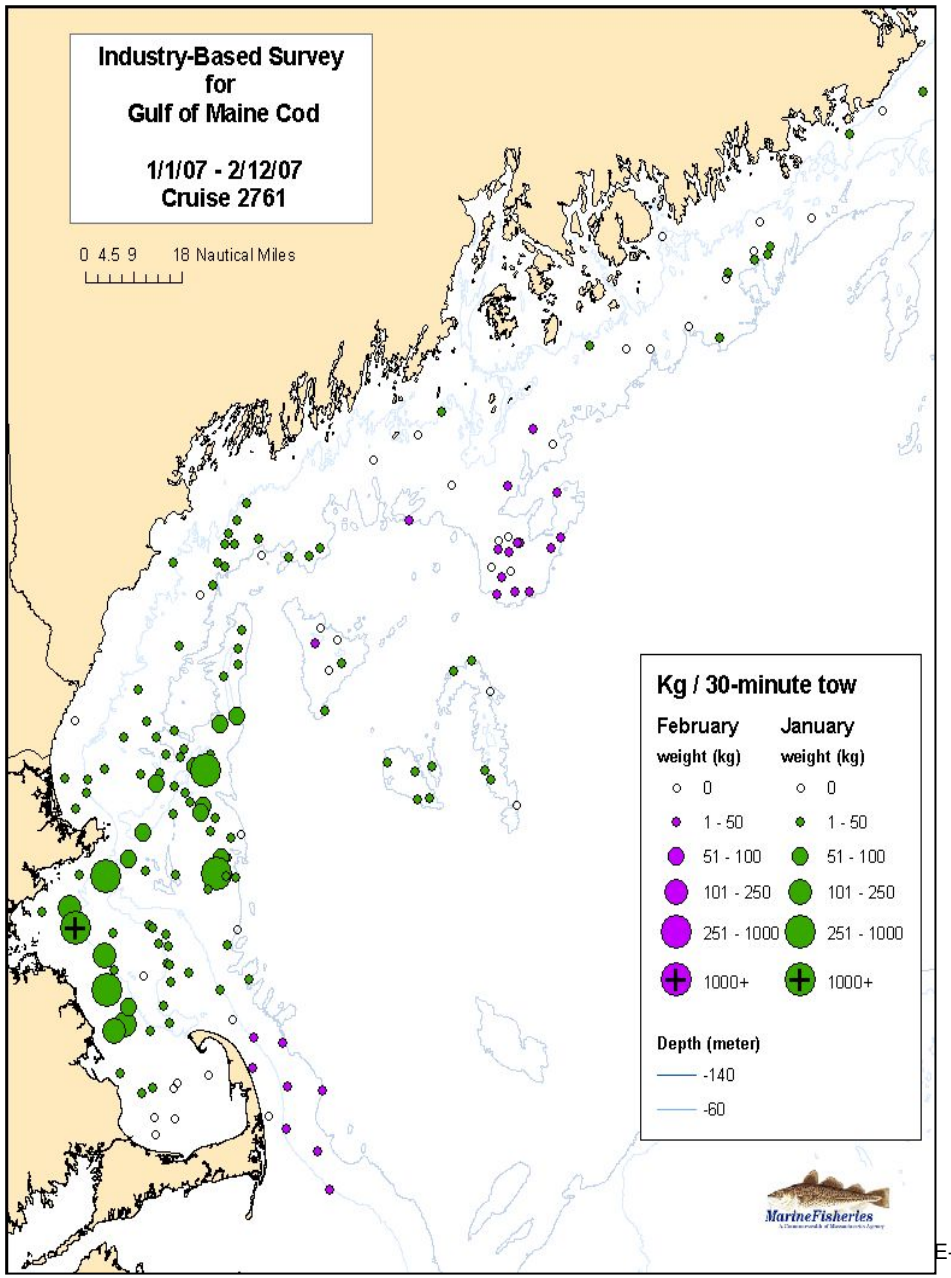
Survey results during November rolling closure. Weights and numbers standardized to 30 minutes in duration.

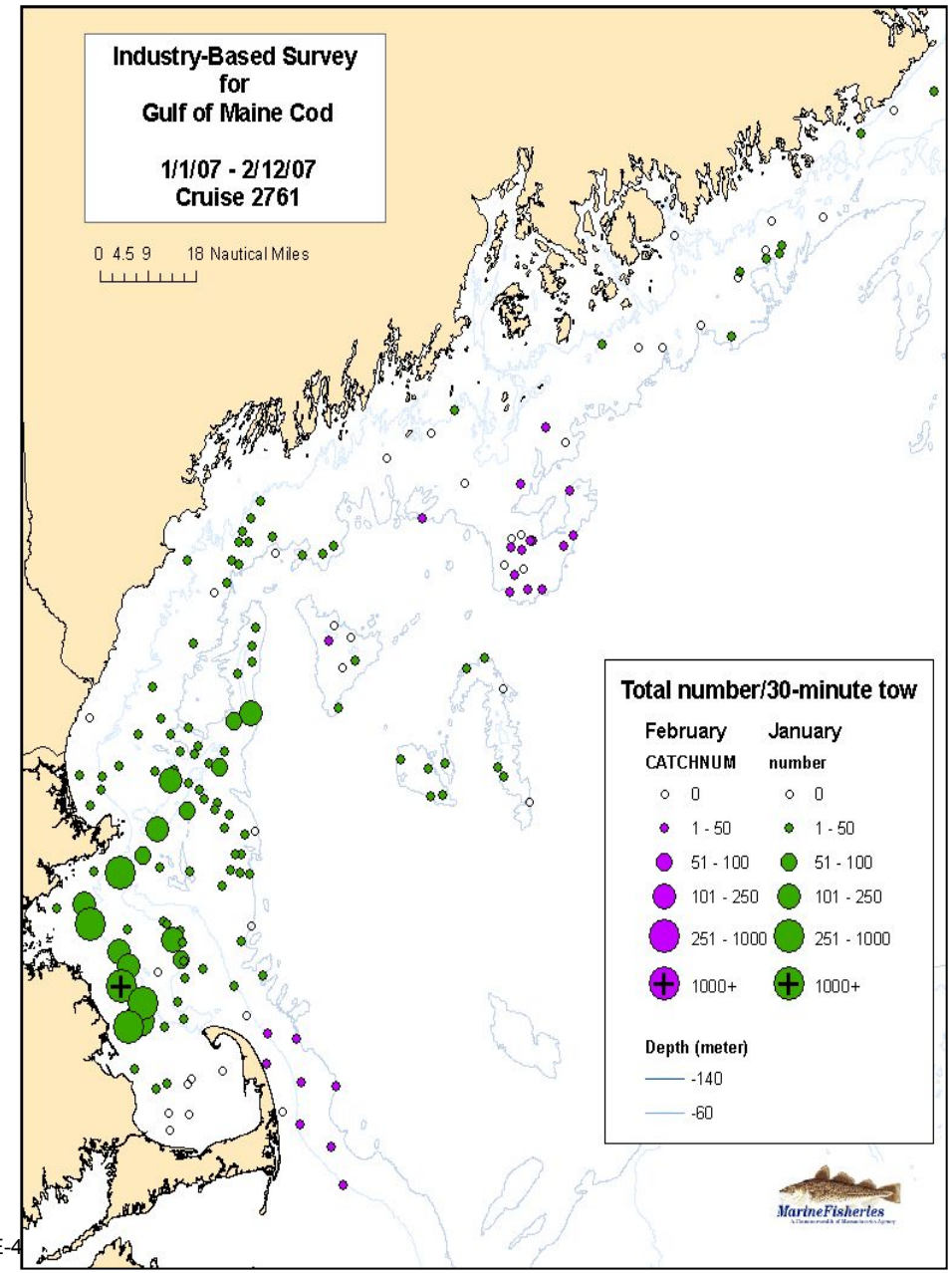




Catch Weight (kg) and Number per Tow

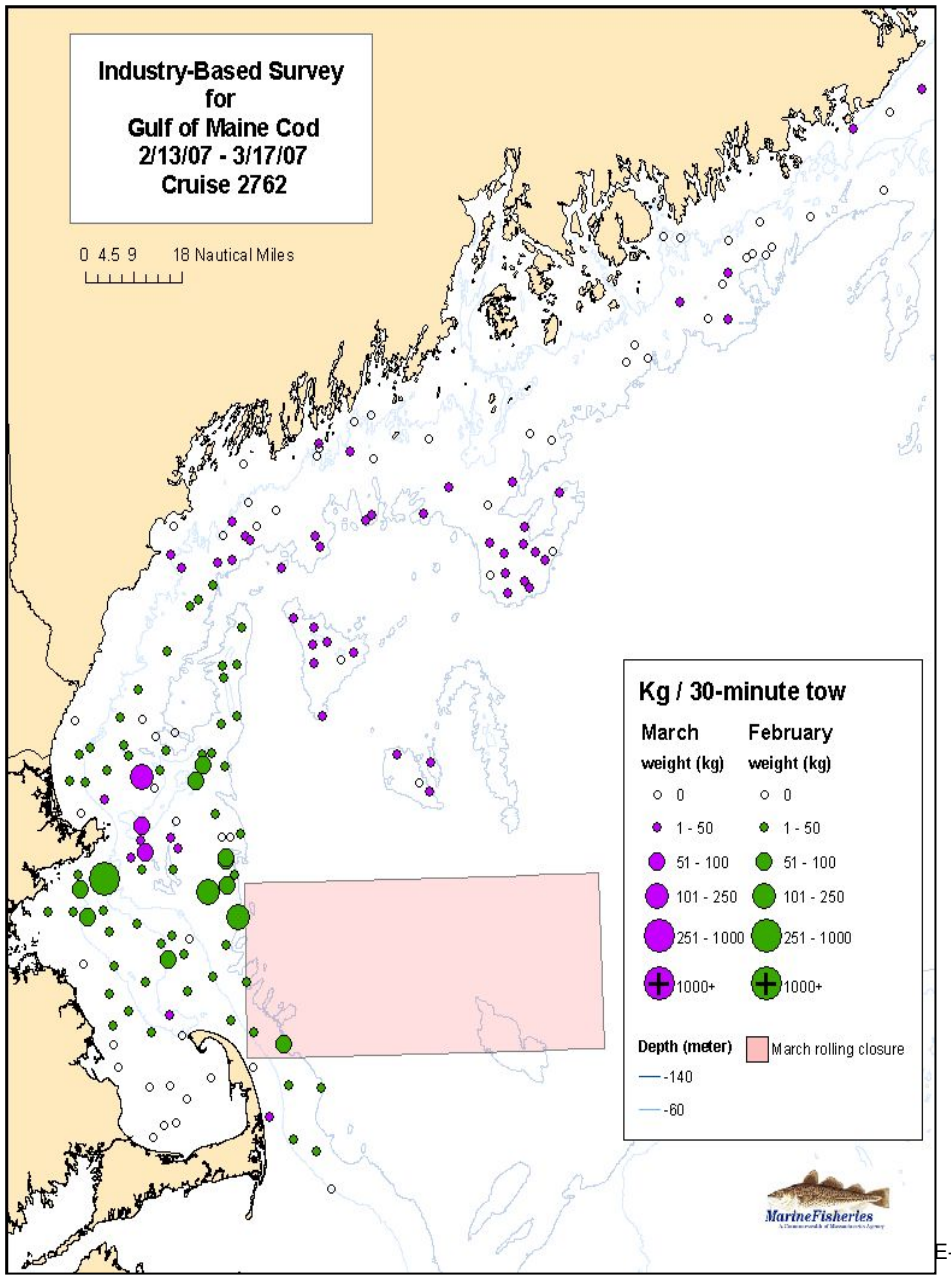
Weights and numbers standardized to 30 minutes in duration.

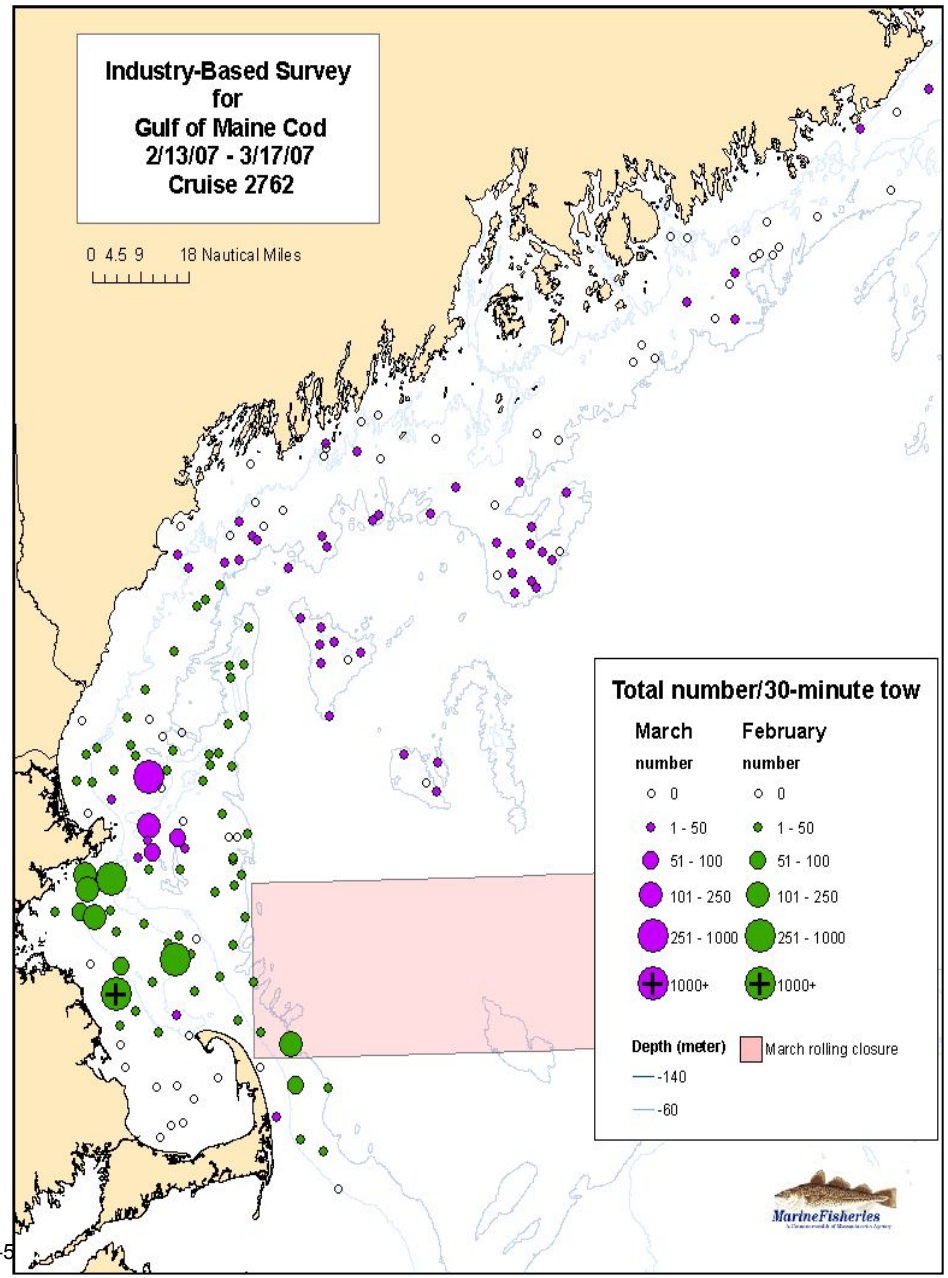




Catch Weight (kg) and Number per Tow

* Survey results during March rolling closure. Weights and numbers standardized to 30 minutes in duration.





Industry-Based Survey for Gulf of Maine Cod

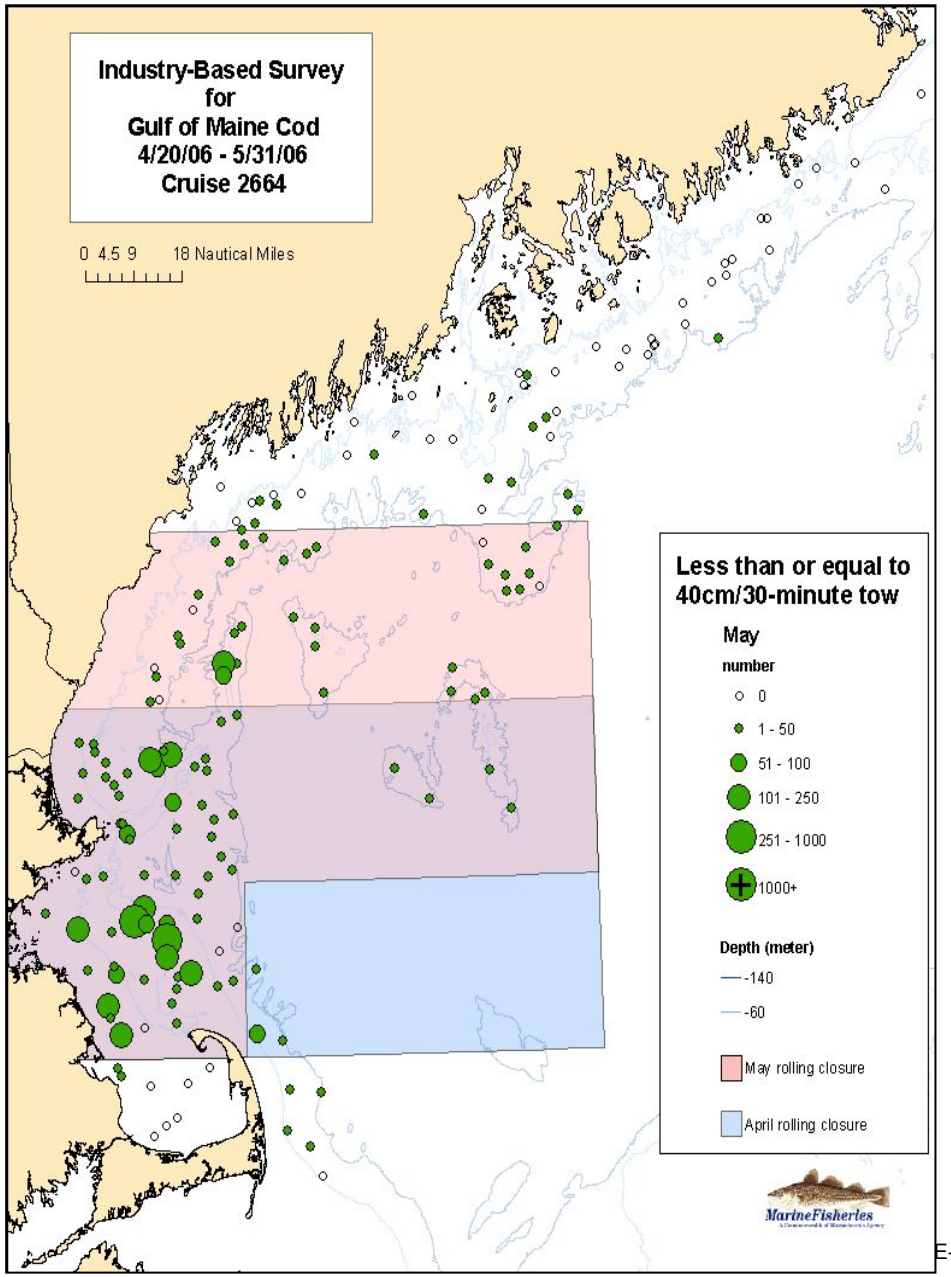
2006 - 2007 Survey Results

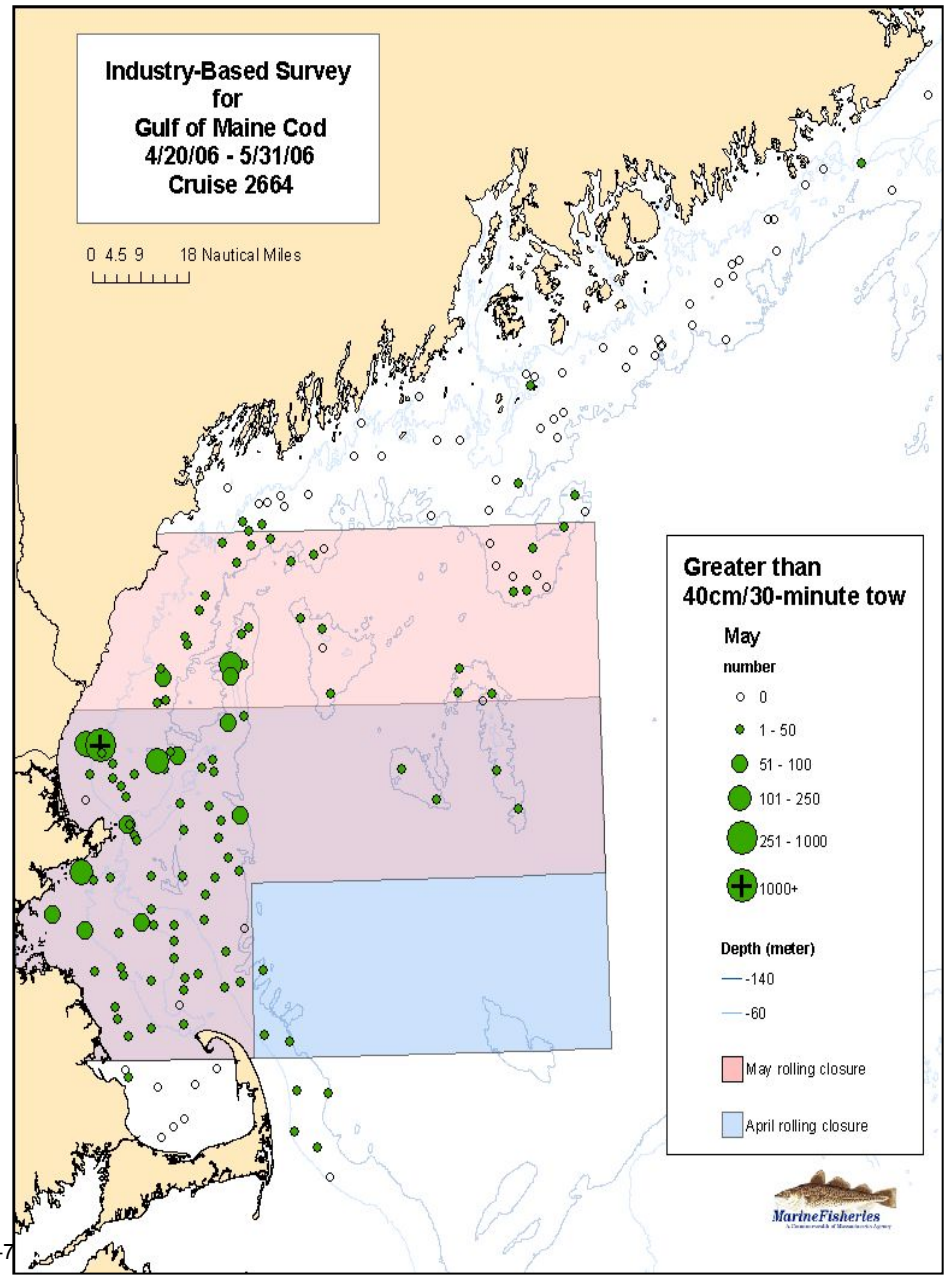
Atlantic Cod

Spatial and temporal distribution by number less than or equal to 40 cm (approximates juveniles) and number greater than 40 cm (approximates adults)

Number Less Than or Equal 40 cm and Number Greater Than 40 cm per Tow

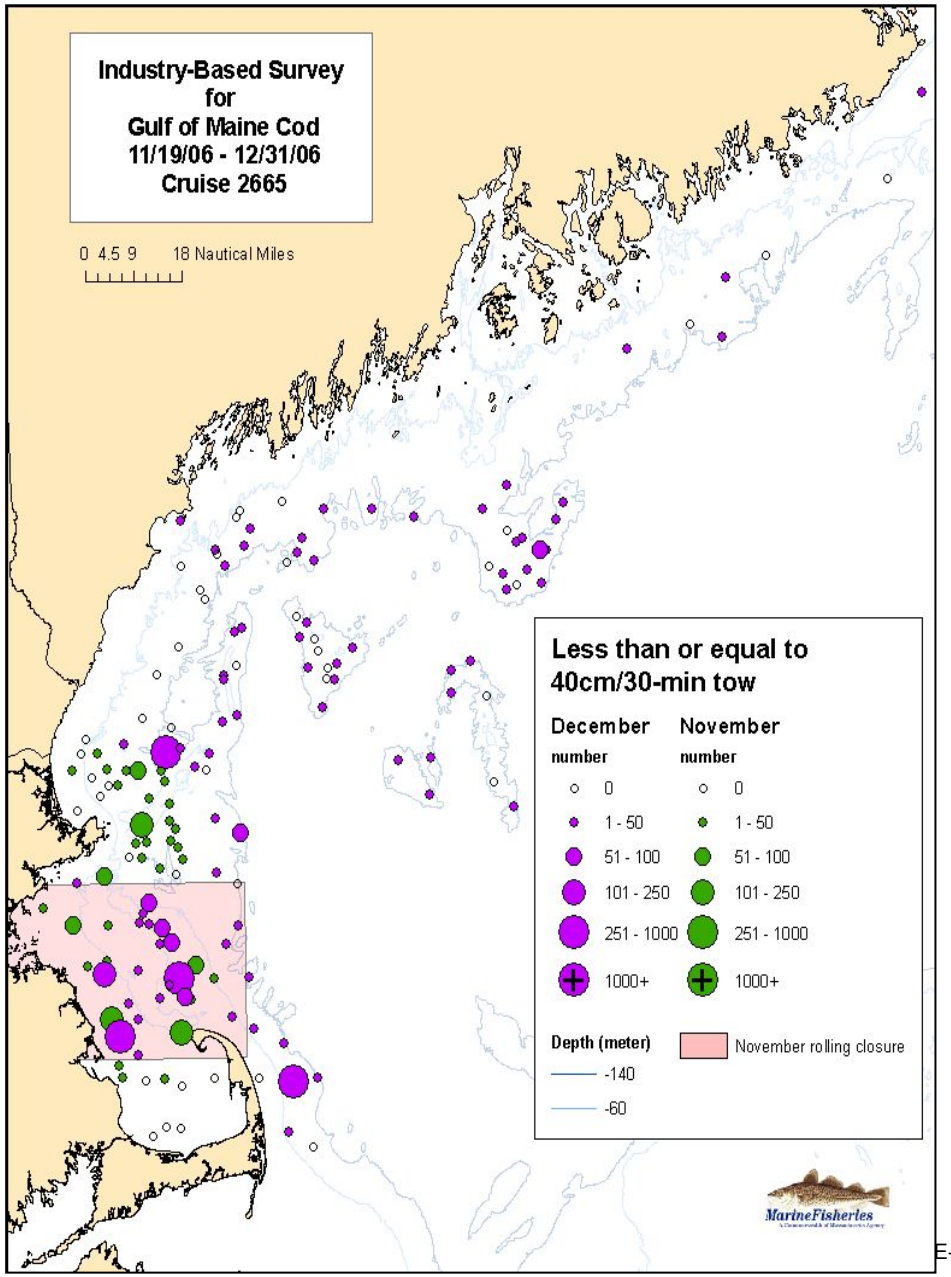
* Survey results during April and May rolling closure periods. Numbers standardized to 30 minutes in duration.

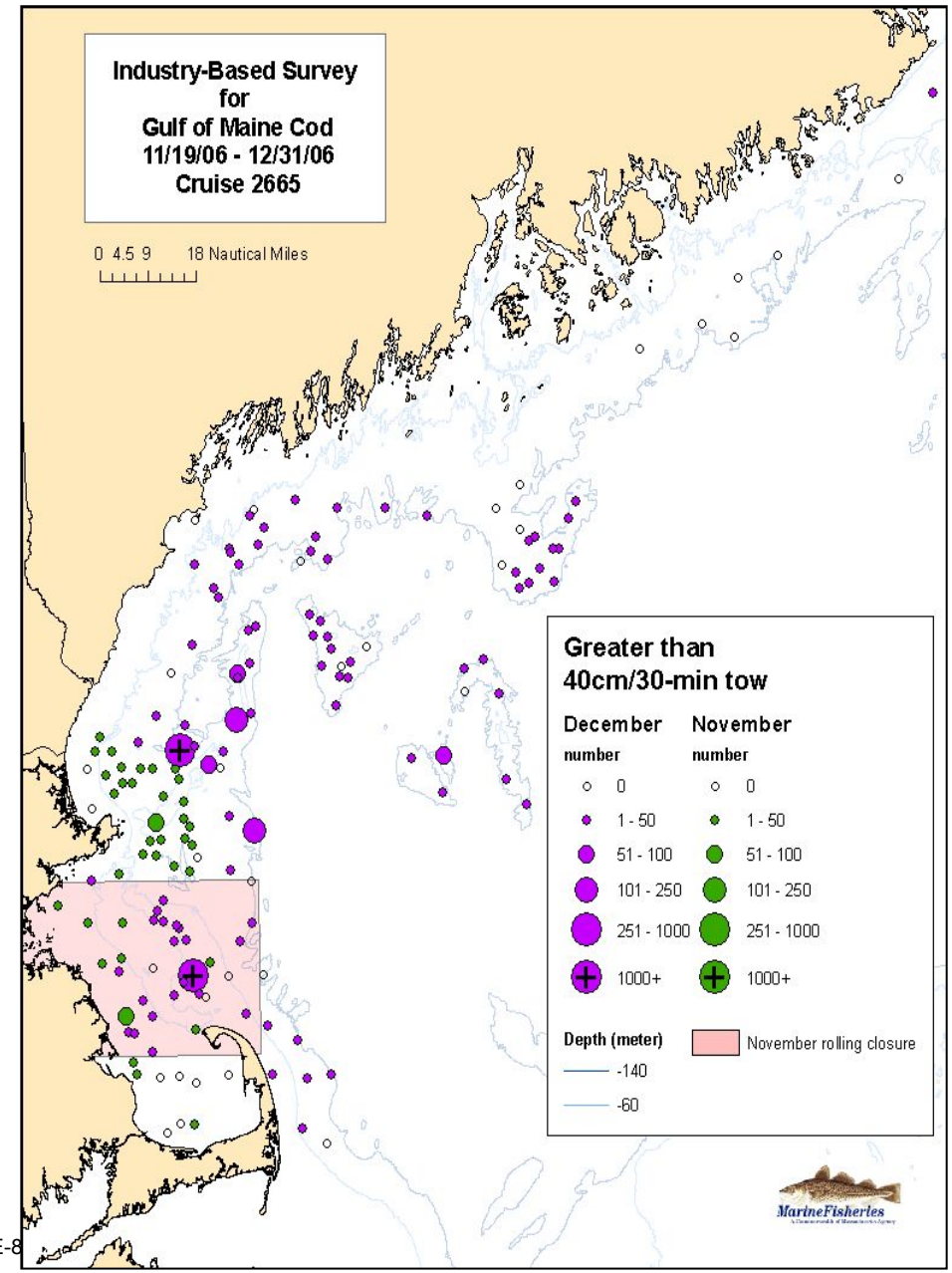




Number Less Than or Equal 40 cm and Number Greater Than 40 cm per Tow

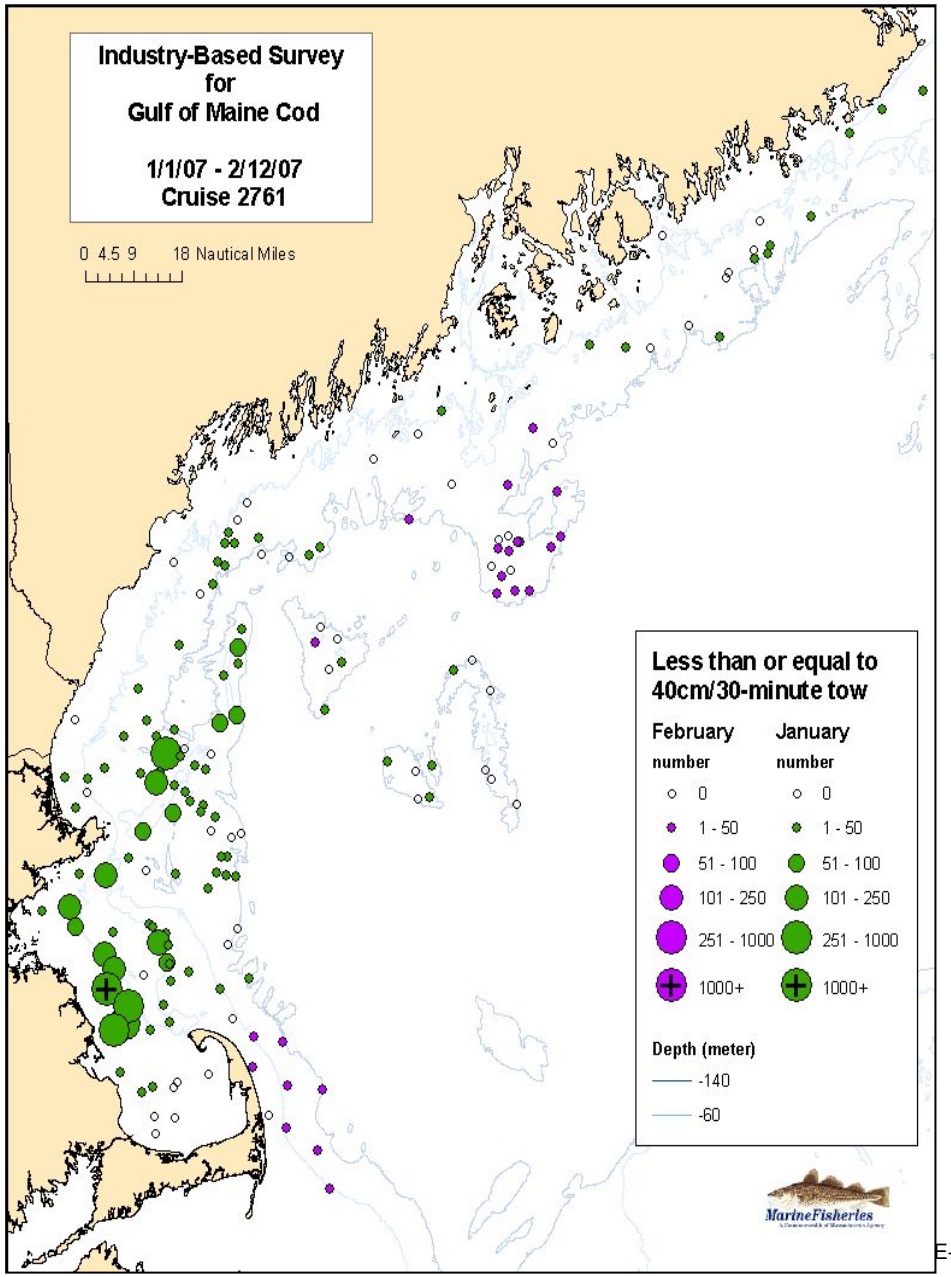
* Survey results during November rolling closure period. Numbers standardized to 30 minutes in duration.

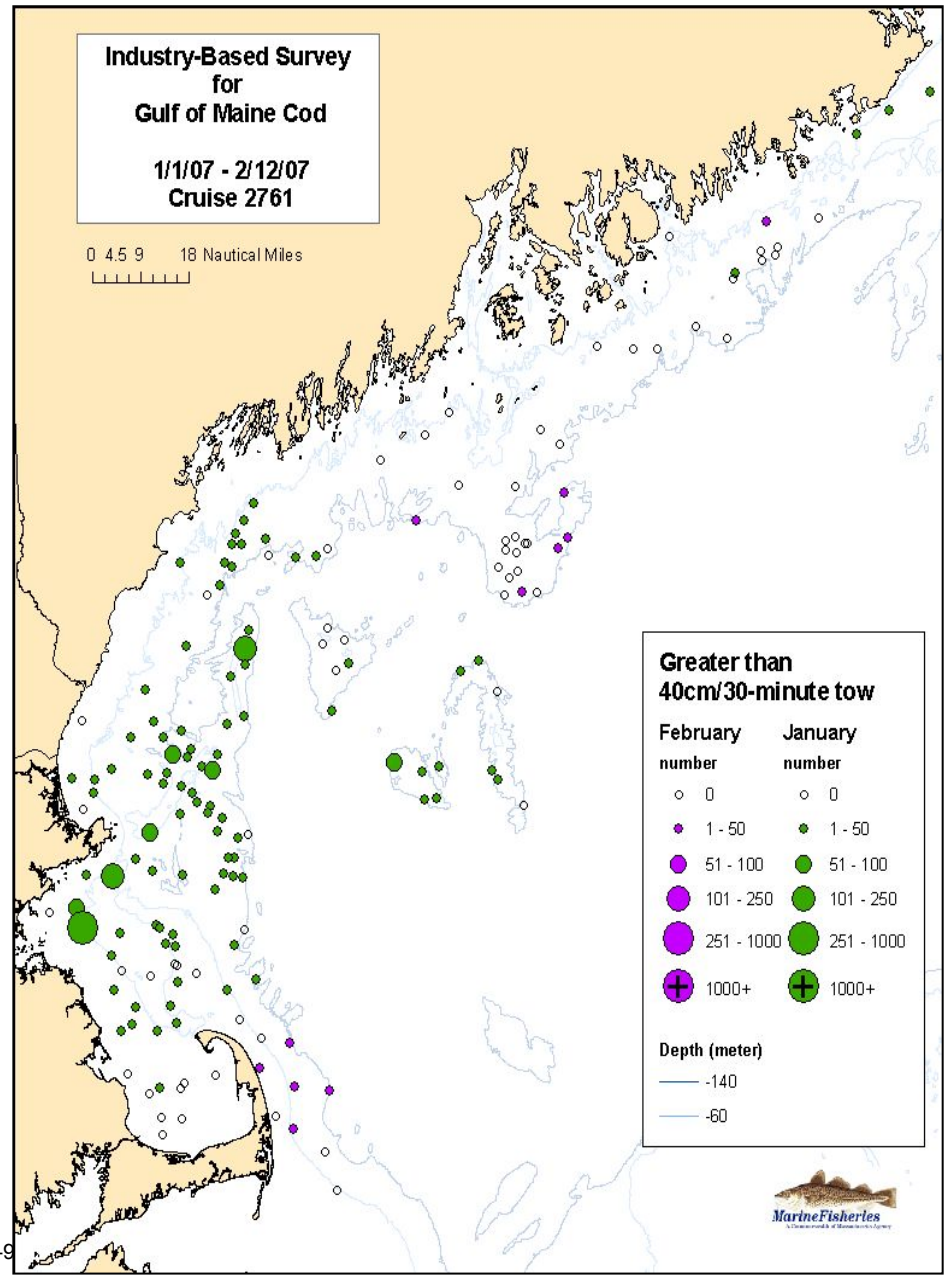




Number Less Than or Equal 40 cm and Number Greater Than 40 cm per Tow

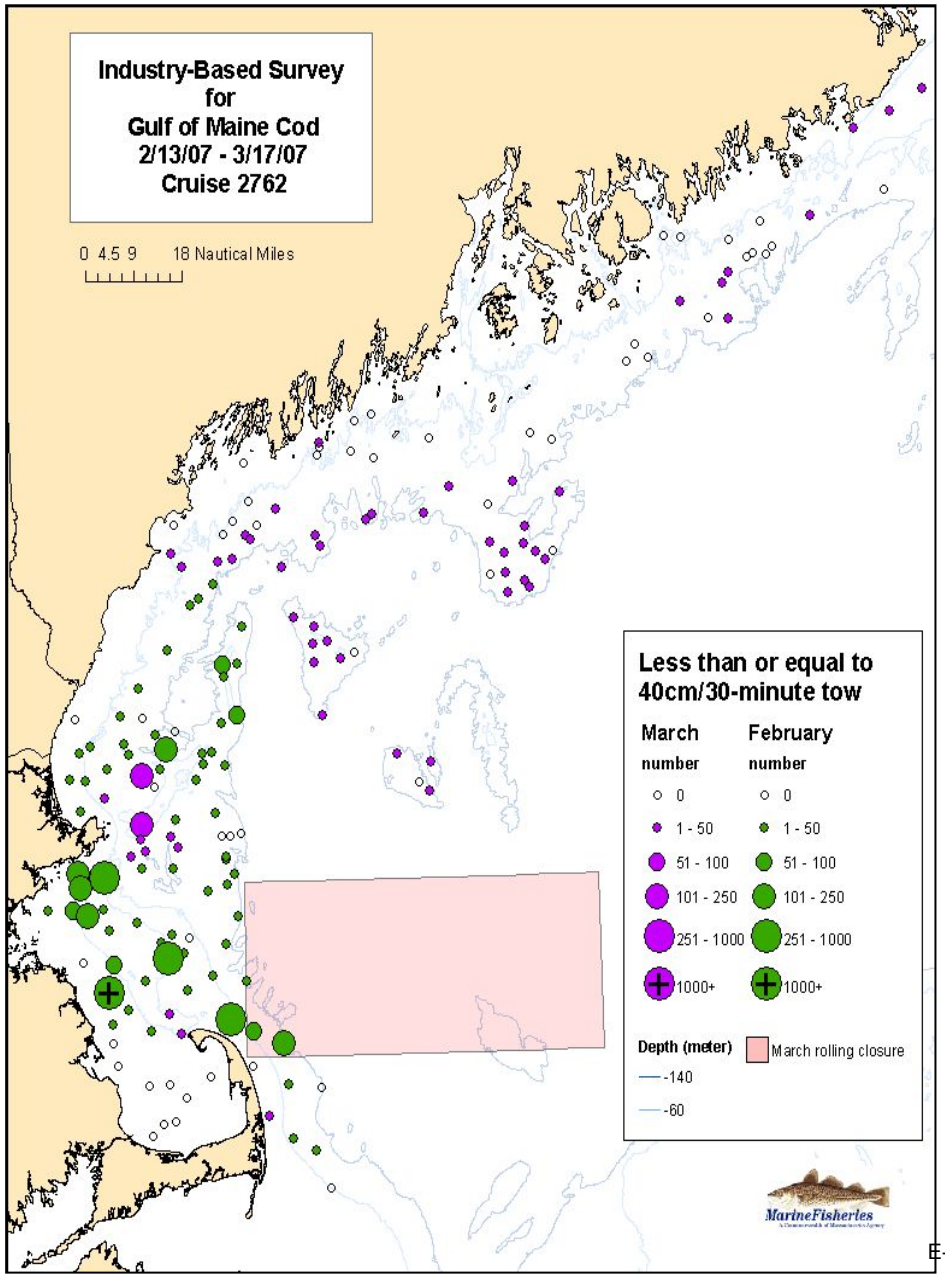
* Numbers standardized to 30 minutes in duration.

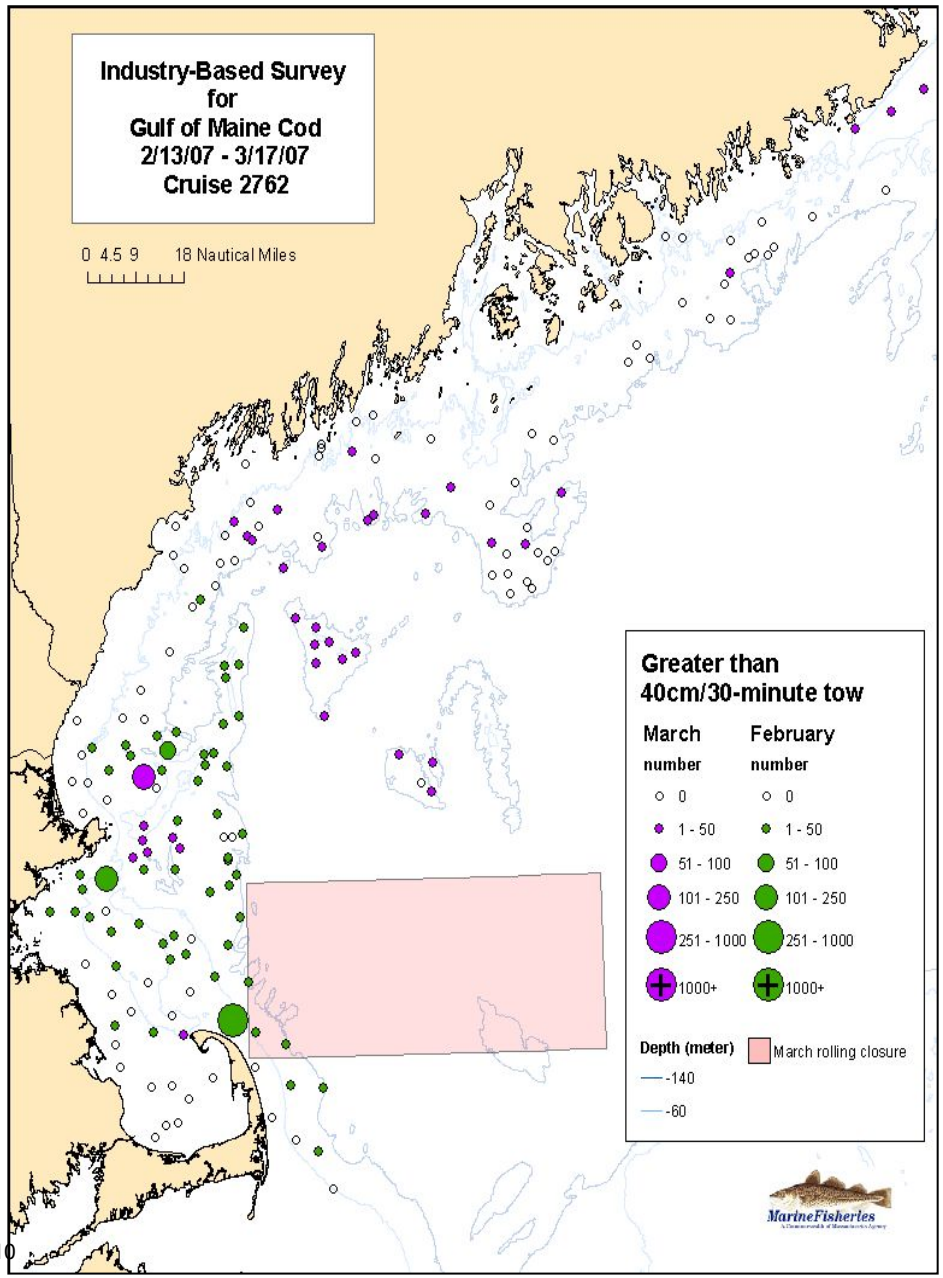




Number Less Than or Equal 40 cm and Number Greater Than 40 cm per Tow

* Survey results during March closure period. Numbers standardized to 30 minutes in duration.





Industry-Based Survey for Gulf of Maine Cod

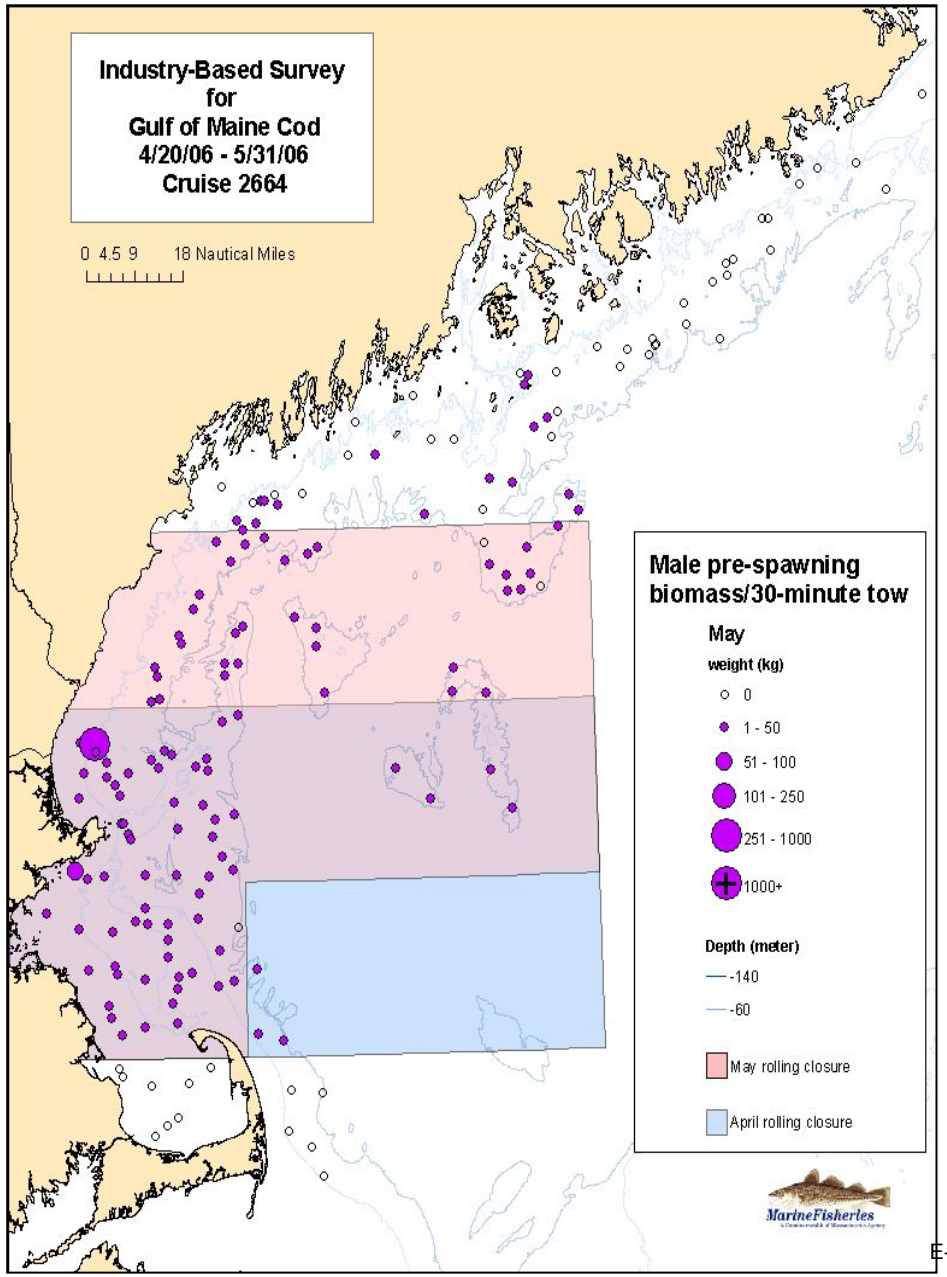
2006 - 2007 Survey Results

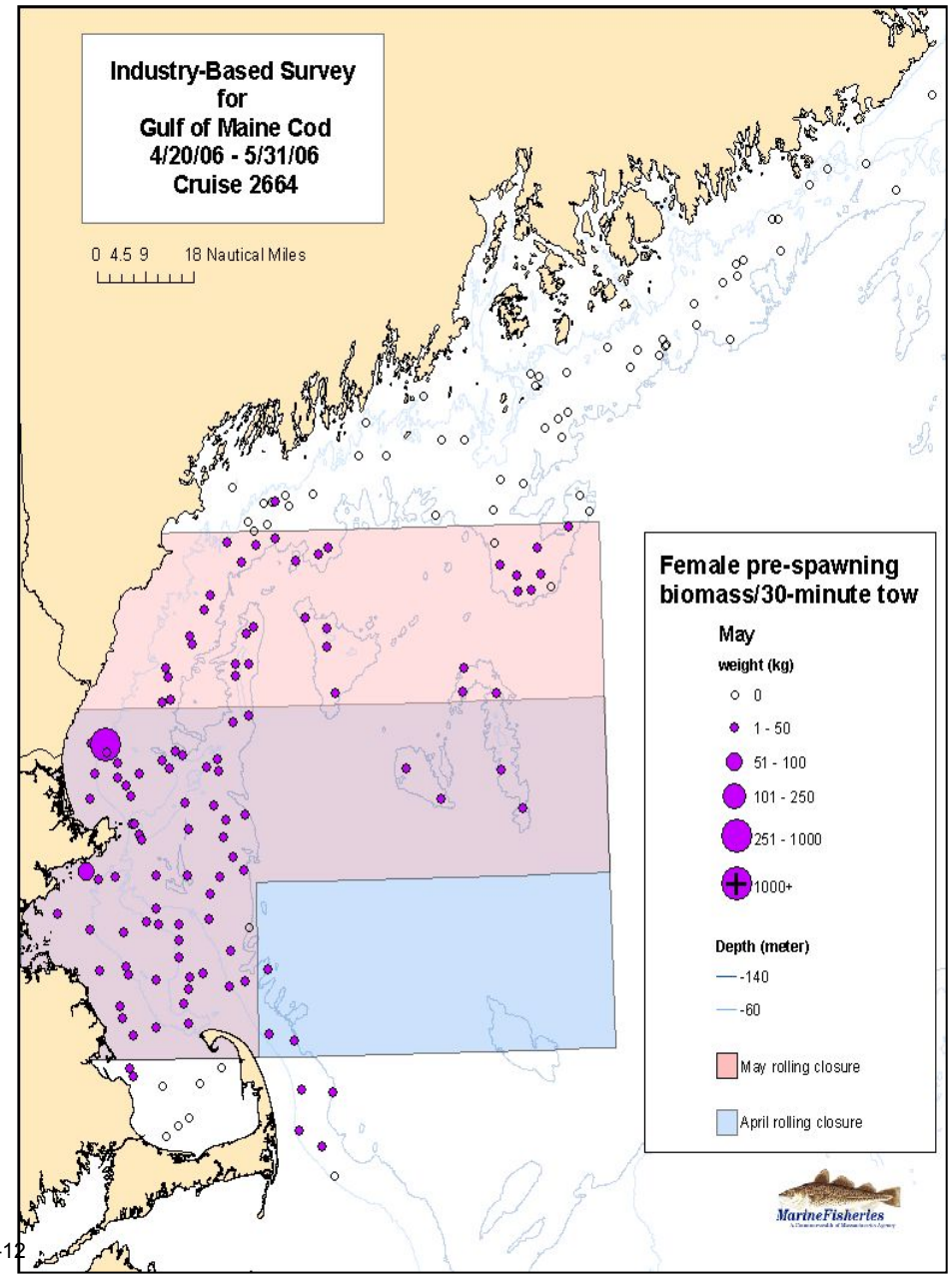
Atlantic Cod

Spatial and temporal distribution by sex of estimated prespawning condition biomass (developing fish)

Estimated Biomass (kg) of Prespawning Males and Females

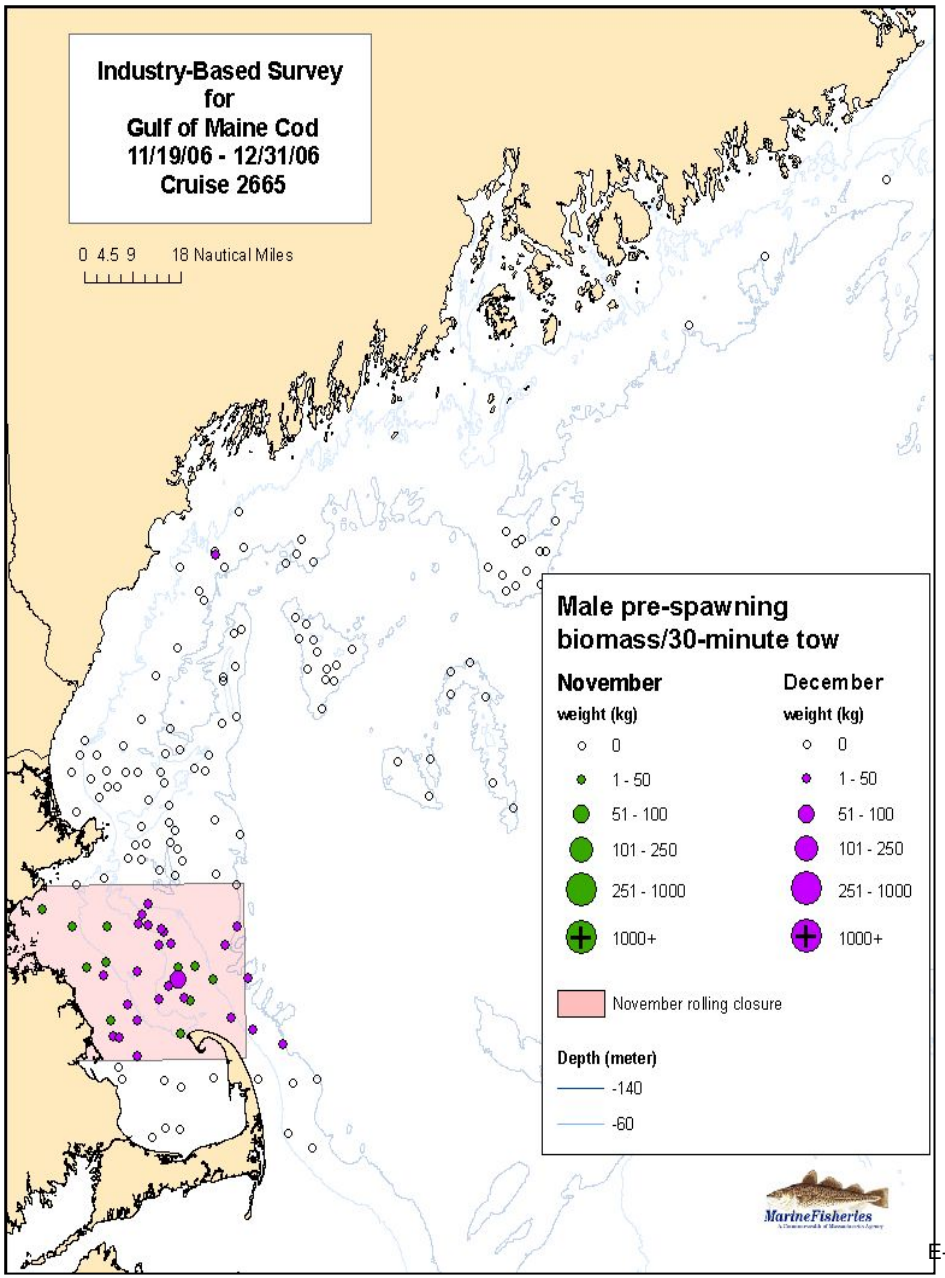
* Survey results during May rolling closure period. Weights standardized to 30 minutes in duration.

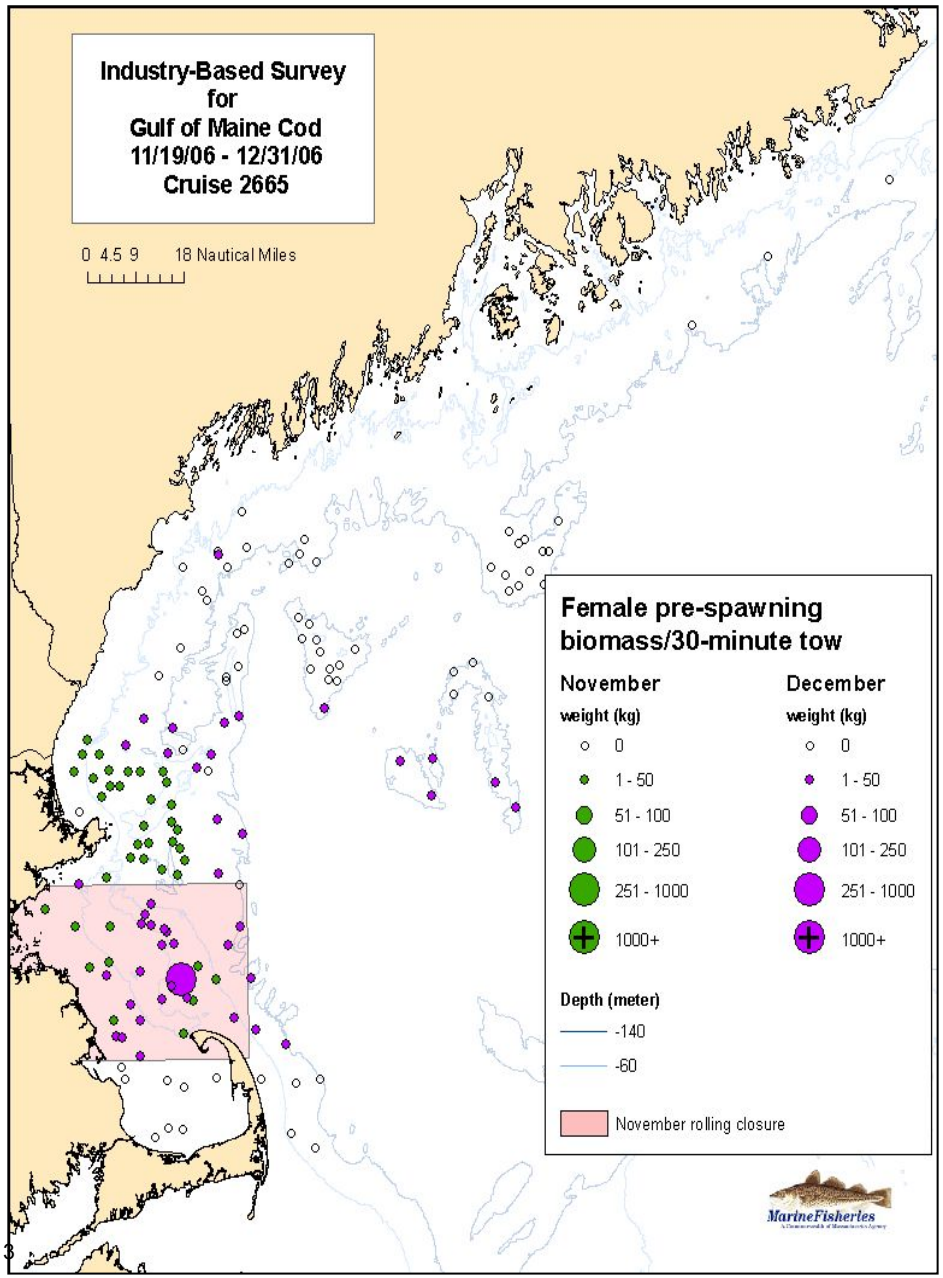




Estimated Biomass (kg) of Prespawning Males and Females

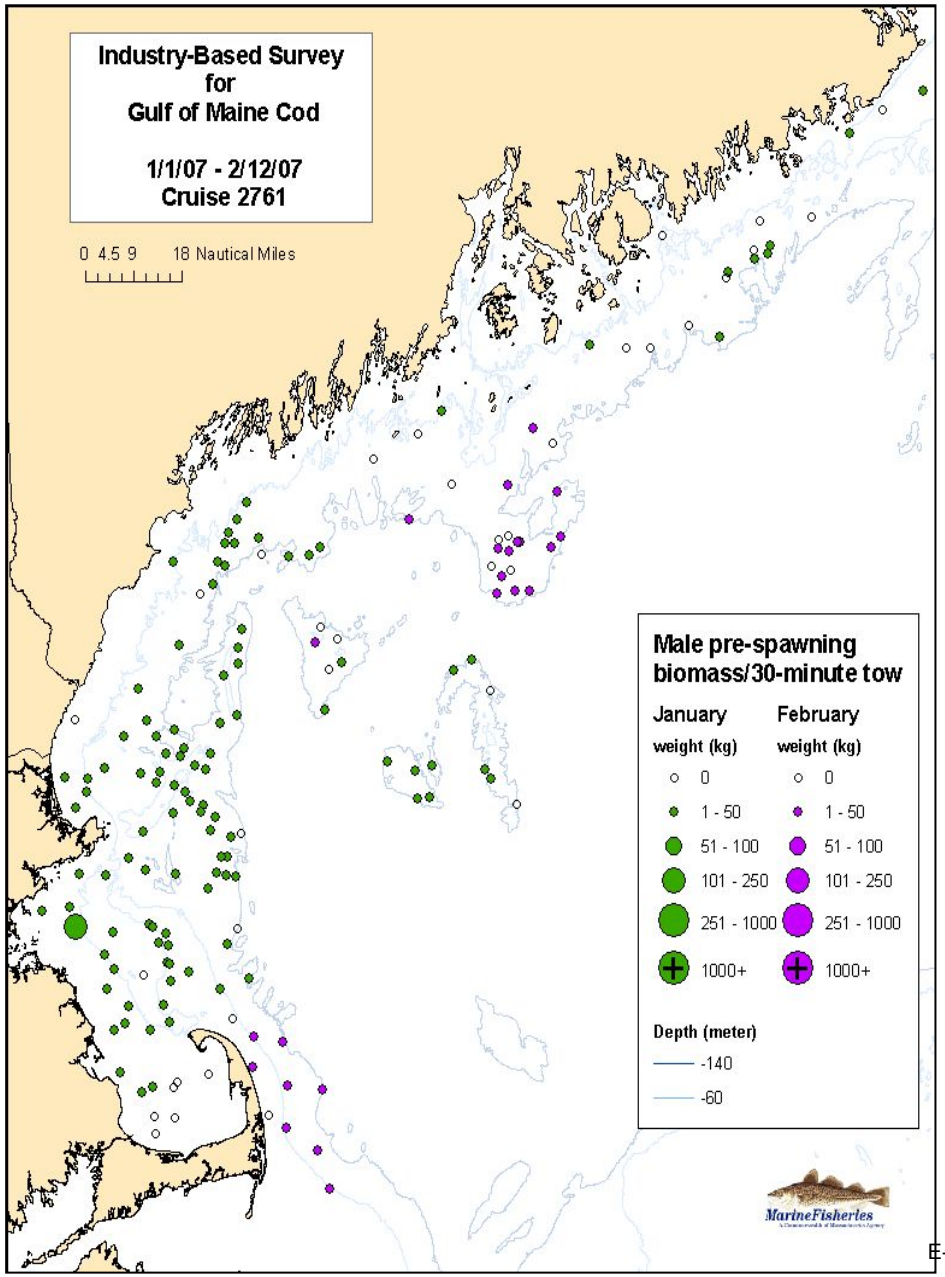
* Survey results during November rolling closure period. Weights standardized to 30 minutes in duration.

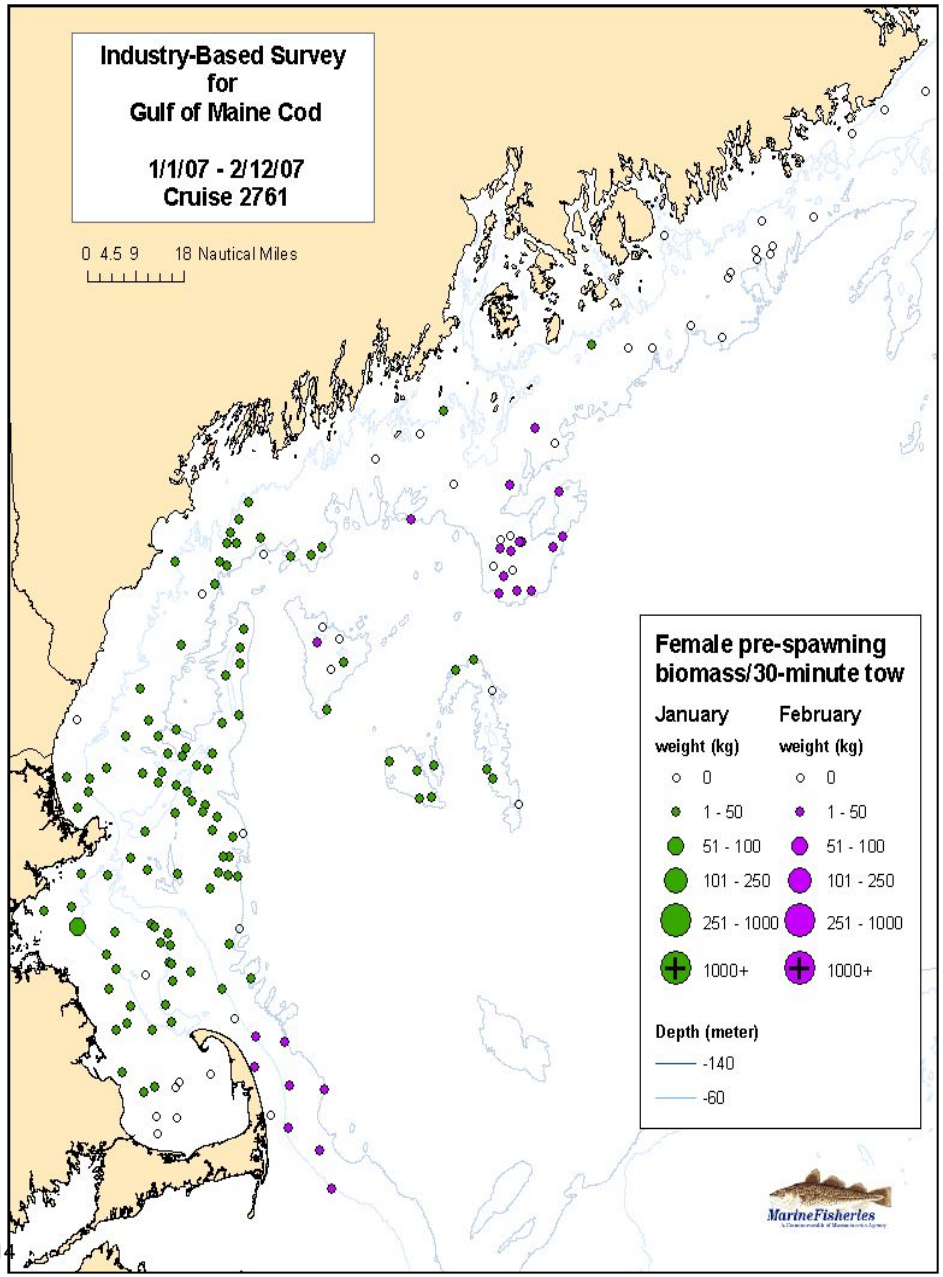




Estimated Biomass (kg) of Prespawning Males and Females

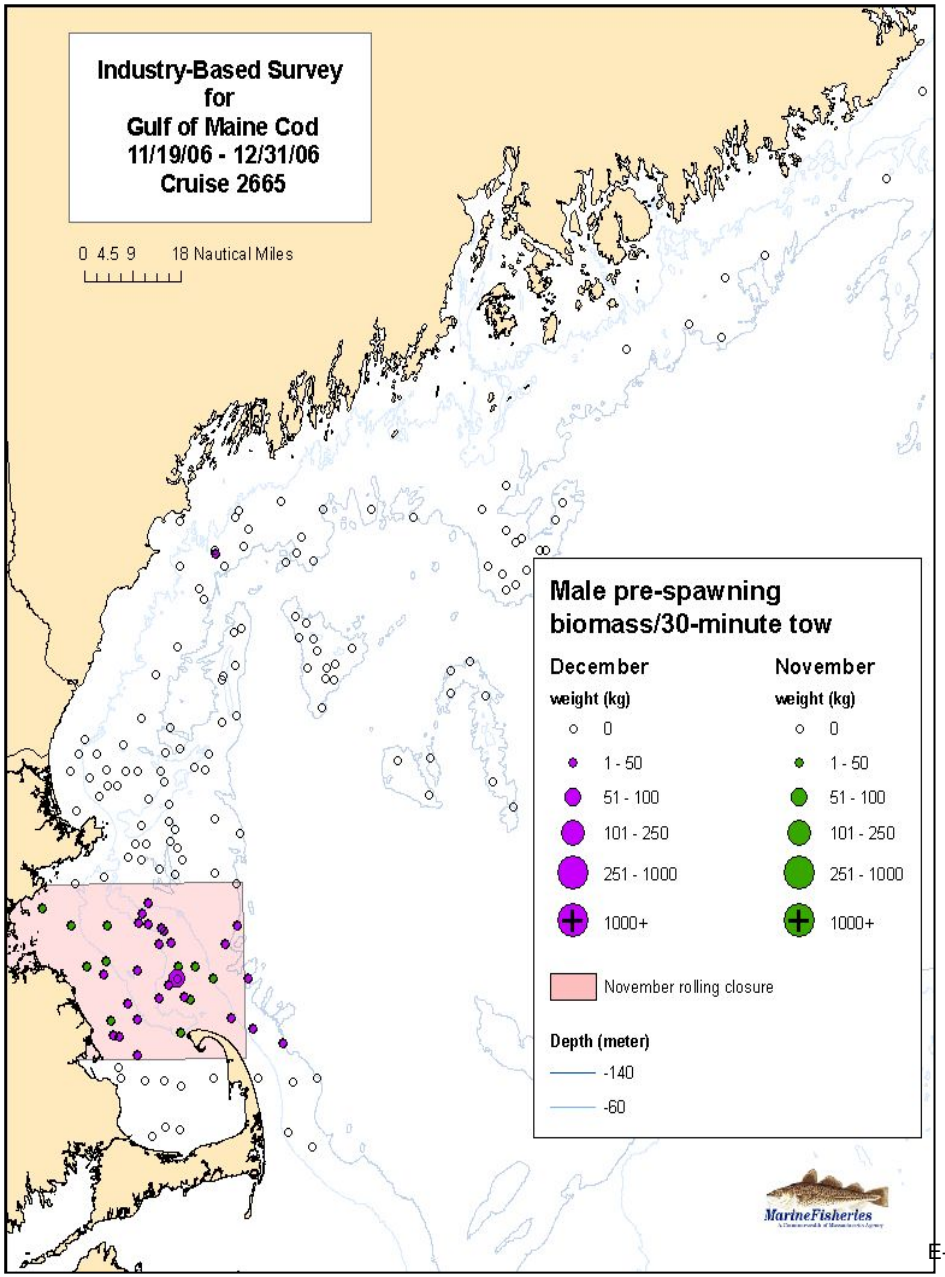
* Weights standardized to 30 minutes in duration.

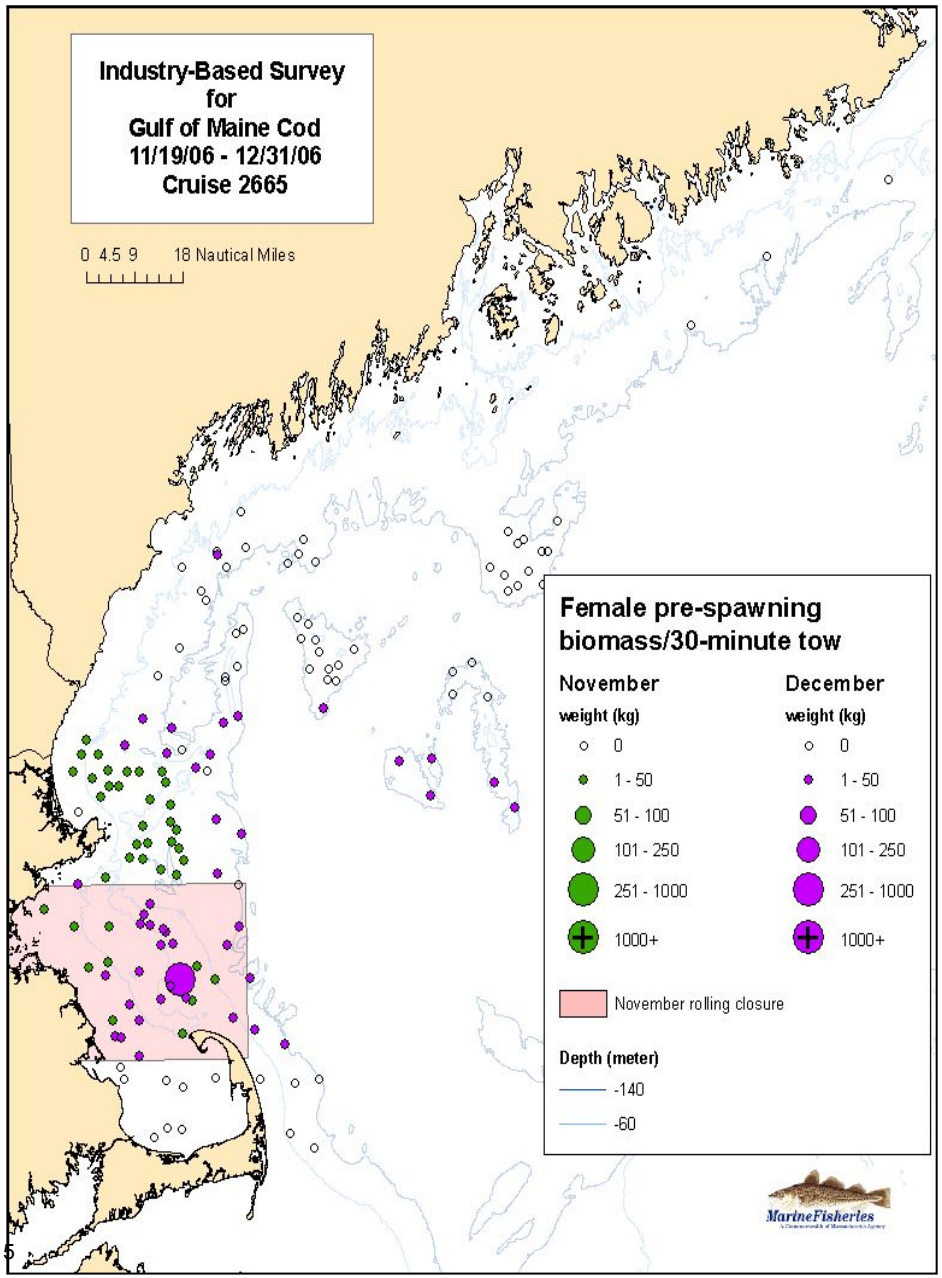




Estimated Biomass (kg) of Prespawning Males and Females

* Survey results during November rolling closure periods. Weights standardized to 30 minutes in duration.





Industry-Based Survey for Gulf of Maine Cod

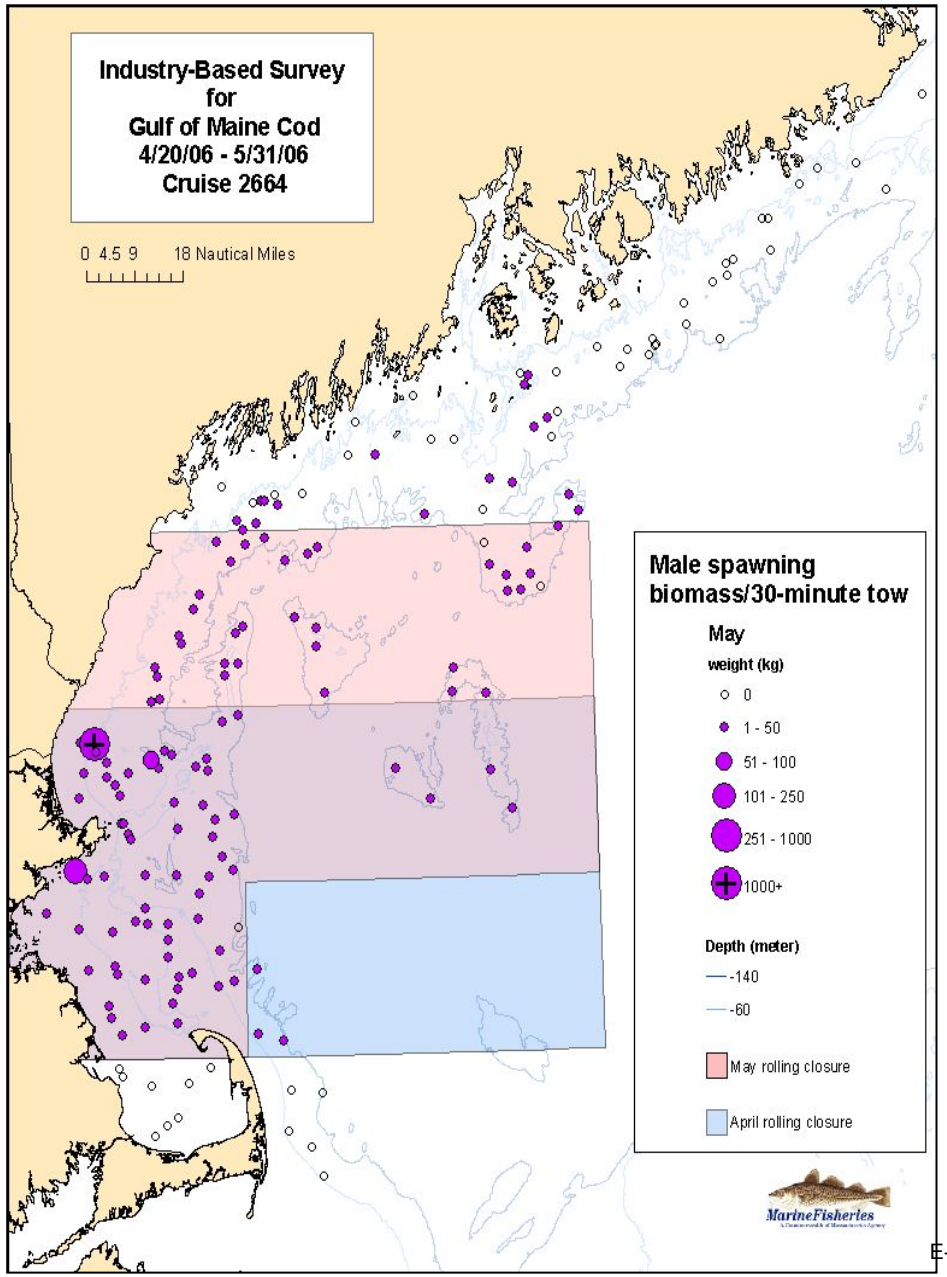
2006 - 2007 Survey Results

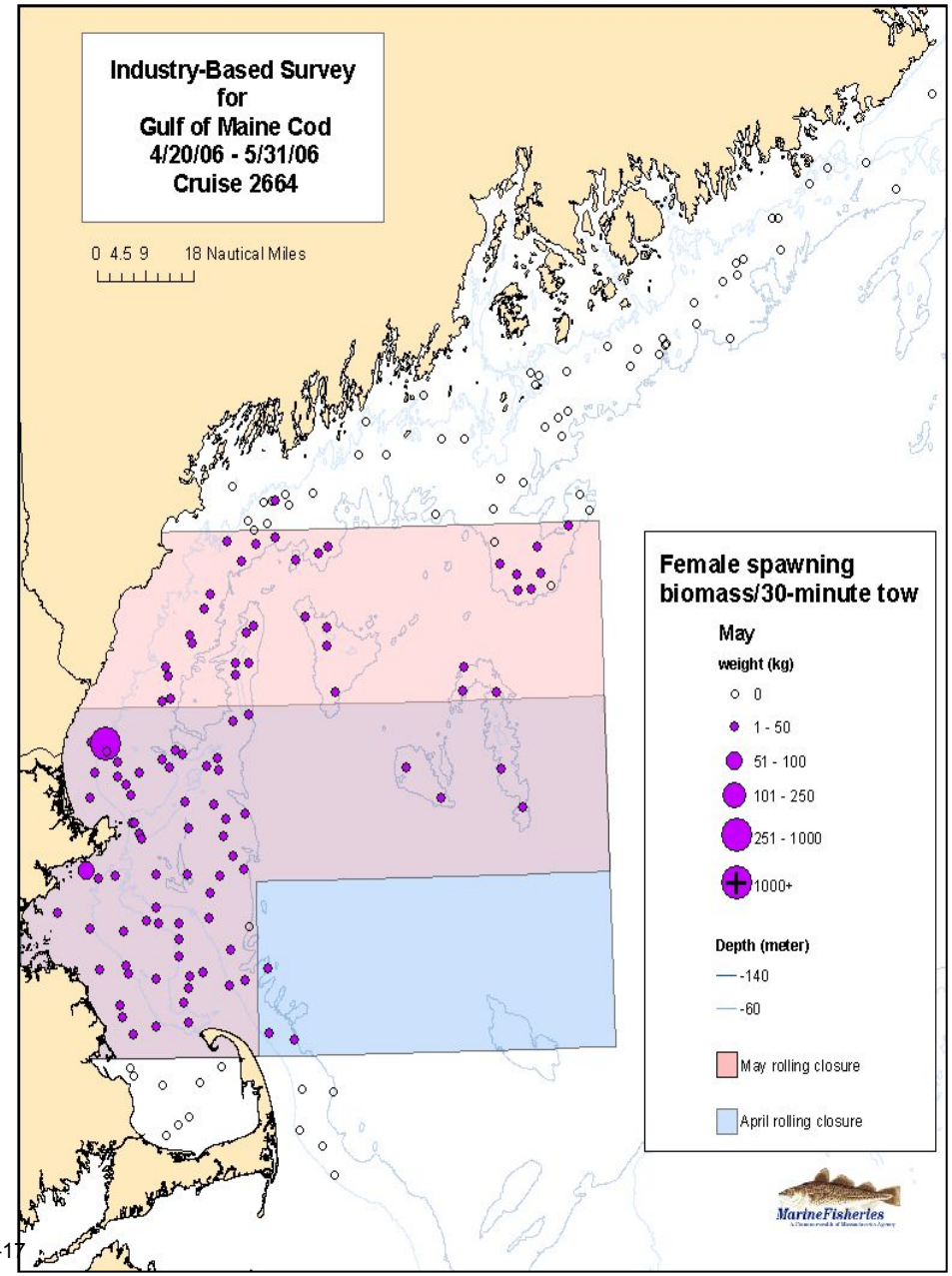
Atlantic Cod

Spatial and temporal distribution by sex of estimated spawning condition biomass (ripe, ripe & running and spent fish)

Estimated Biomass (kg) of Spawning Males and Females

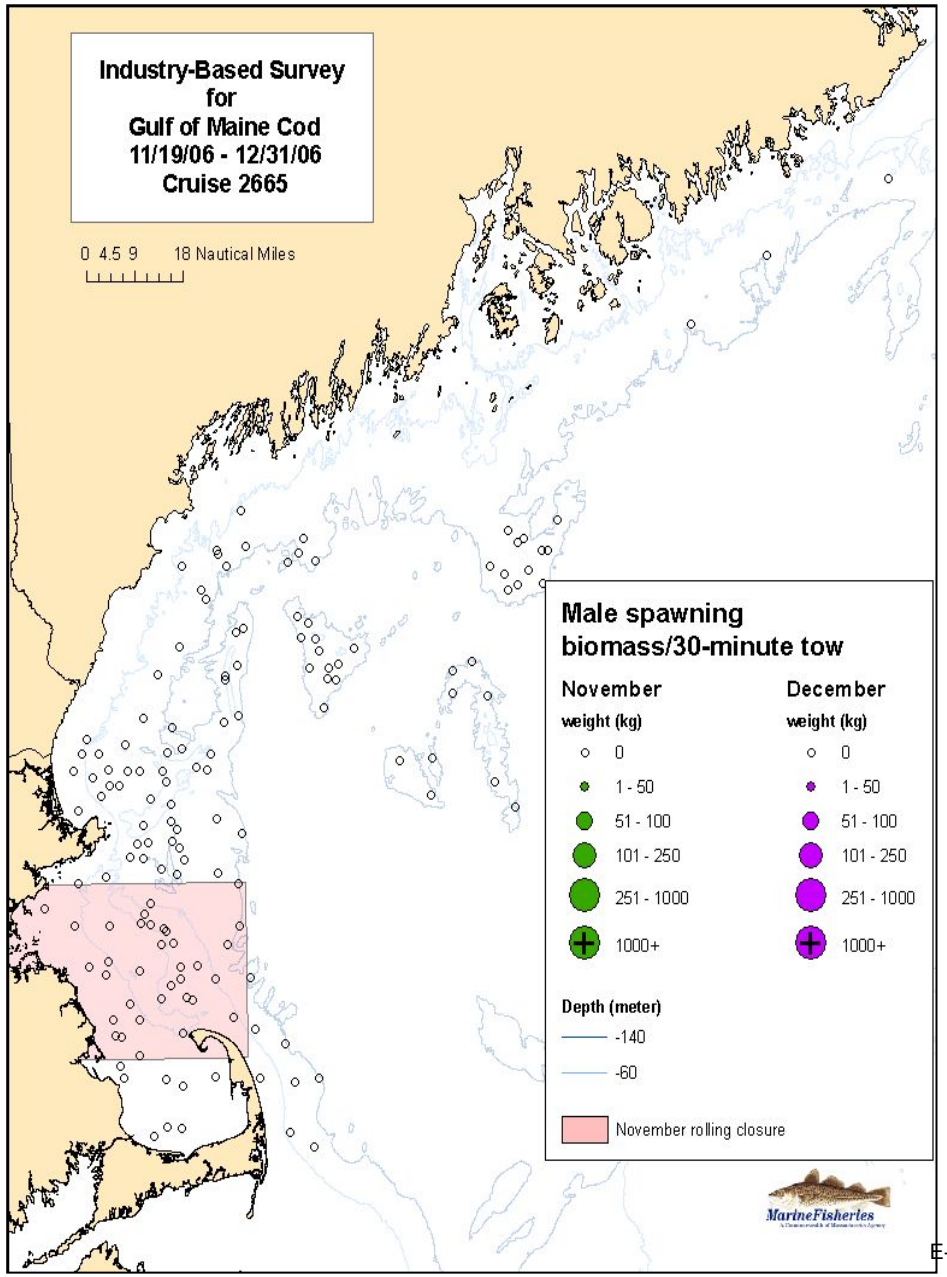
* Survey results during April and May rolling closure periods. Weights standardized to 30 minutes in duration.

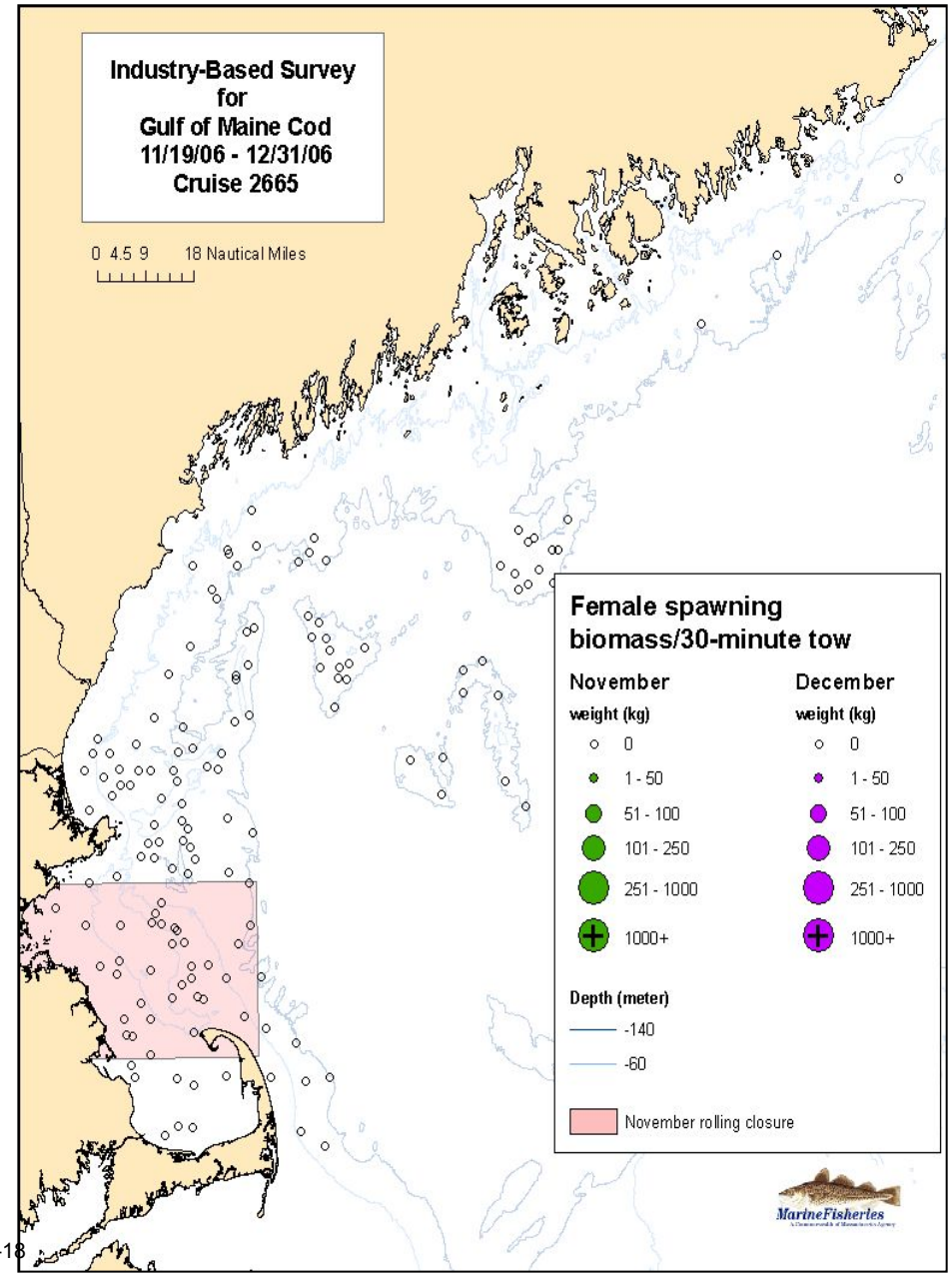




Estimated Biomass (kg) of Spawning Males and Females

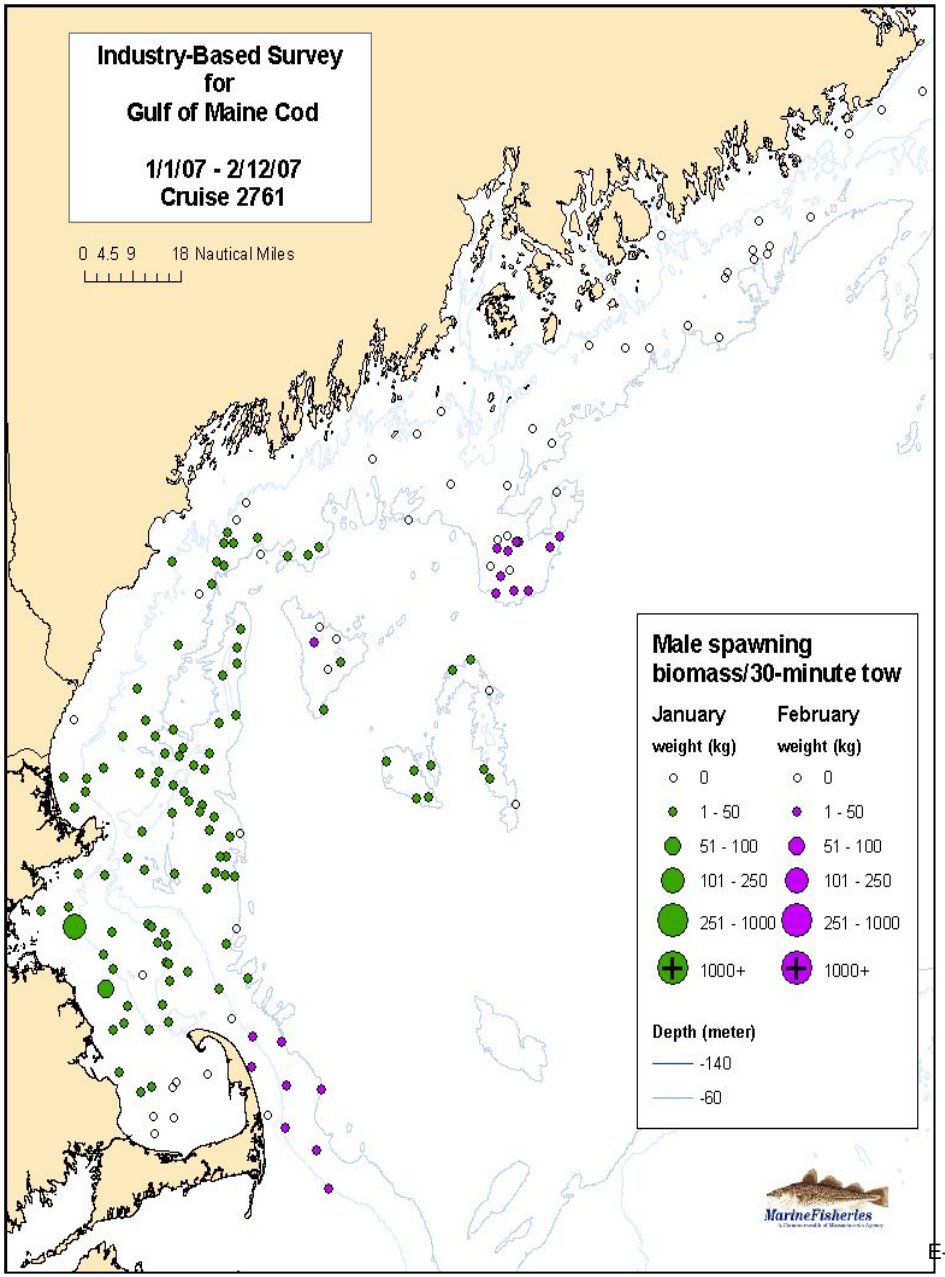
* Survey results during November rolling closure period. Weights standardized to 30 minutes in duration.

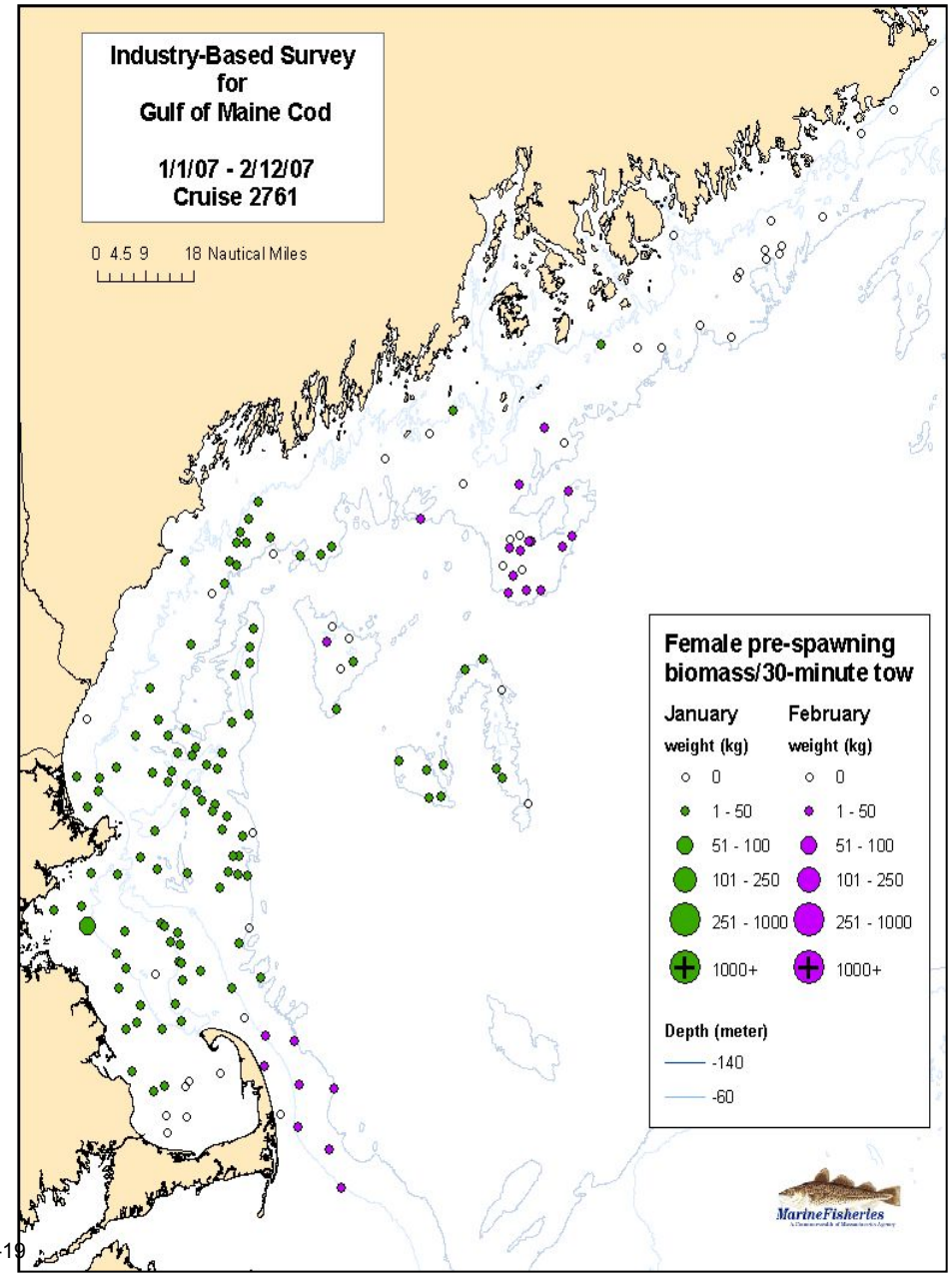




Estimated Biomass (kg) of Spawning Males and Females

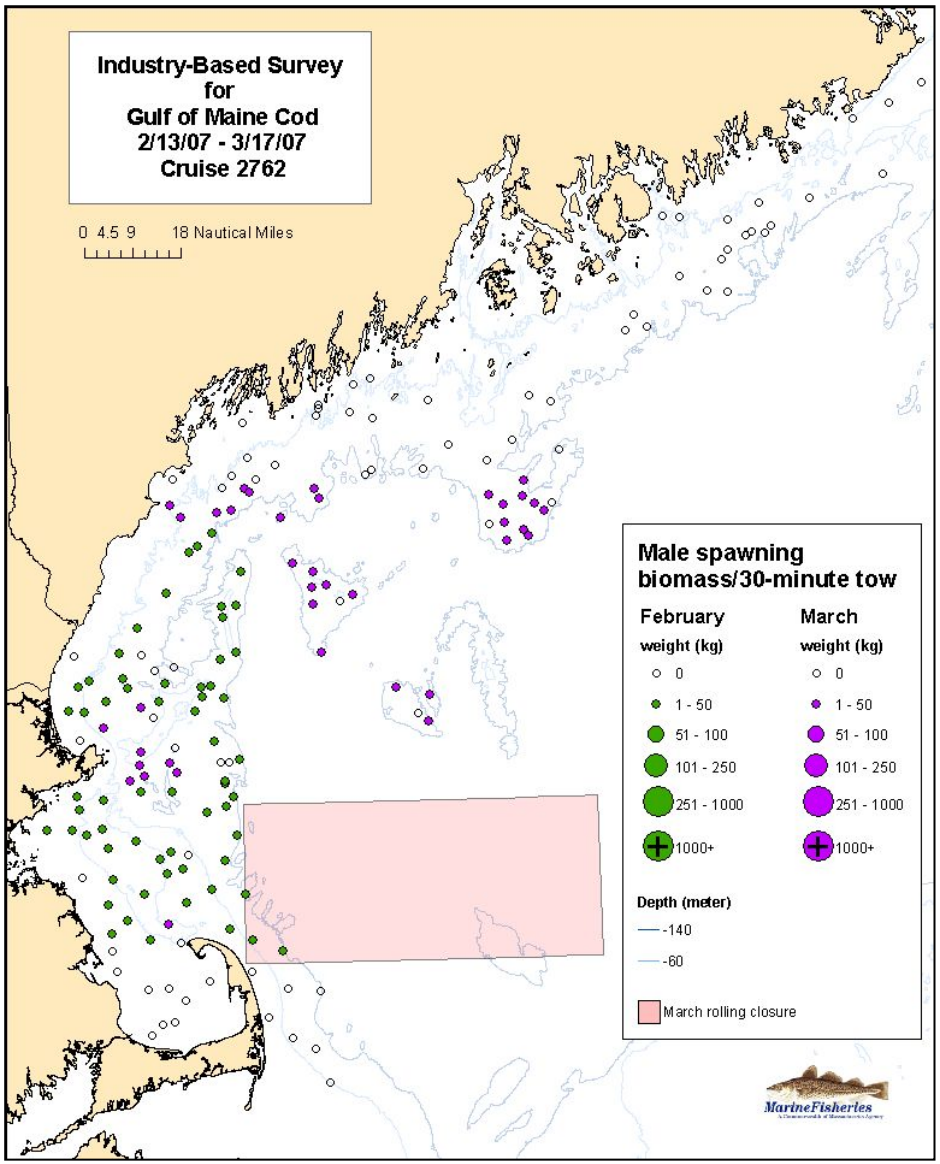
* Weights standardized to 30 minutes in duration.

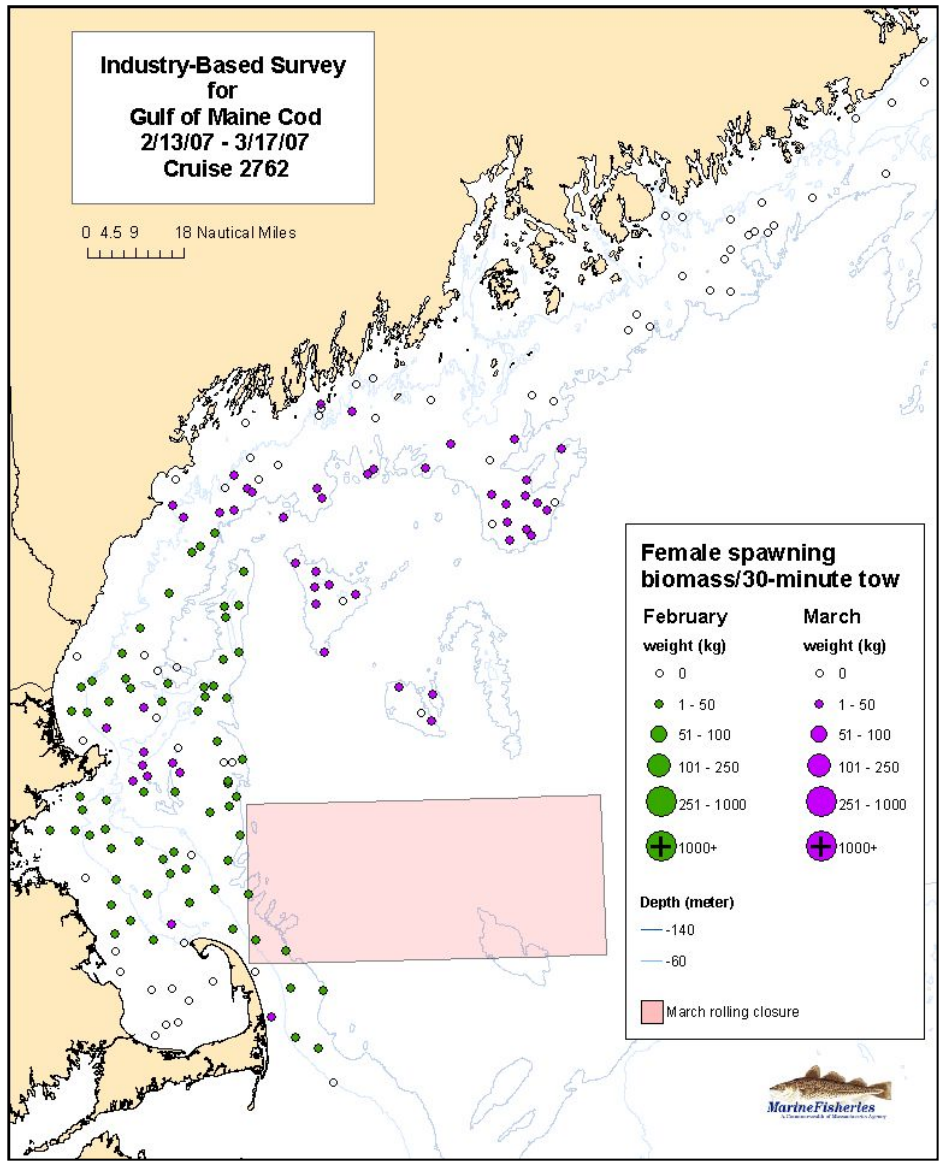




Estimated Biomass (kg) of Spawning Males and Females

* Survey results during March rolling closure periods. Weights standardized to 30 minutes in duration.



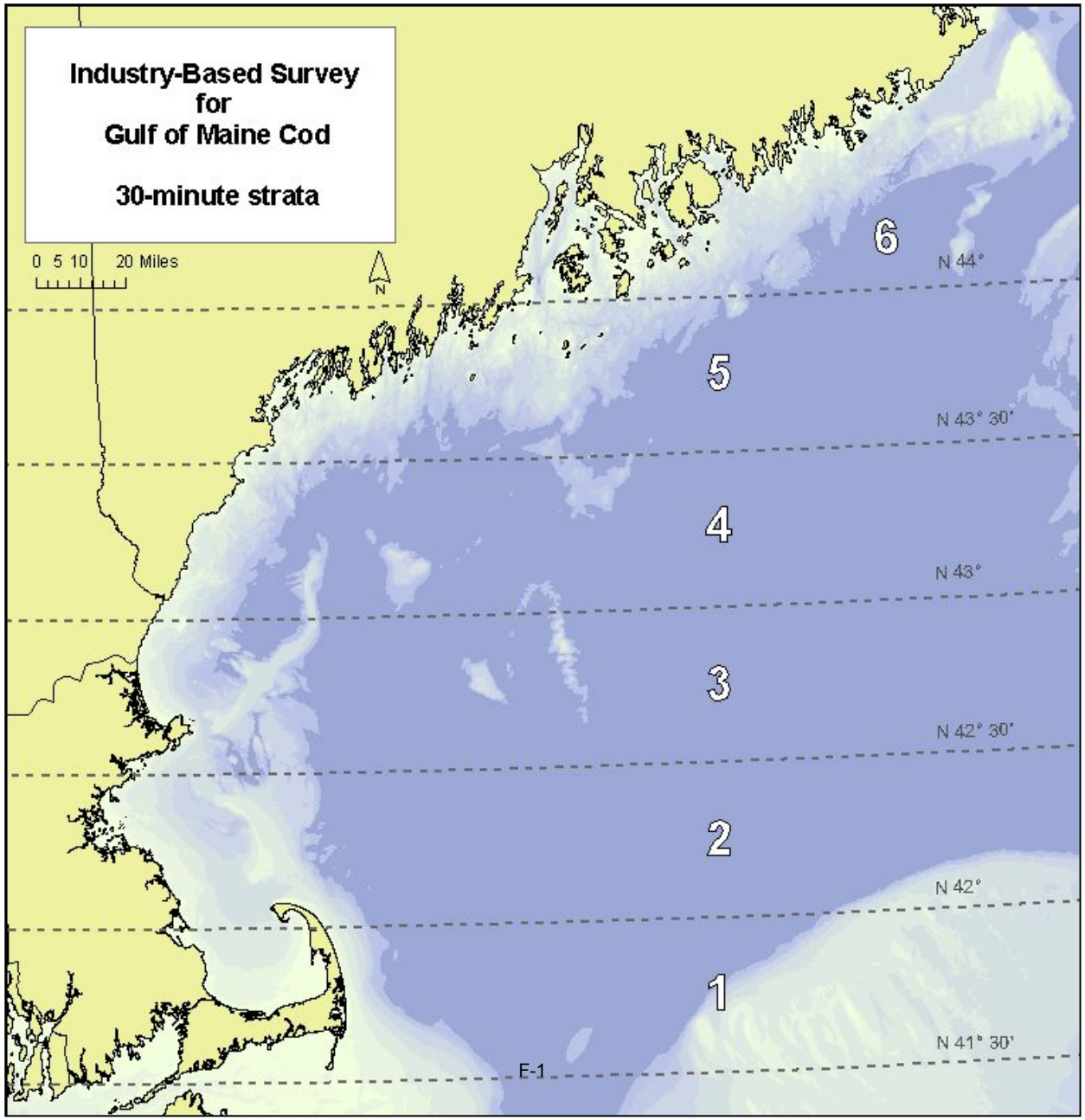


Appendix F

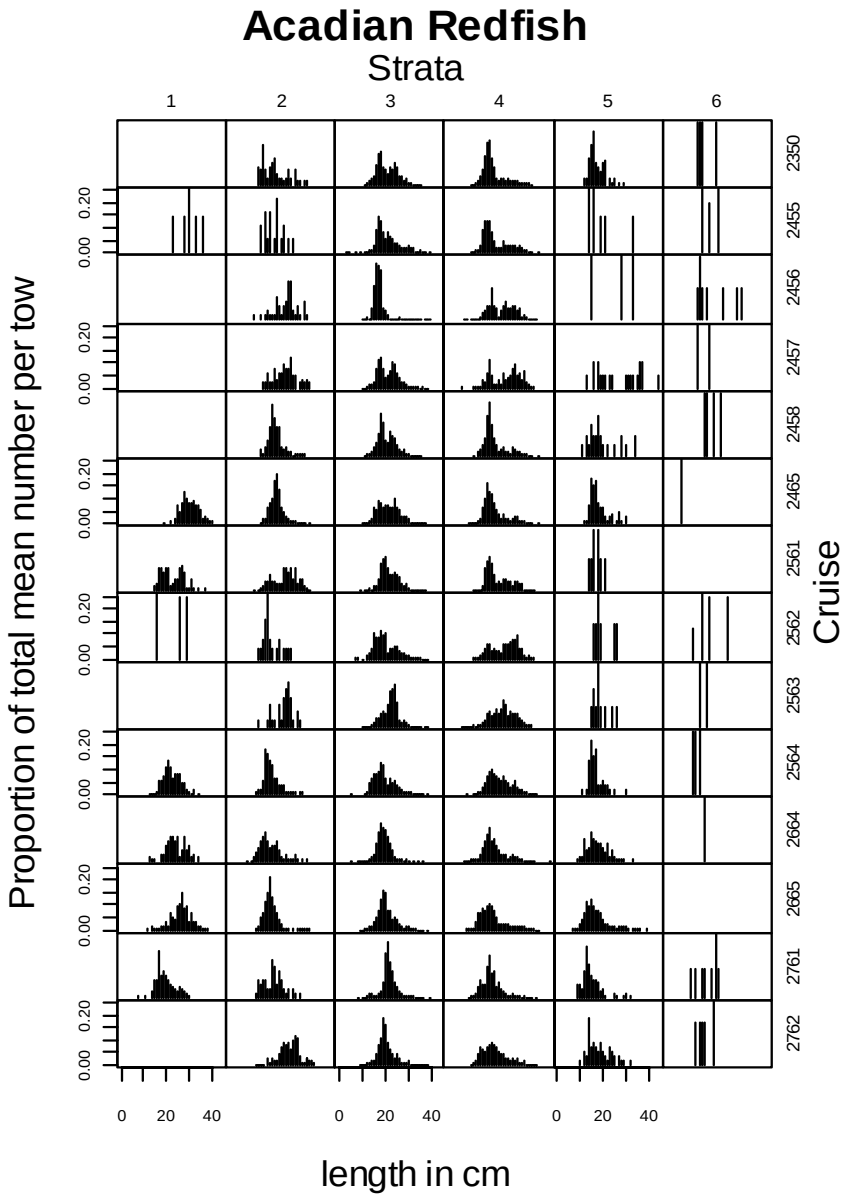
Industry-Based Survey
for
Gulf of Maine Cod
Pilot Study

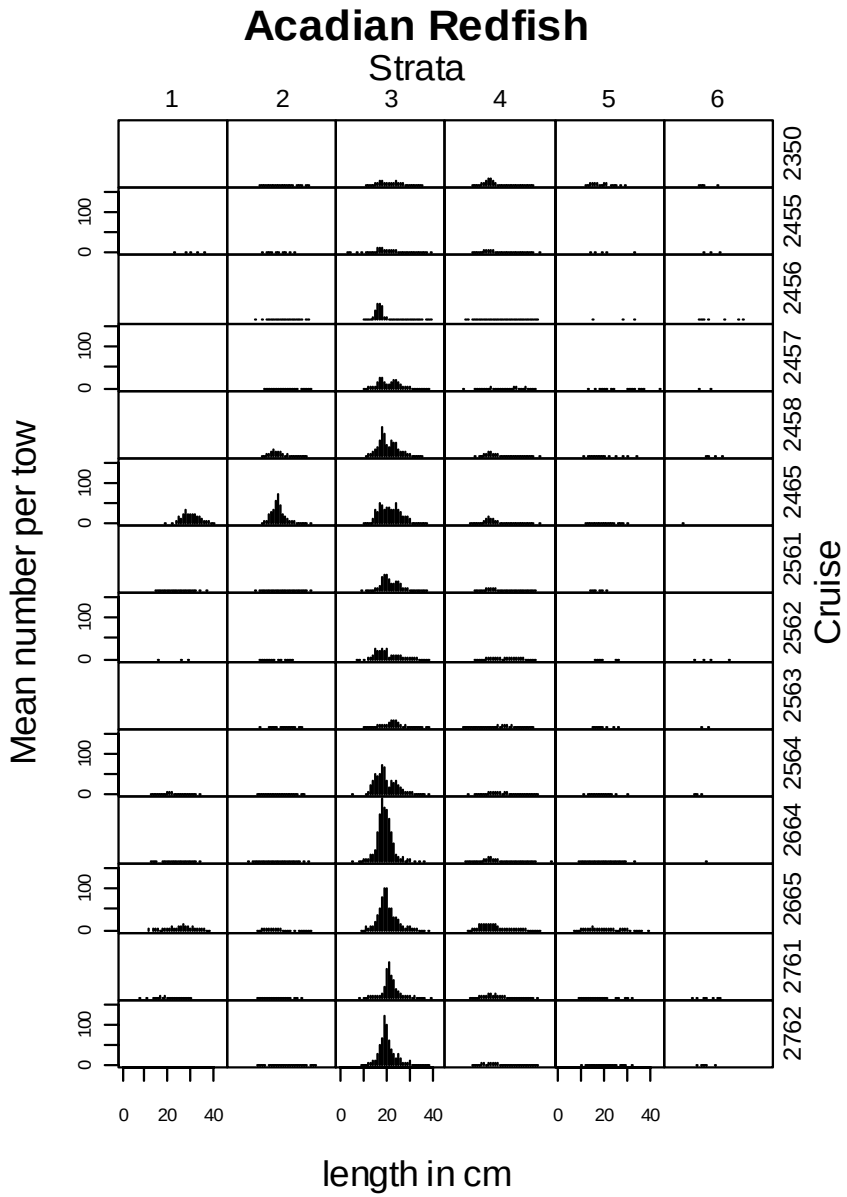
Length Frequency Figures for Cod and Other Species

Appendix F. Strata Map

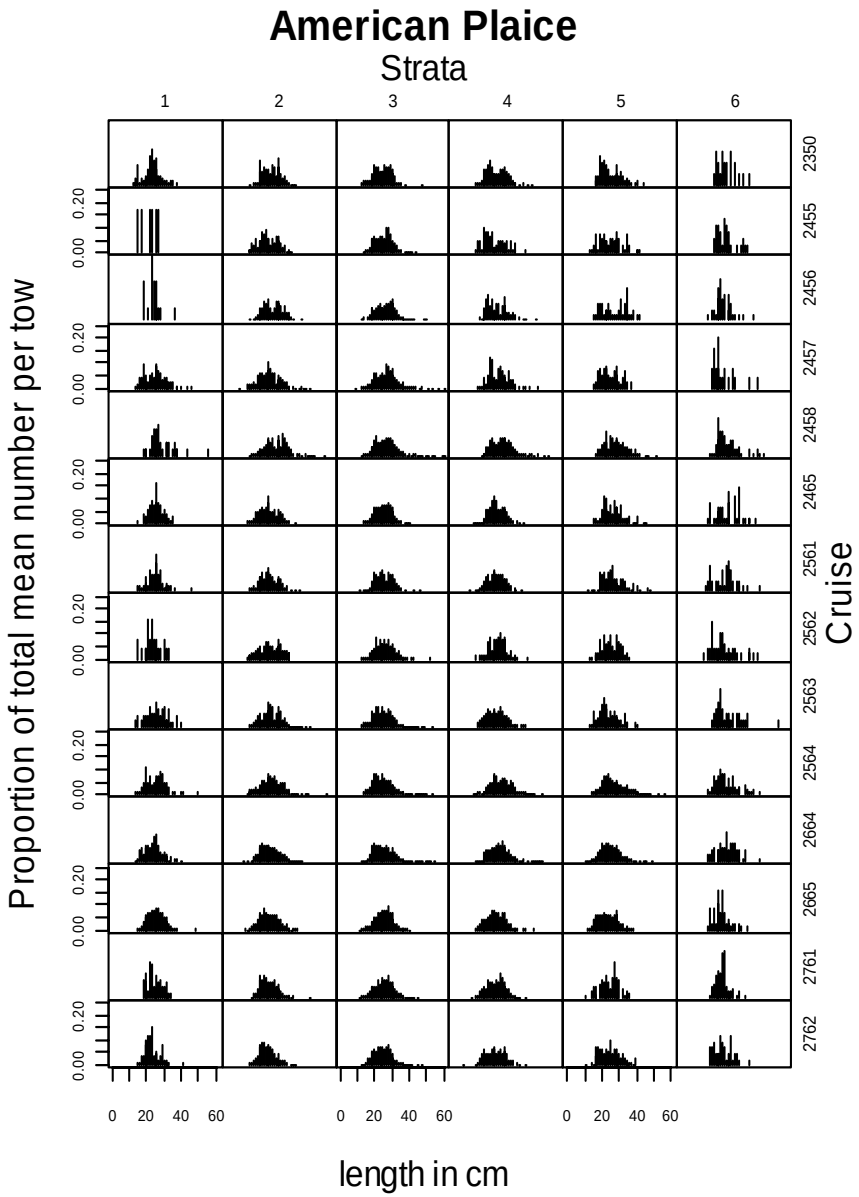


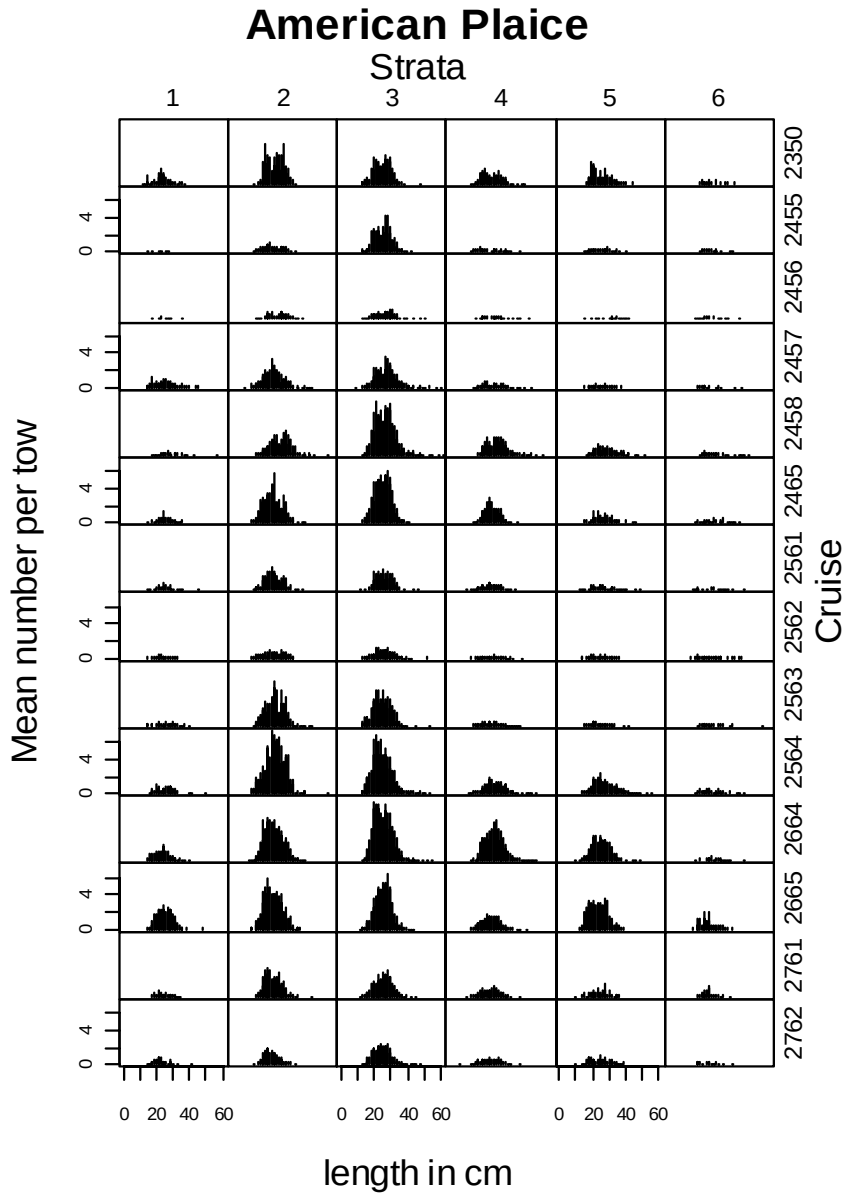
Appendix F. Acadian Redfish

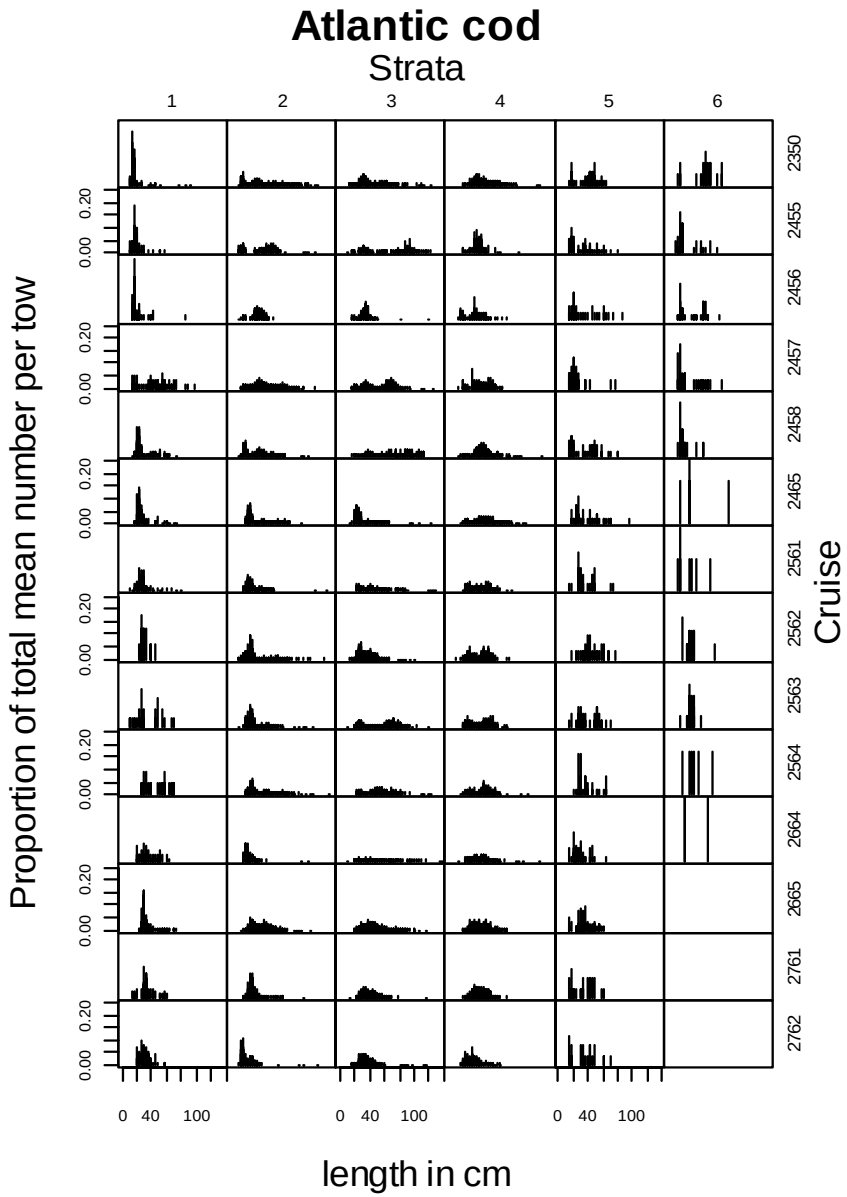


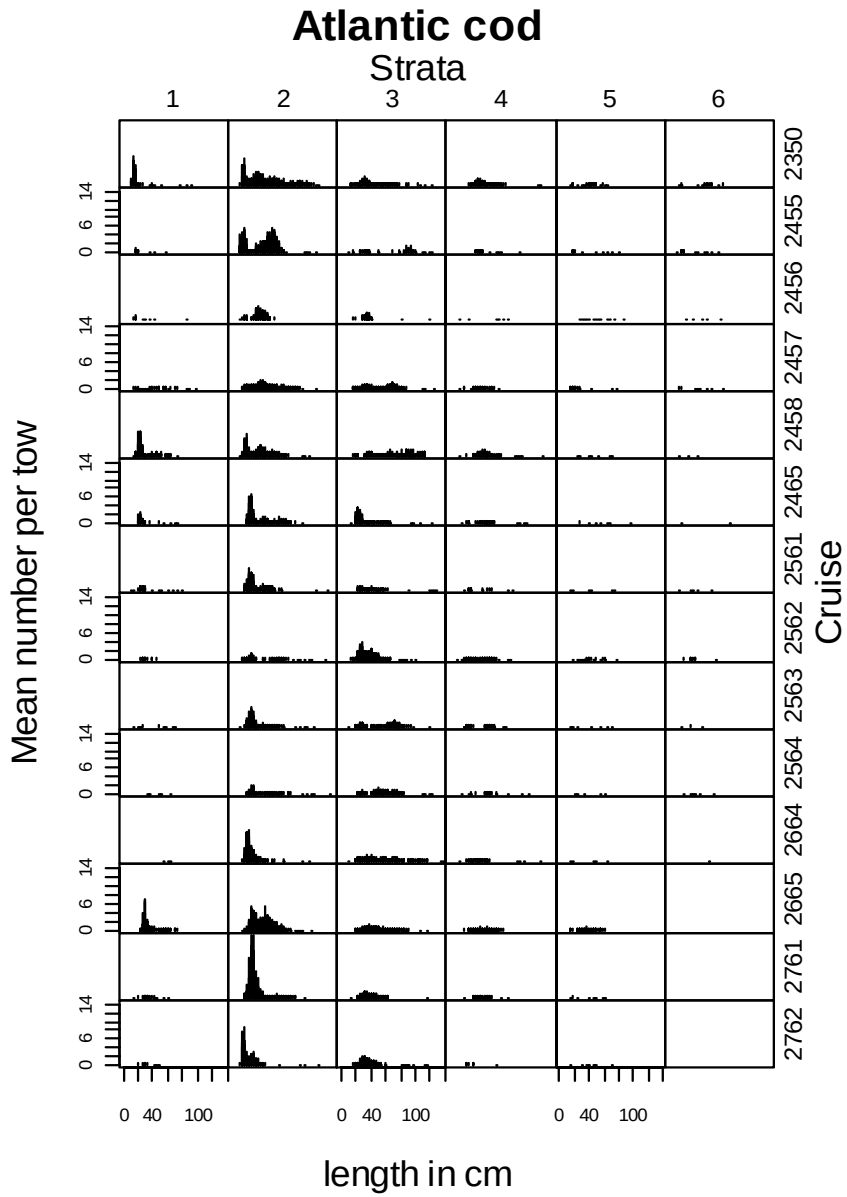


Appendix F. American Plaice

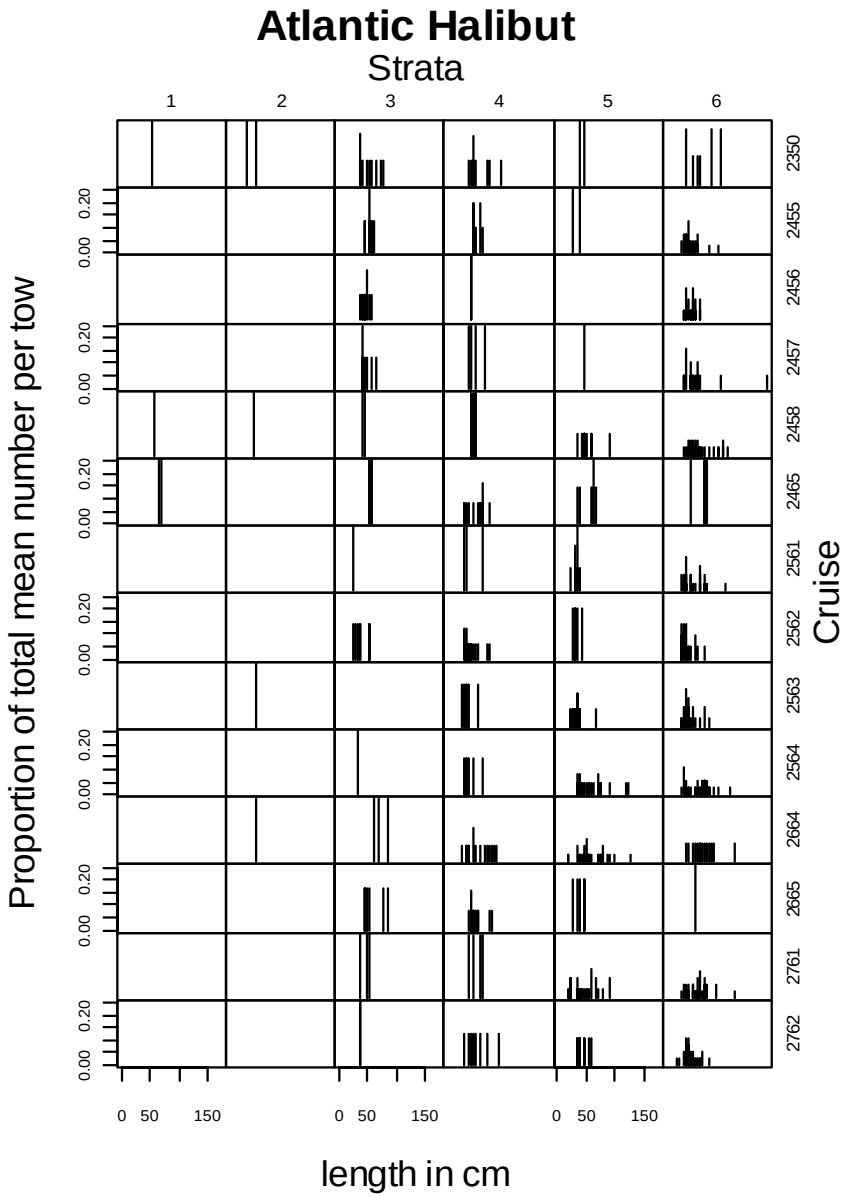


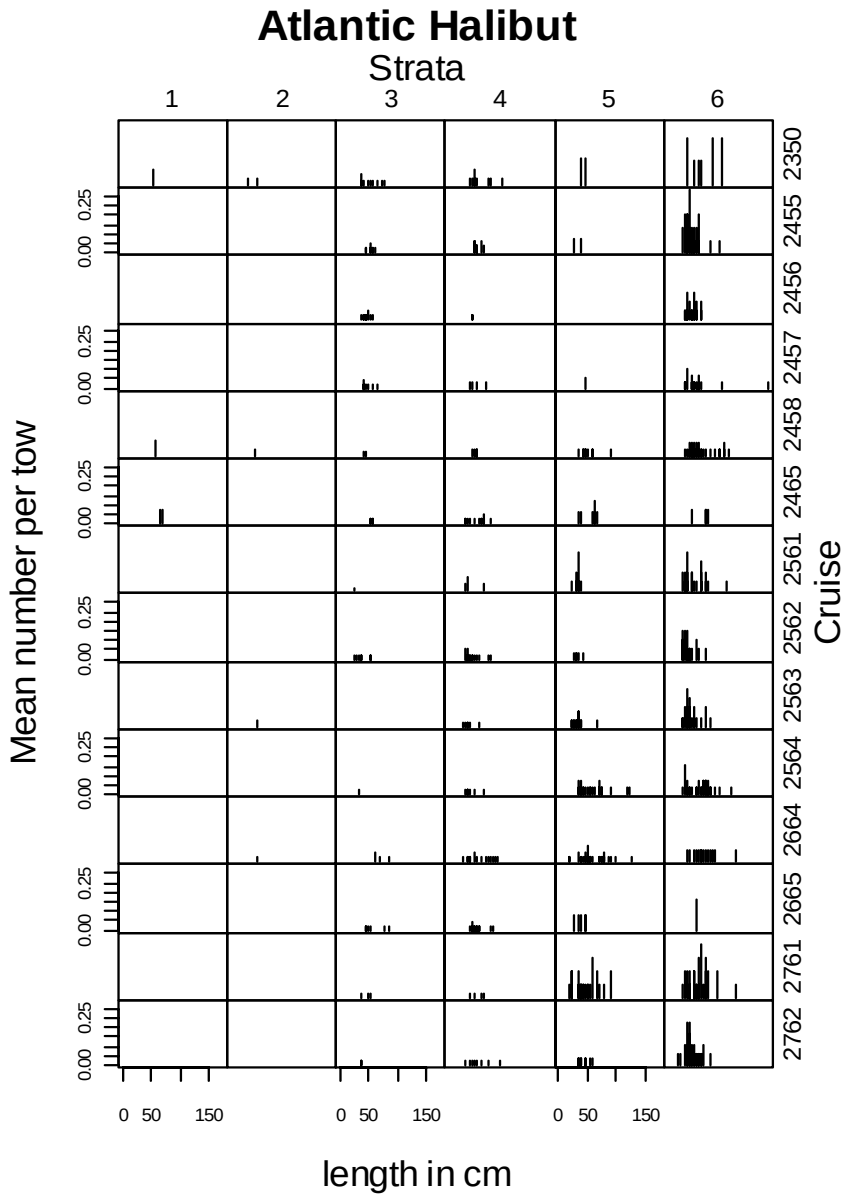


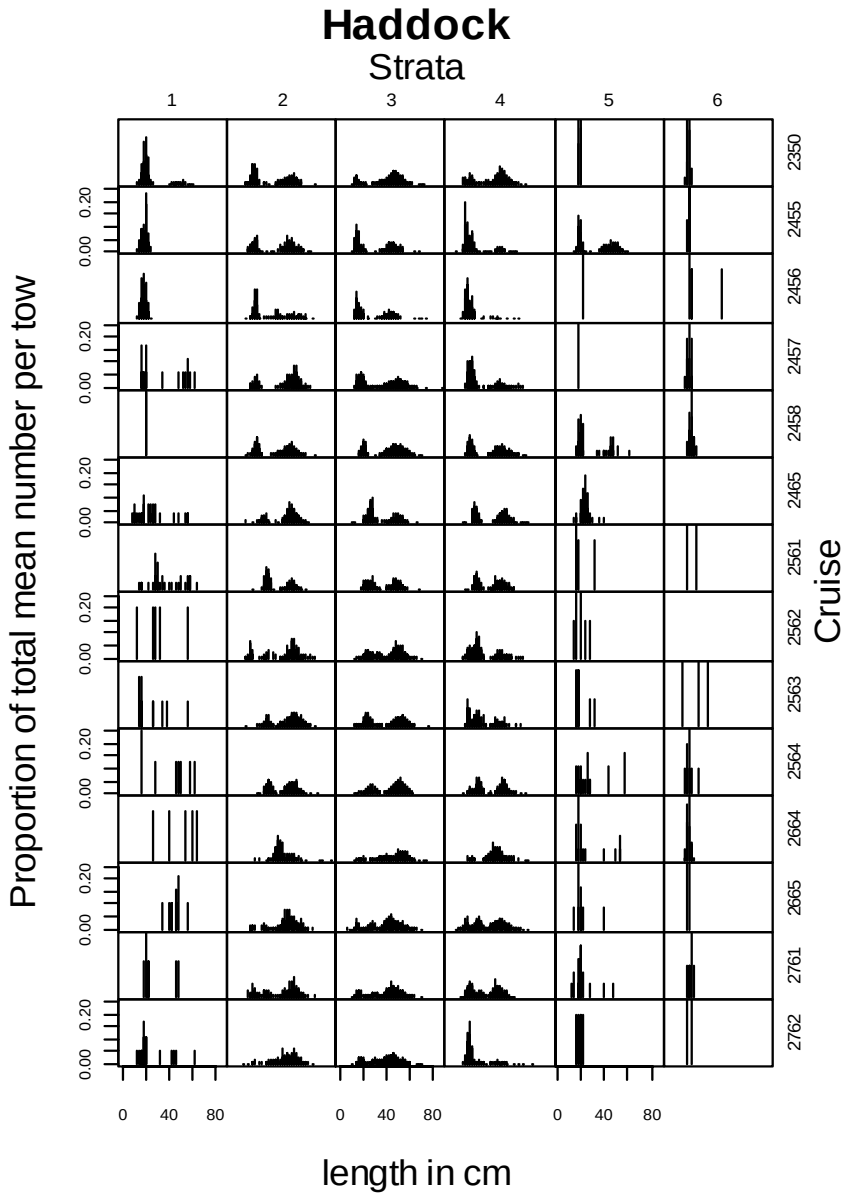

Atlantic cod
Strata
1
2
3
4
5
6
Proportion of total mean number per tow
0.00
0.20
Cruise
2350
2455
2456
2457
2458
2465
2561
2562
2563
2564
2664
2665
2761
2762
0
40
100
length in cm

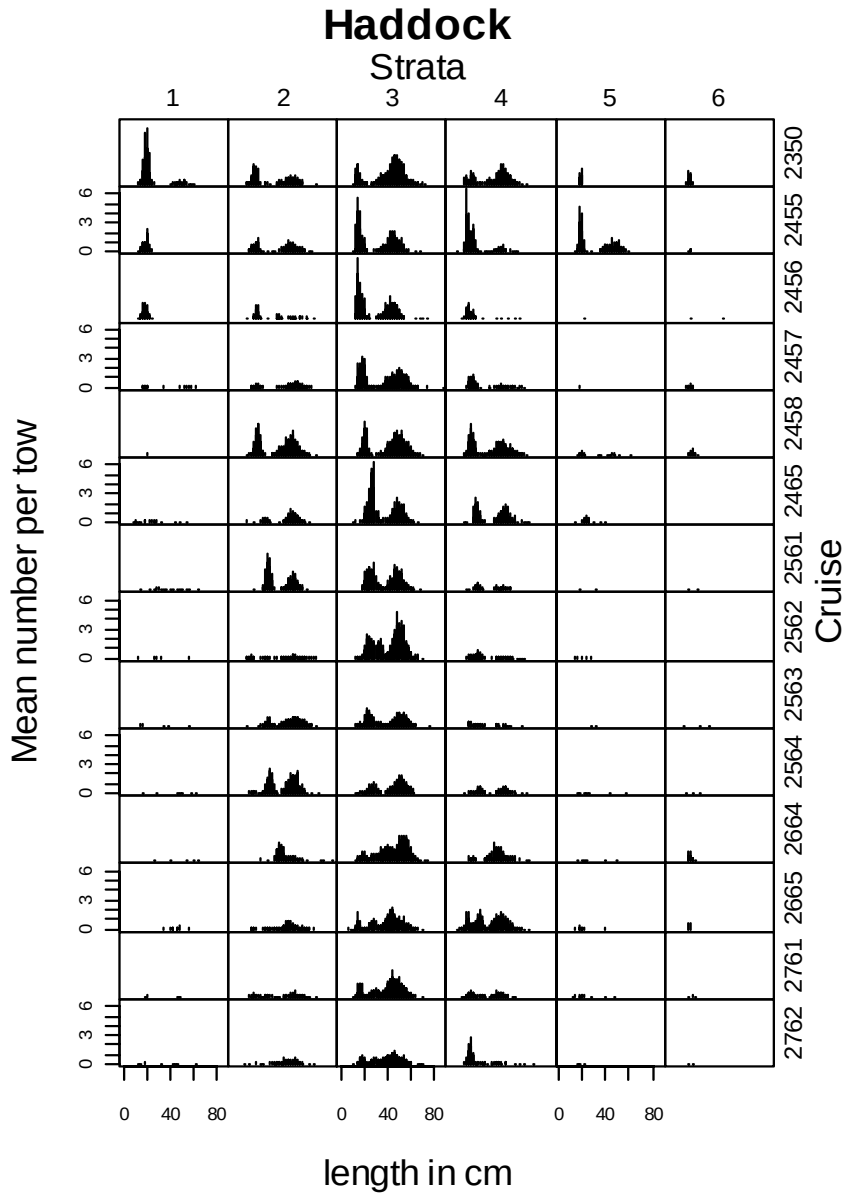

Atlantic cod
Strata
1
2
3
4
5
6
Mean number per tow
0
6
14
Cruise
2350
2455
2456
2457
2458
2465
2561
2562
2563
2564
2664
2665
2761
2762
0
40
100
length in cm

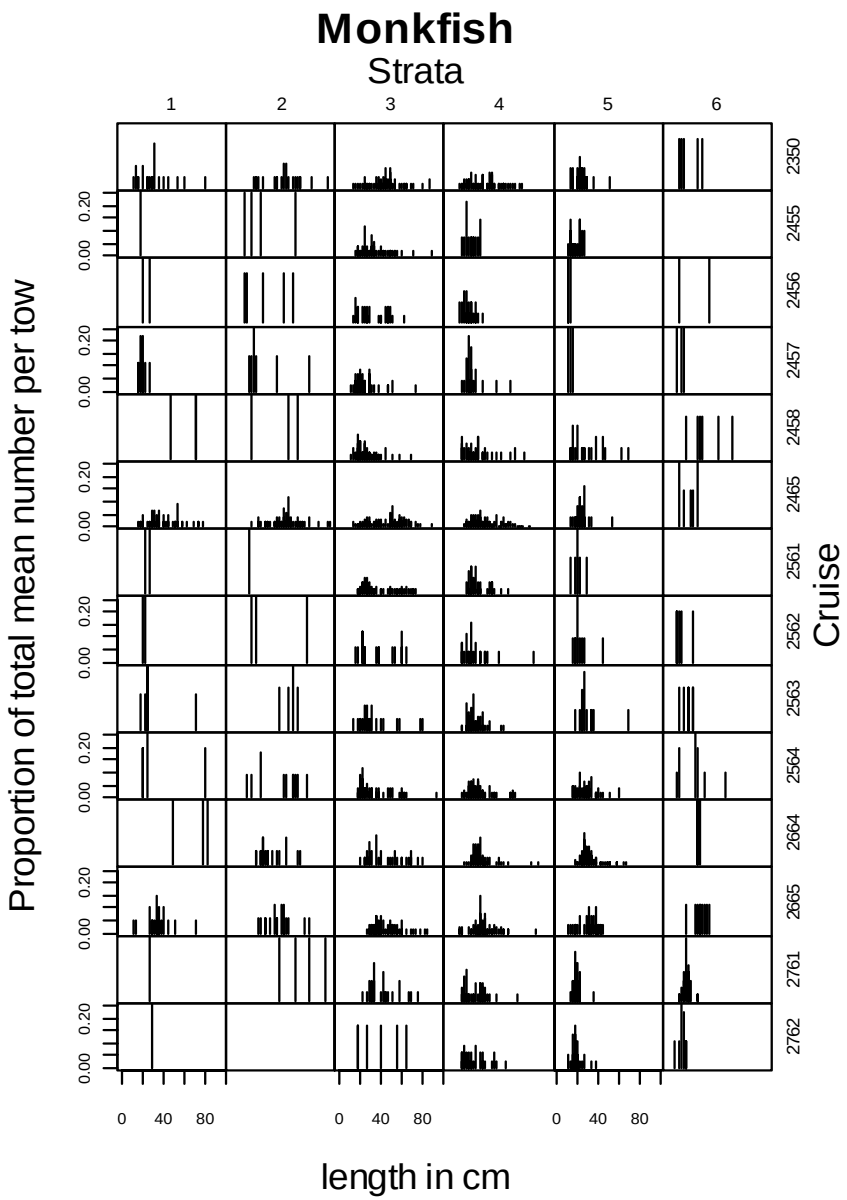
Appendix F. Atlantic Halibut

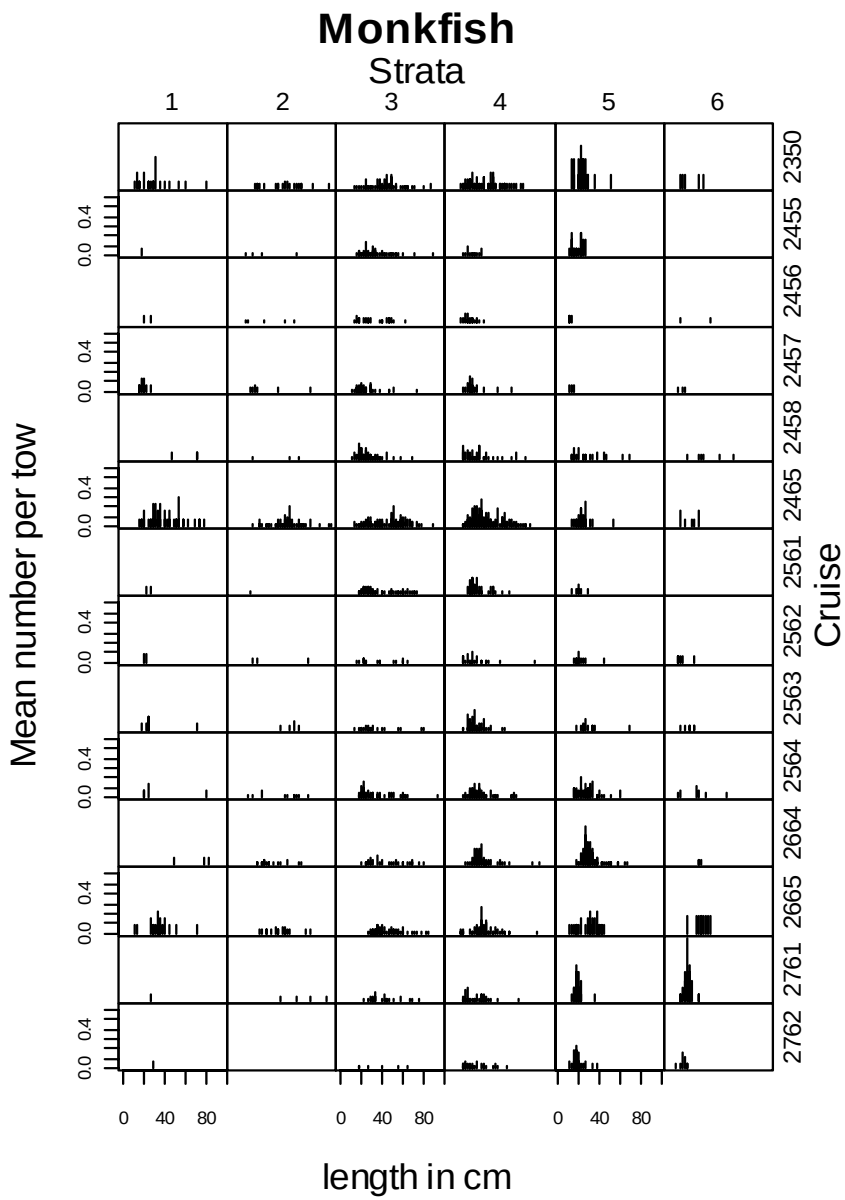


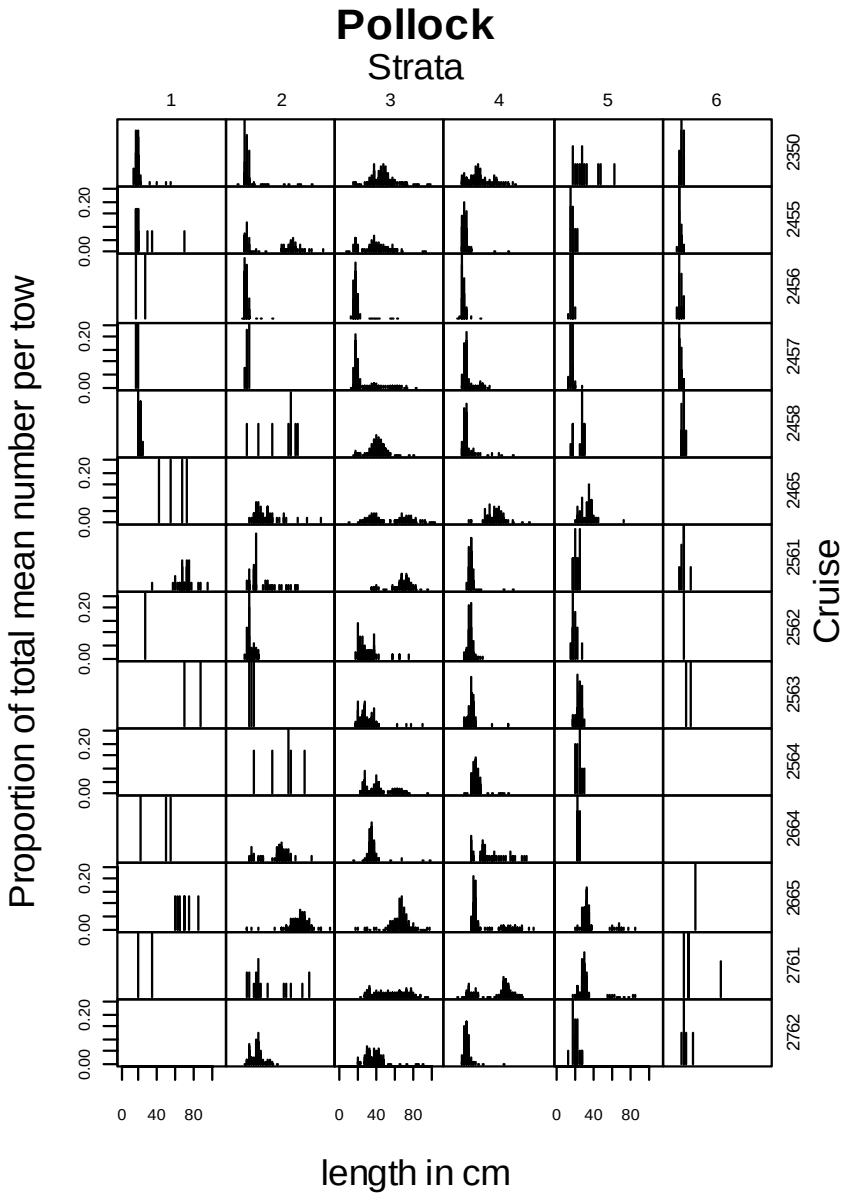


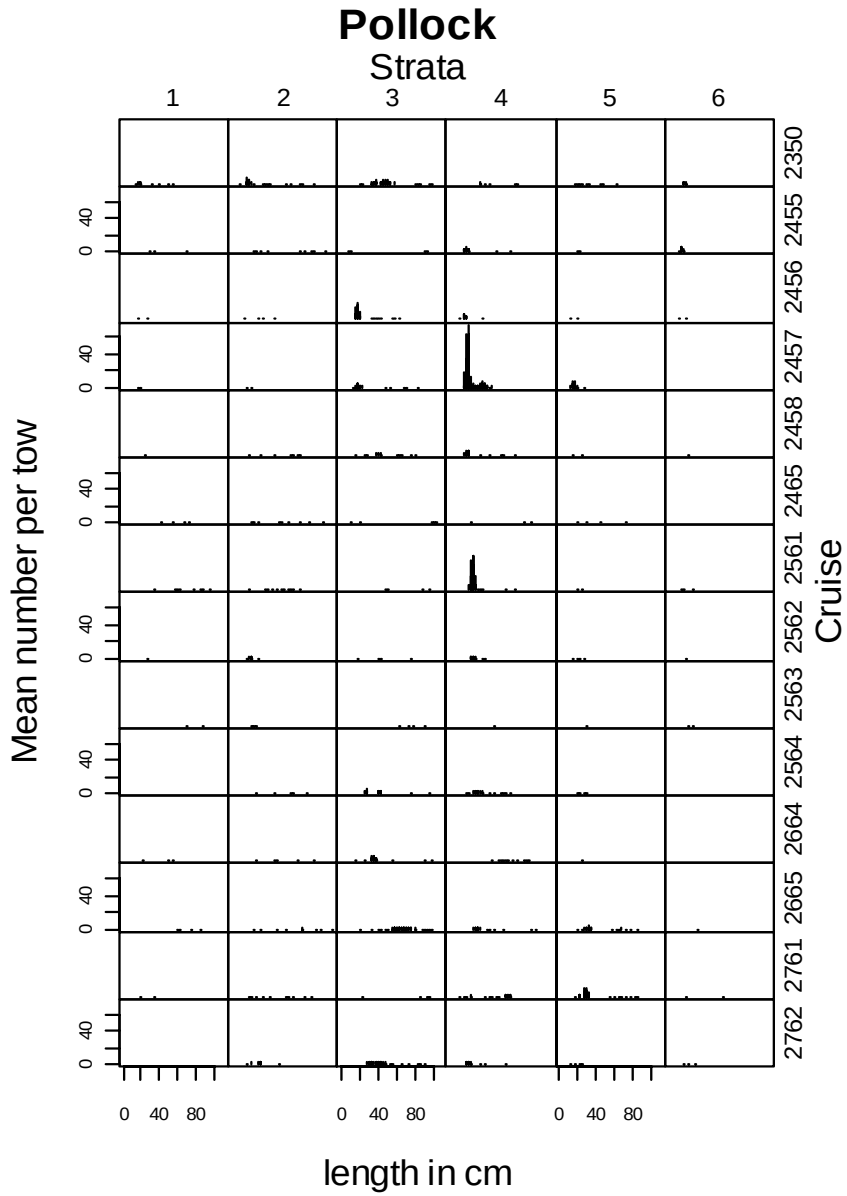

Haddock
Strata
1
2
3
4
5
6
Proportion of total mean number per tow
0.00
0.20
Cruise
2350
2455
2456
2457
2458
2465
2561
2562
2563
2564
2664
2665
2761
2762
0
40
80
length in cm


Haddock
Strata
1
2
3
4
5
6
Mean number per tow
0
3
6
Cruise
2350
2455
2456
2457
2458
2465
2561
2562
2563
2564
2664
2665
2761
2762
0
40
80
length in cm

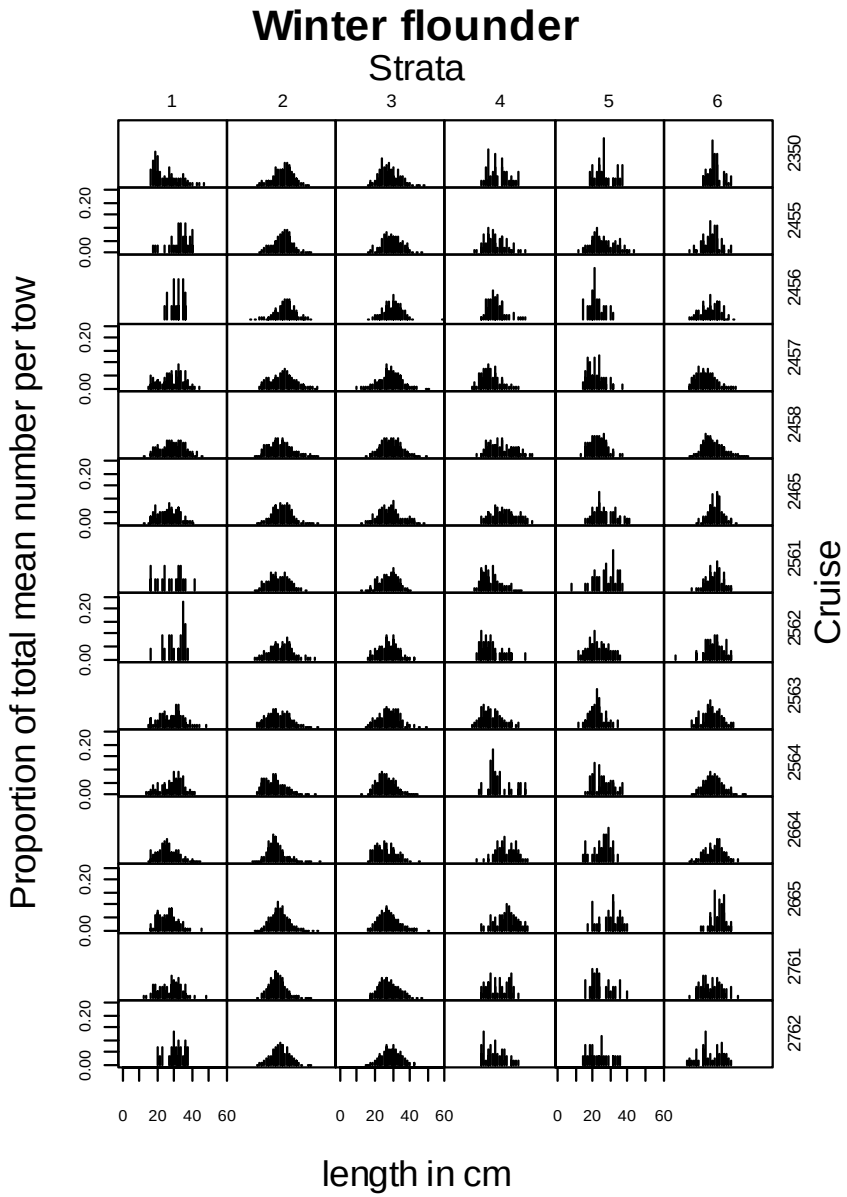

Monkfish
Strata
1
2
3
4
5
6
Proportion of total mean number per tow
0.00
0.20
Cruise
2350
2455
2456
2457
2458
2465
2561
2562
2563
2564
2664
2665
2761
2762
0
40
80
length in cm

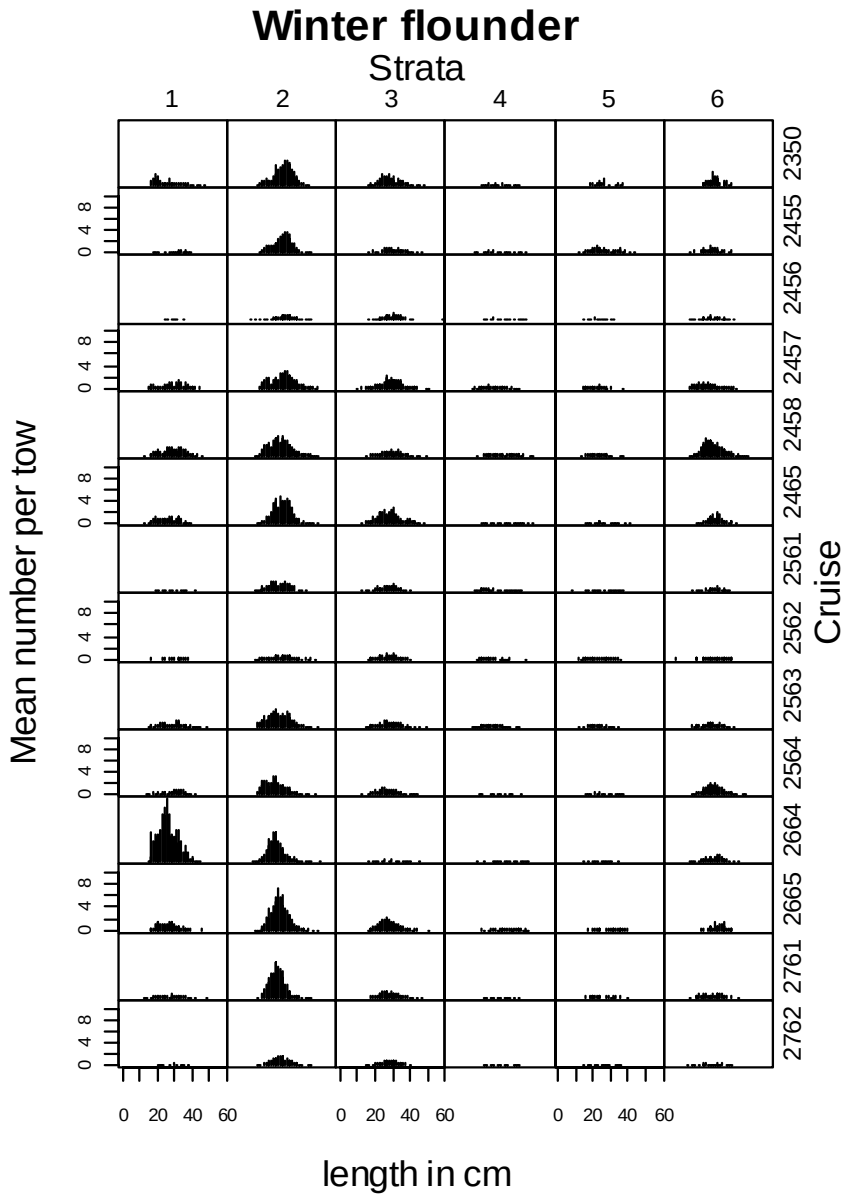

Monkfish
Strata
1
2
3
4
5
6
Mean number per tow
0.0
0.4
Cruise
2350
2455
2456
2457
2458
2465
2561
2562
2563
2564
2664
2665
2761
2762
0
40
80
length in cm


Pollock
Strata
1
2
3
4
5
6
Proportion of total mean number per tow
0.00
0.20
Cruise
2350
2455
2456
2457
2458
2465
2561
2562
2563
2564
2664
2665
2761
2762
0
40
80
length in cm

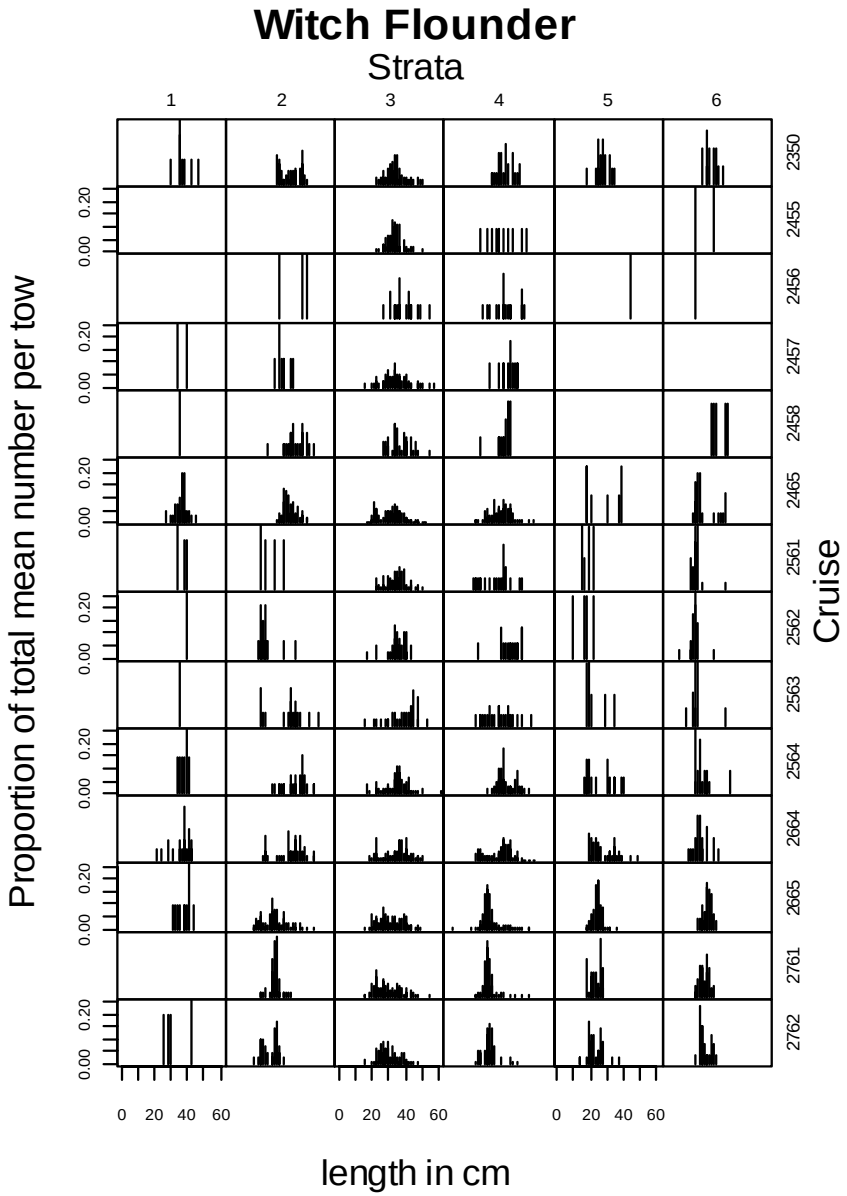

Pollock
Strata
1
2
3
4
5
6
Mean number per tow
0
40
Cruise
2350
2455
2456
2457
2458
2465
2561
2562
2563
2564
2664
2665
2761
2762
0
40
80
length in cm

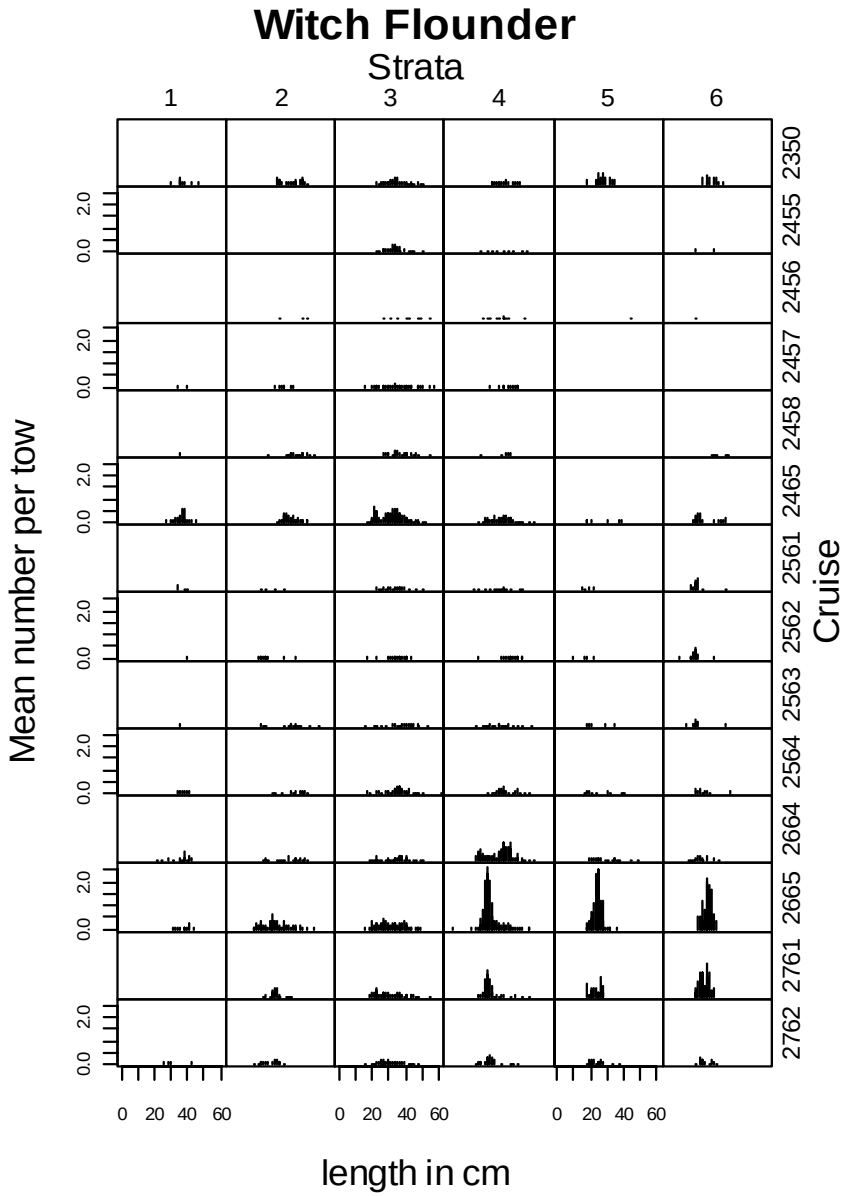
Appendix F. Winter Flounder

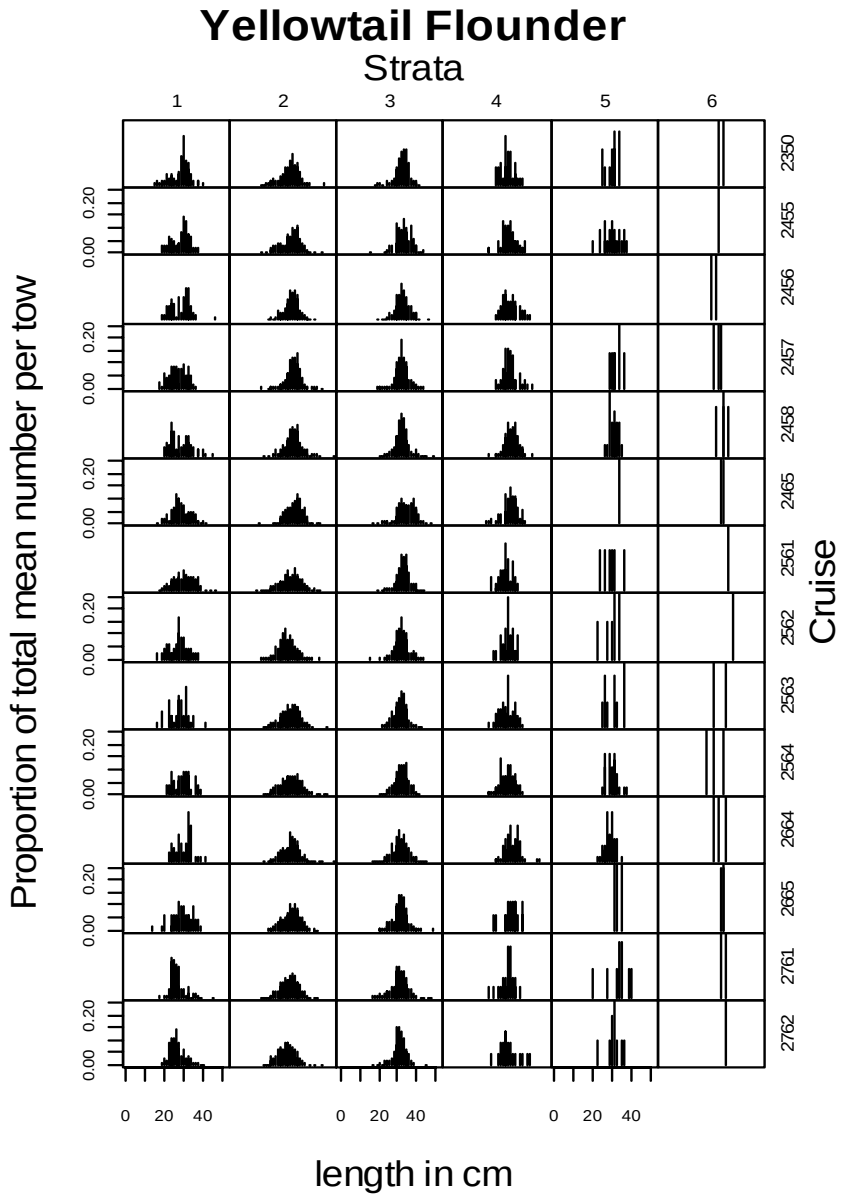


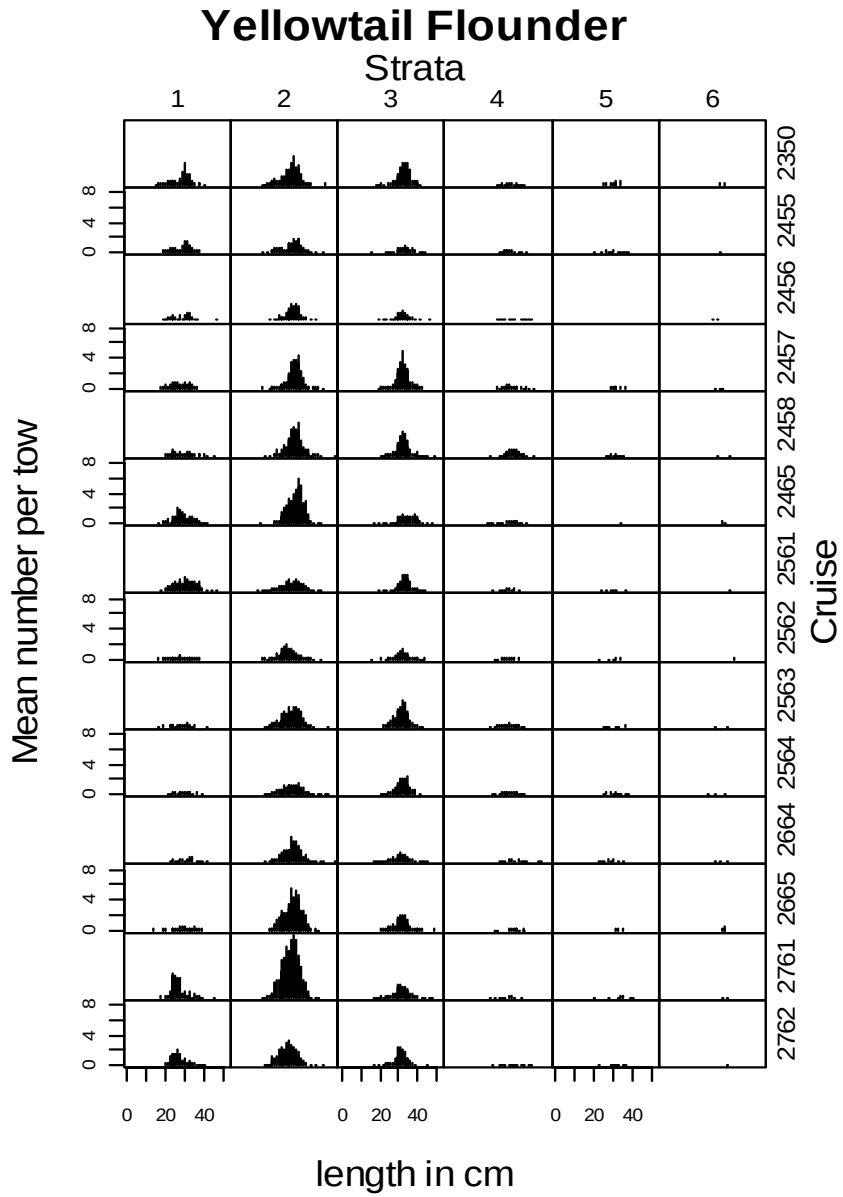


Appendix F. Witch Flounder






Yellowtail Flounder
Strata
1
2
3
4
5
6
Proportion of total mean number per tow
0.00
0.20
Cruise
2350
2455
2456
2457
2458
2465
2561
2562
2563
2564
2664
2665
2761
2762
0
20
40
length in cm


Yellowtail Flounder
Strata
1
2
3
4
5
6
Mean number per tow
0
4
8
Cruise
2350
2455
2456
2457
2458
2465
2561
2562
2563
2564
2664
2665
2761
2762
0
20
40
length in cm

Appendix G

Industry-Based Survey
for
Gulf of Maine Cod
Pilot Study

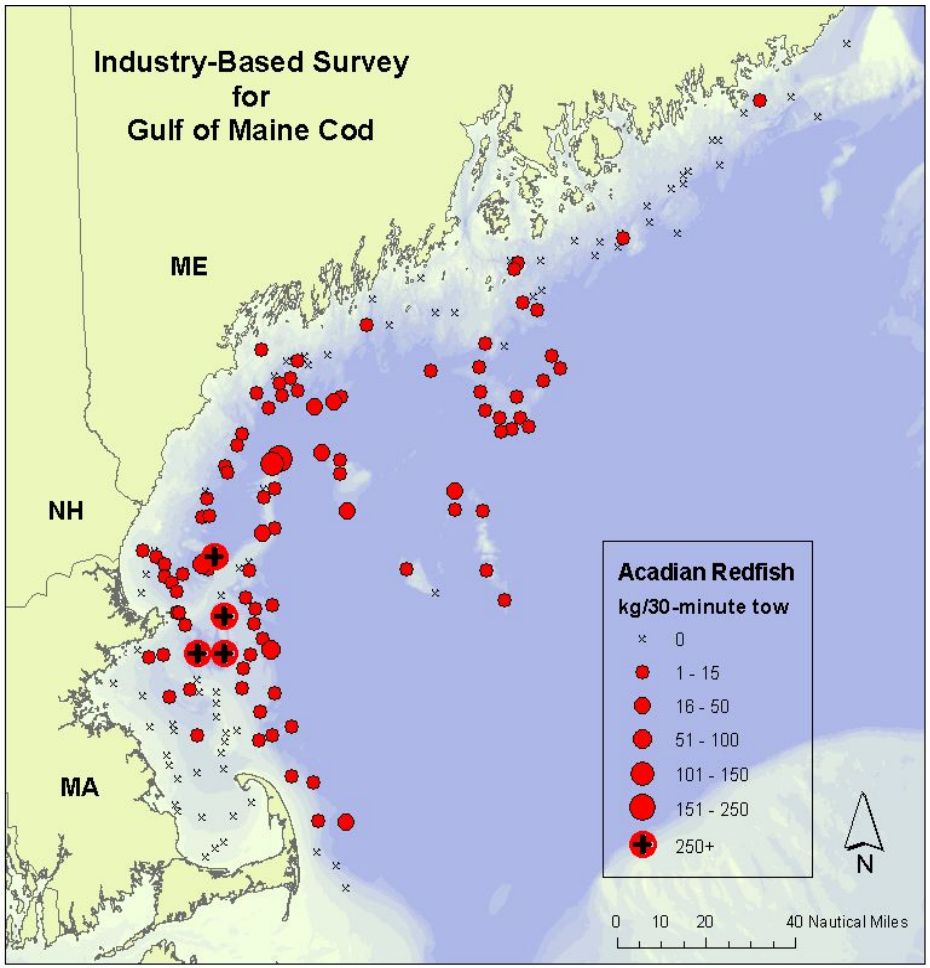
Ancillary Data: Species of Interest Distribution maps

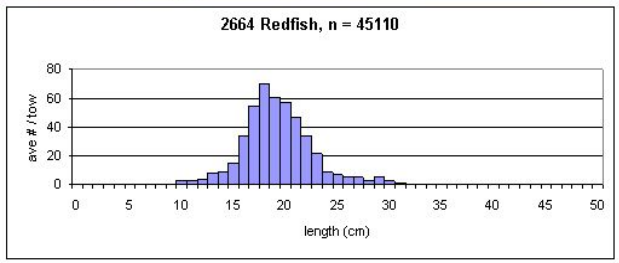
Industry-Based Survey for Gulf of Maine Cod

2006-2007 Survey Results

Acadian Redfish

Spatial and temporal distribution by cruise, average number of fish at length where species were caught by cruise, and percent frequency at length by cruise



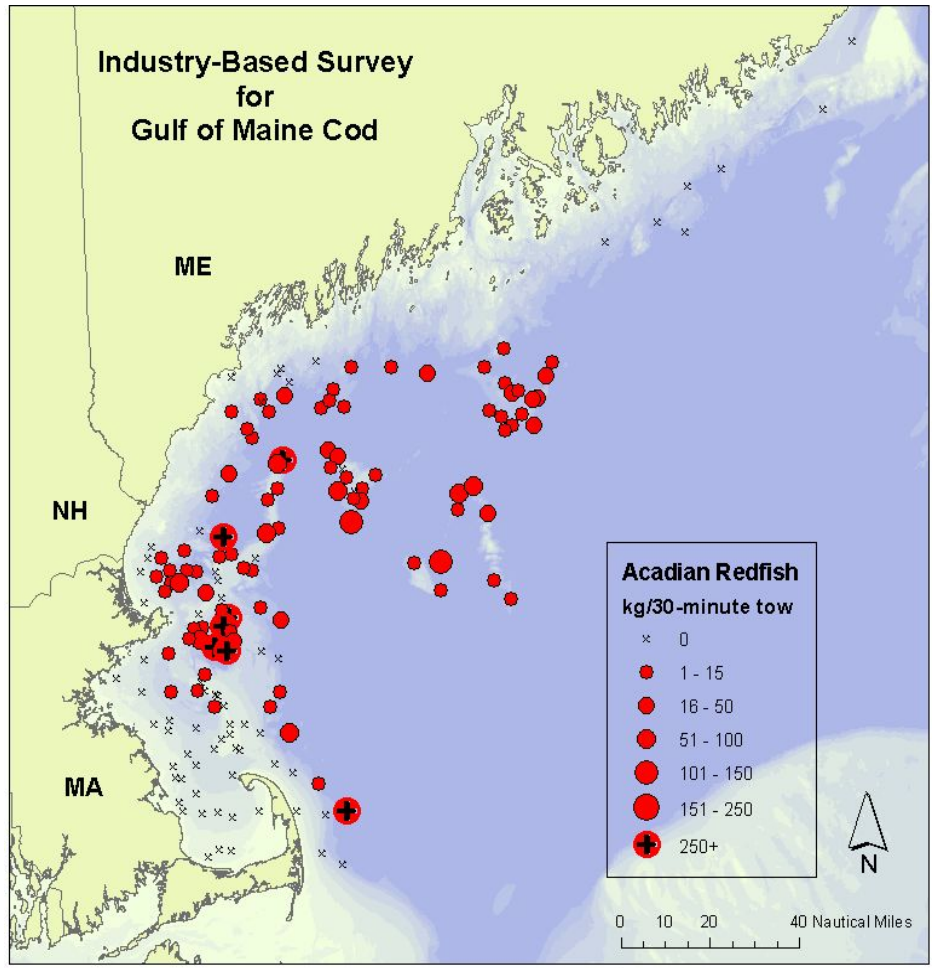


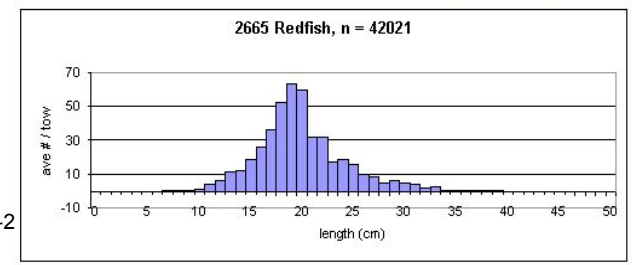
Acadian Redfish
caught during the IBS for GOM cod survey

mid April - May
Year: 2006
Cruise: 2664

MarineFisheries

**Average number of fish at length for all tows where species were caught



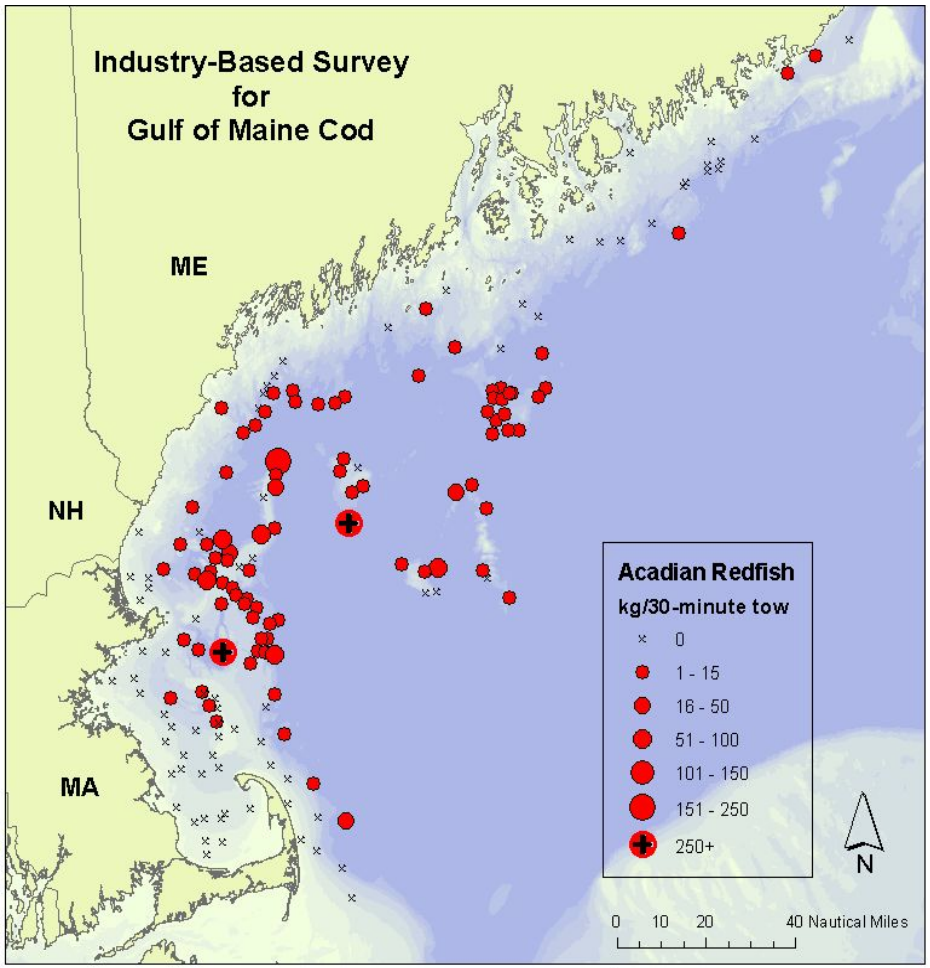


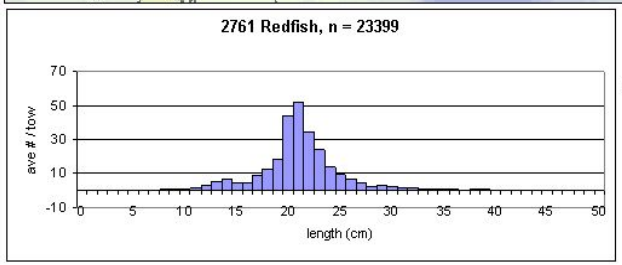
Acadian Redfish
caught during the IBS for GOM cod survey

mid November - December
Year: 2006
Cruise: 2665

MarineFisheries

**Average number of fish at length for all tows where species were caught



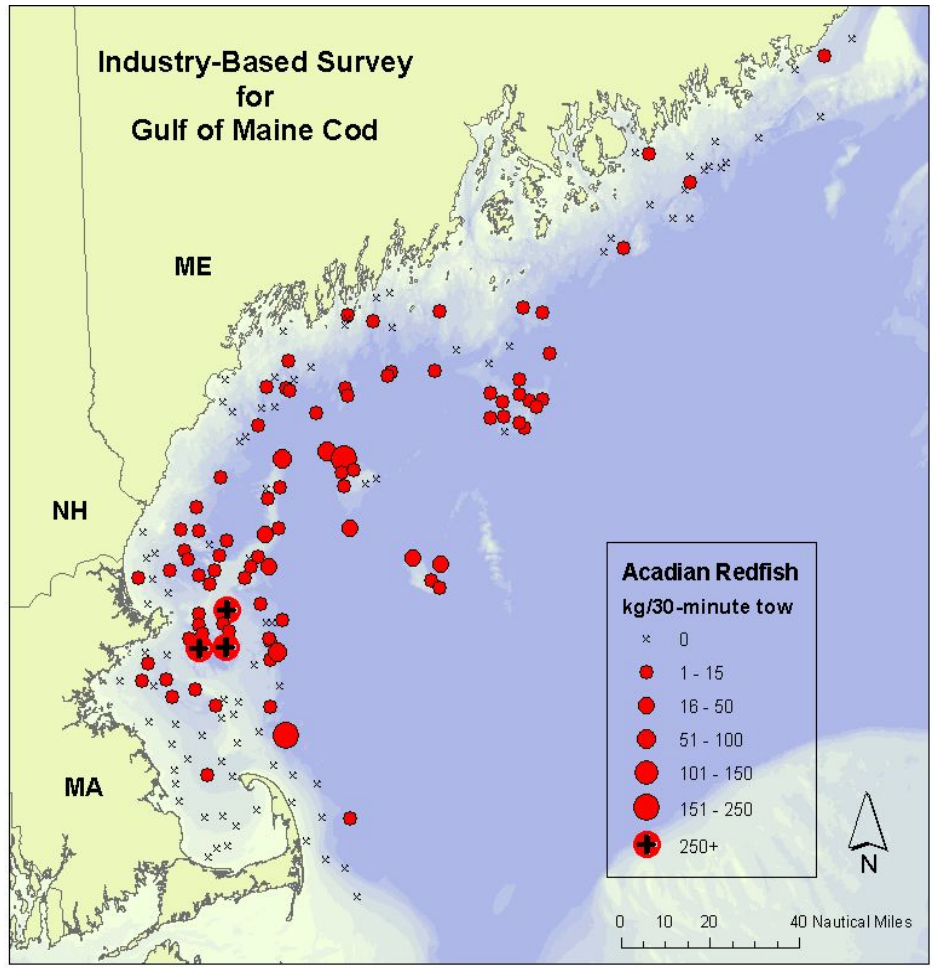


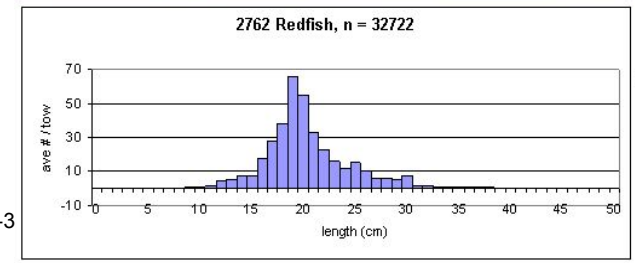
Acadian Redfish
caught during the IBS for GOM cod survey

January - mid February
Year: 2007
Cruise: 2761

MarineFisheries

**Average number of fish at length for all tows where species were caught





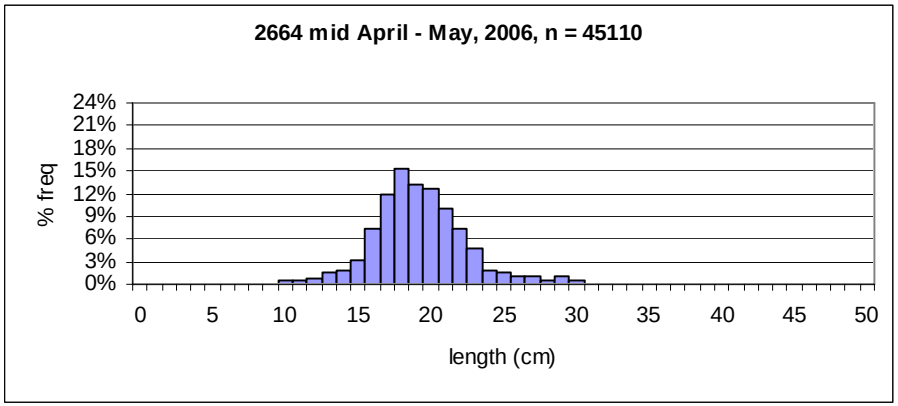
Acadian Redfish
caught during the IBS for GOM cod survey

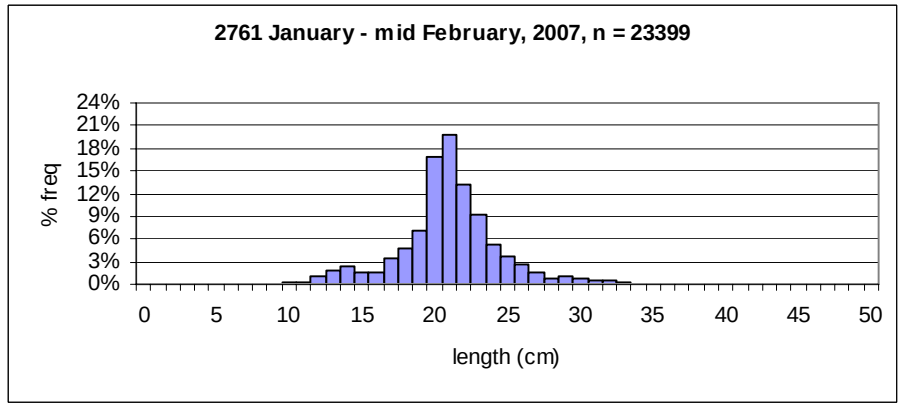
mid February - mid March
Year: 2007
Cruise: 2762

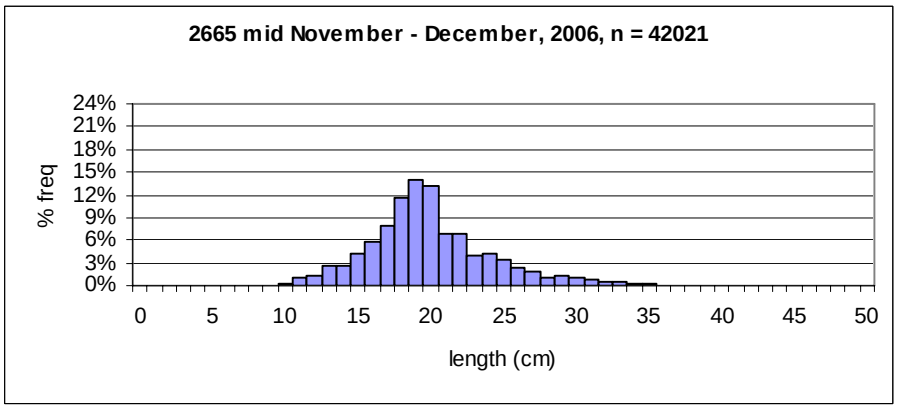
MarineFisheries

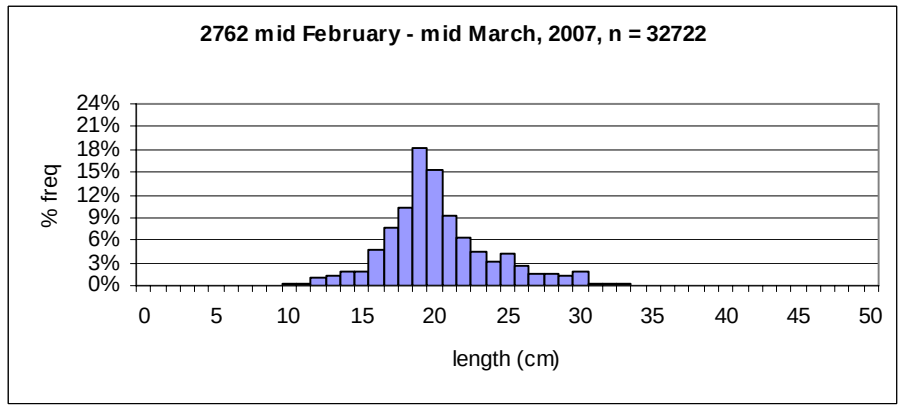
**Average number of fish at length for all tows where species were caught

Red Fish
2006 – 2007







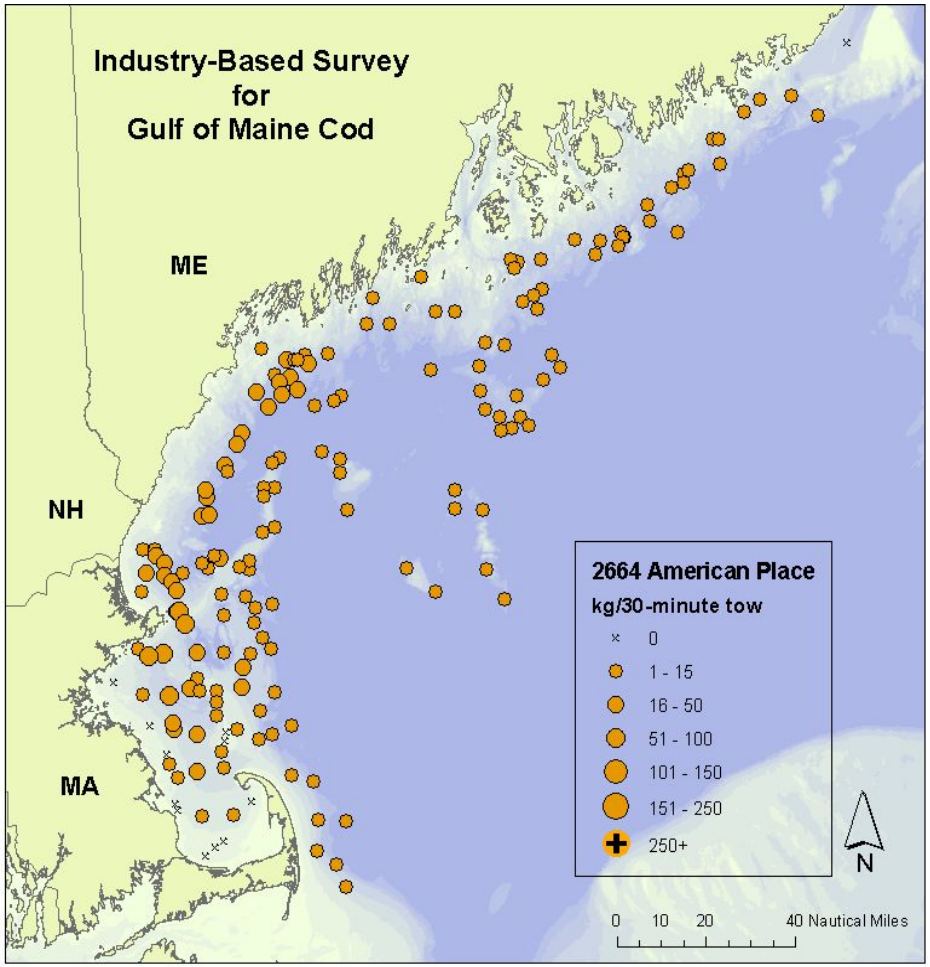


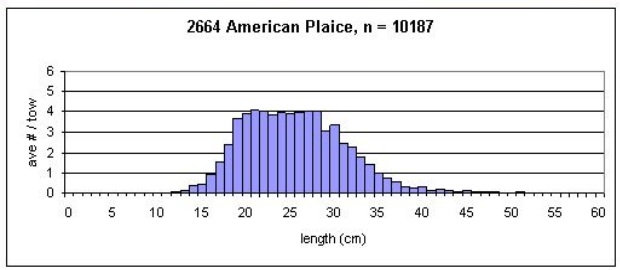
Industry-Based Survey for Gulf of Maine Cod

2006-2007 Survey Results

American Plaice

Spatial and temporal distribution by cruise, average number of fish at length where species were caught by cruise, and percent frequency at length by cruise



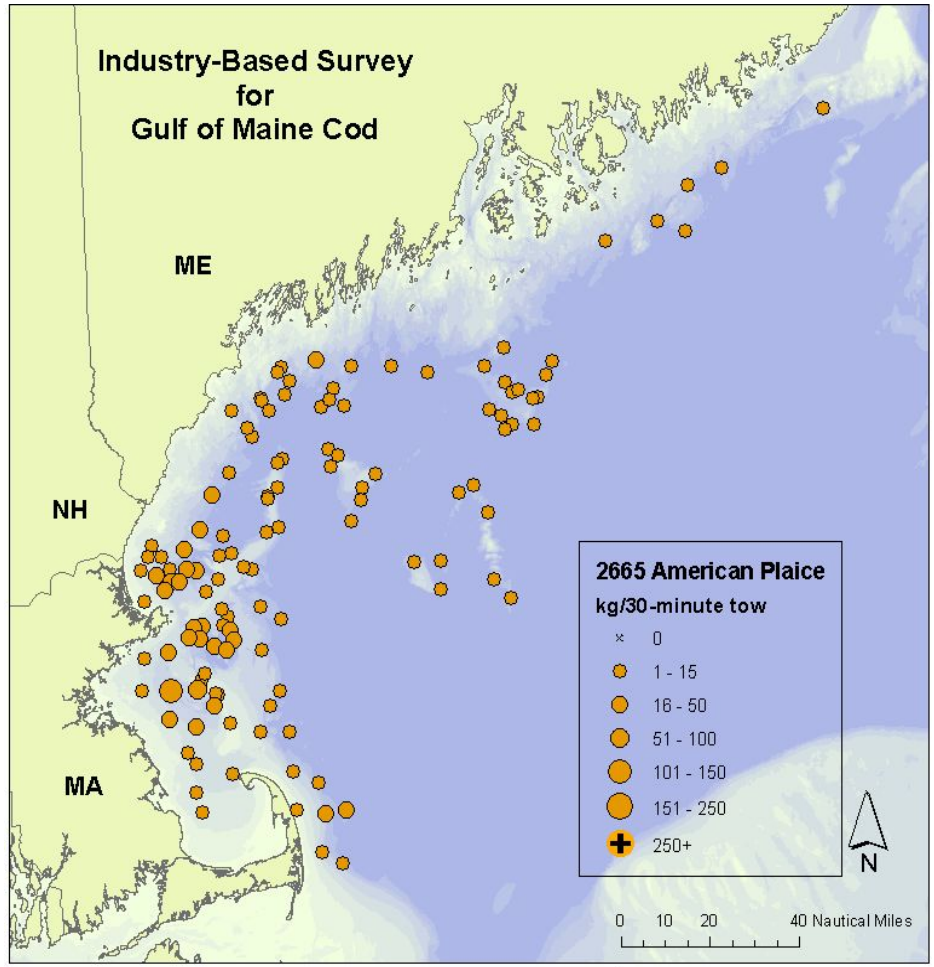


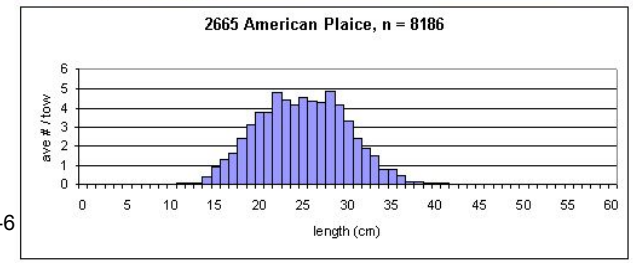
American Plaice
caught during the IBS for GOM cod survey

mid April - May
Year: 2007
Cruise: 2664

MarineFisheries

**Average number of fish at length for all tows where species were caught



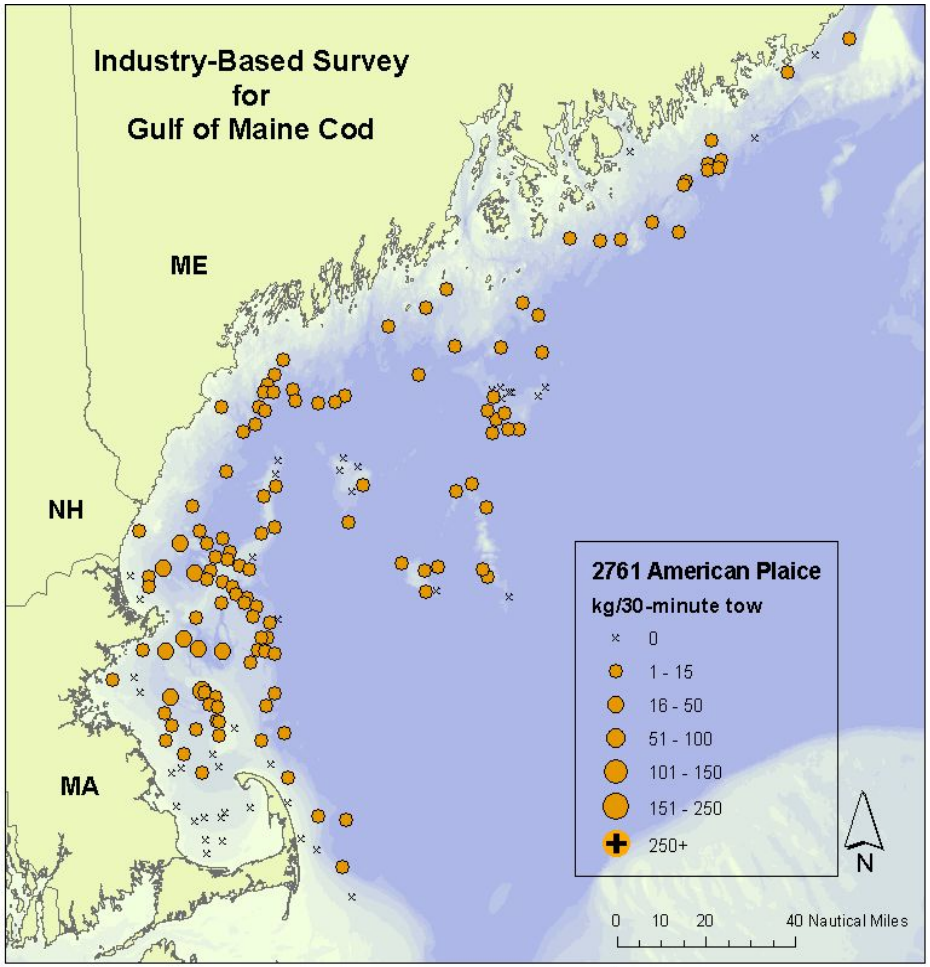


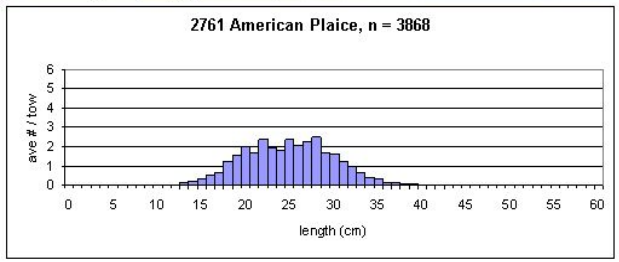
American Plaice
caught during the IBS for GOM cod survey

mid November - December
Year: 2006
Cruise: 2665

MarineFisheries

**Average number of fish at length for all tows where species were caught



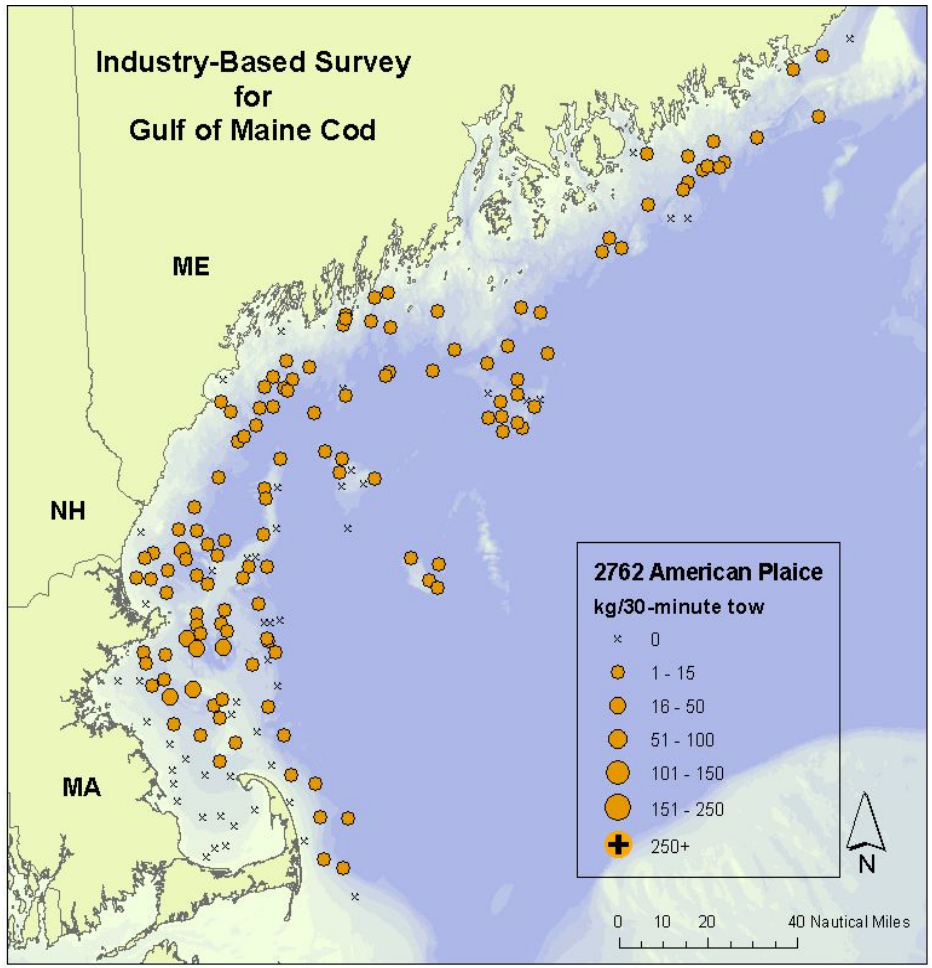


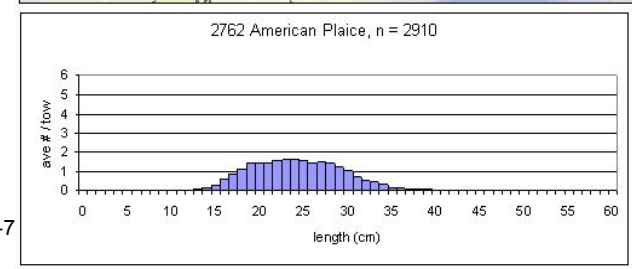
American Plaice
caught during the IBS for GOM cod survey

January - mid February
Year: 2007
Cruise: 2761

MarineFisheries

**Average number of fish at length for all tows where species were caught





American Plaice
caught during the IBS for GOM cod survey

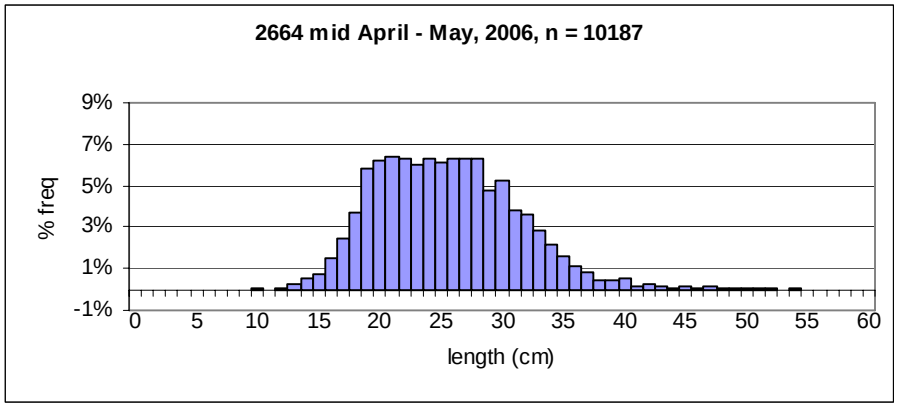
mid February - mid March
Year: 2007
Cruise: 2762

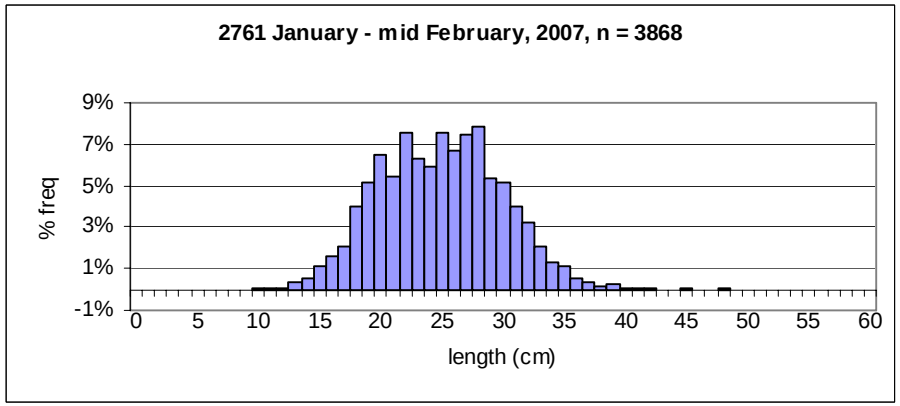
MarineFisheries

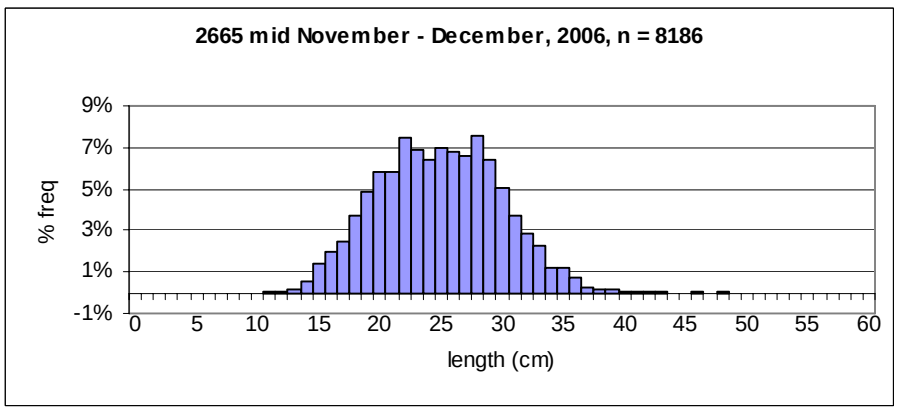
**Average number of fish at length for all tows where species were caught

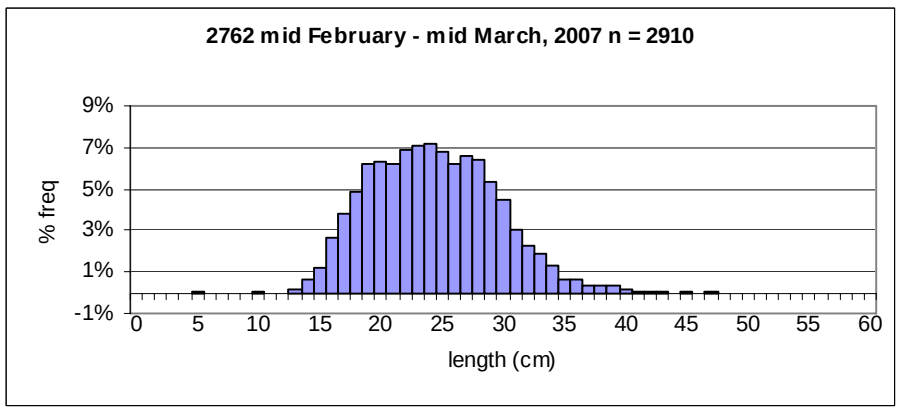
American Plaice

2006 -2007







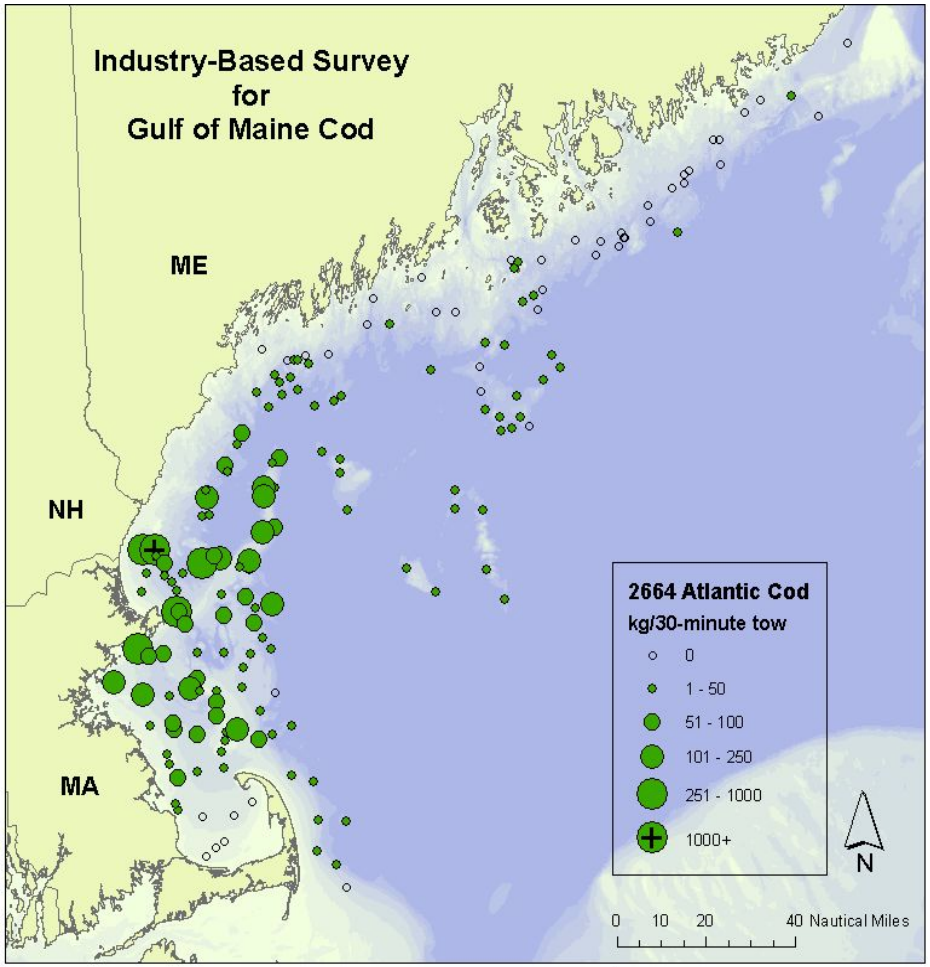


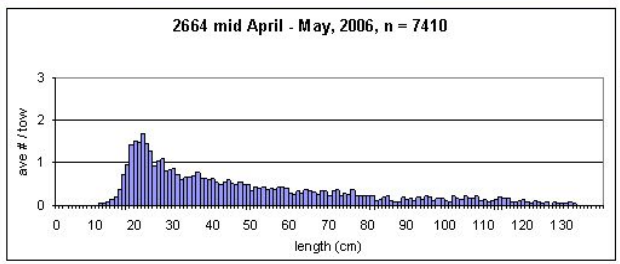
Industry-Based Survey for Gulf of Maine Cod

2006-2007 Survey Results

Atlantic Cod

Spatial and temporal distribution by cruise, average number of fish at length by cruise, and percent frequency at length by cruise



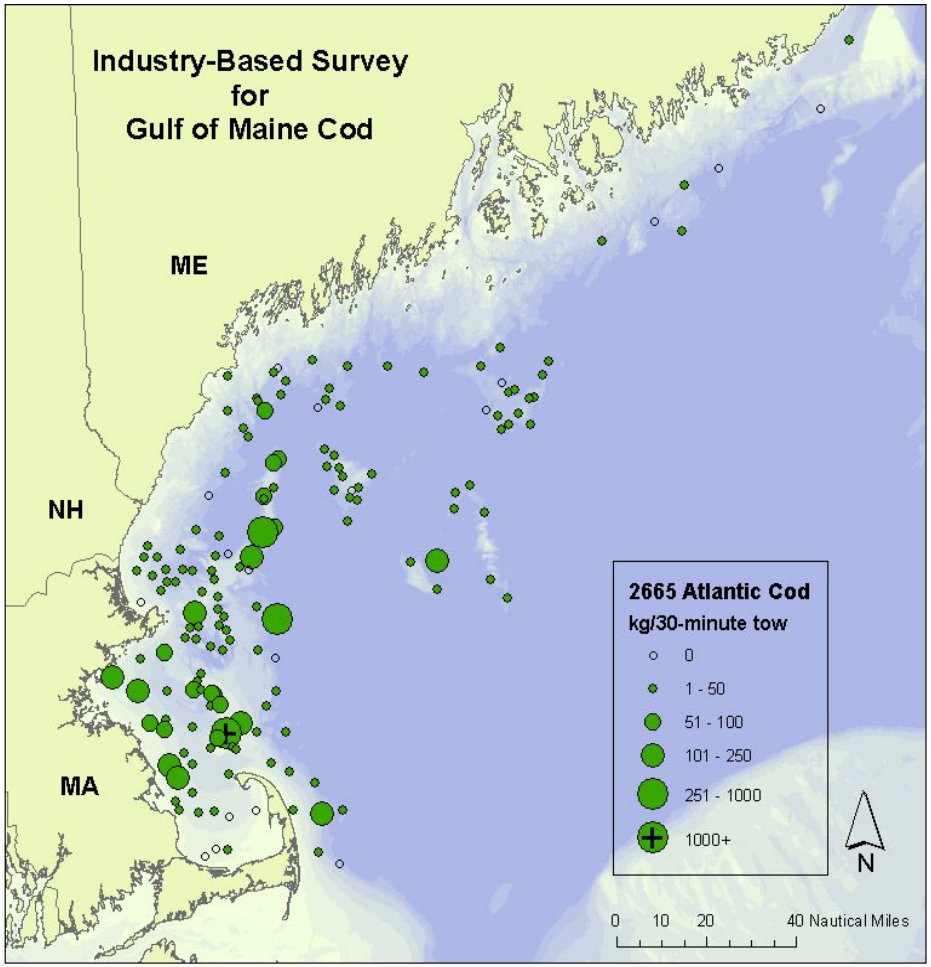


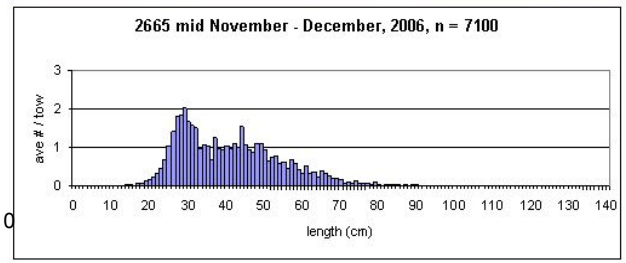
Atlantic Cod
caught during the IBS for GOM cod survey

mid November - December
Year: 2006
Cruise: 2664

MarineFisheries

**Average number of fish at length for all tows



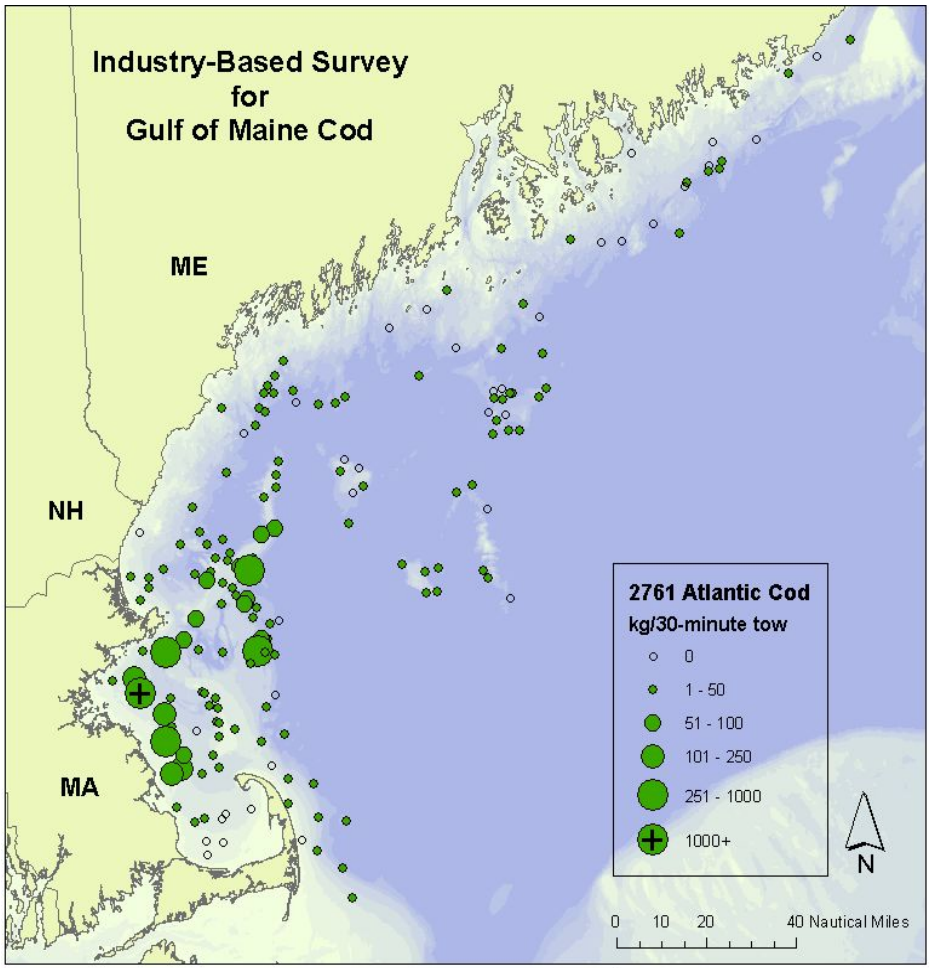


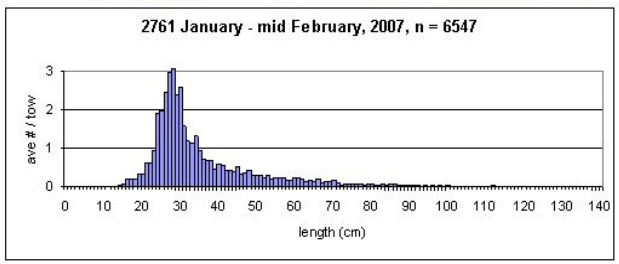
Atlantic Cod
caught during the IBS for GOM cod survey

mid November - December
Year: 2006
Cruise: 2665

MarineFisheries

**Average number of fish at length for all tows



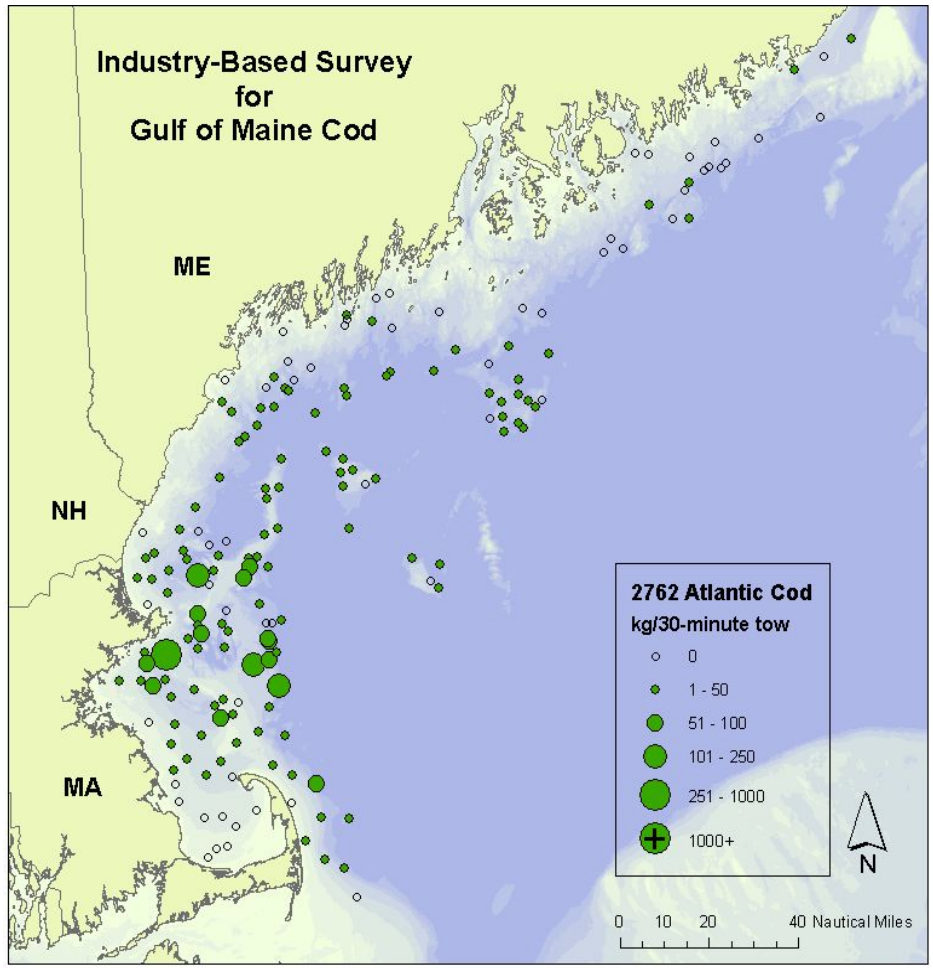


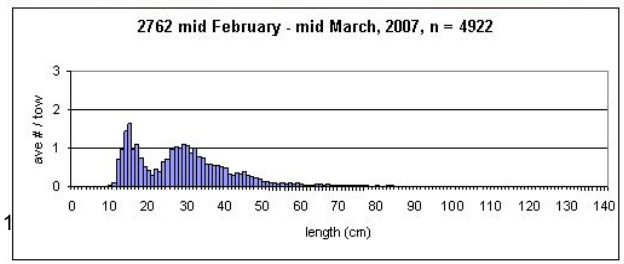
Atlantic Cod
caught during the IBS for GOM cod survey

January - mid Febuary
Year: 2007
Cruise: 2761

MarineFisheries

**Average number of fish at length for all tows





Atlantic Cod
caught during the IBS for GOM cod survey

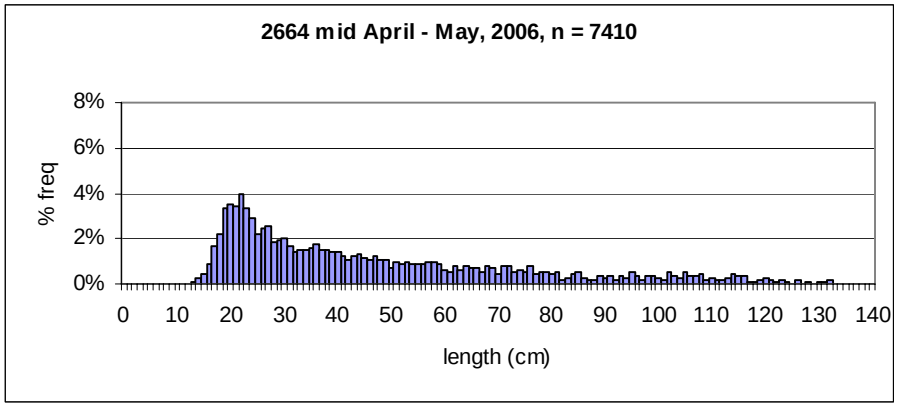
mid Febuary - mid March
Year: 2007
Cruise: 2762

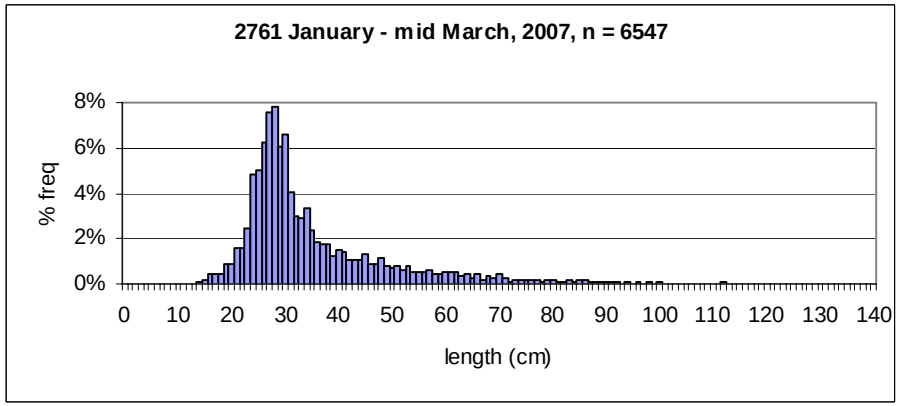
MarineFisheries

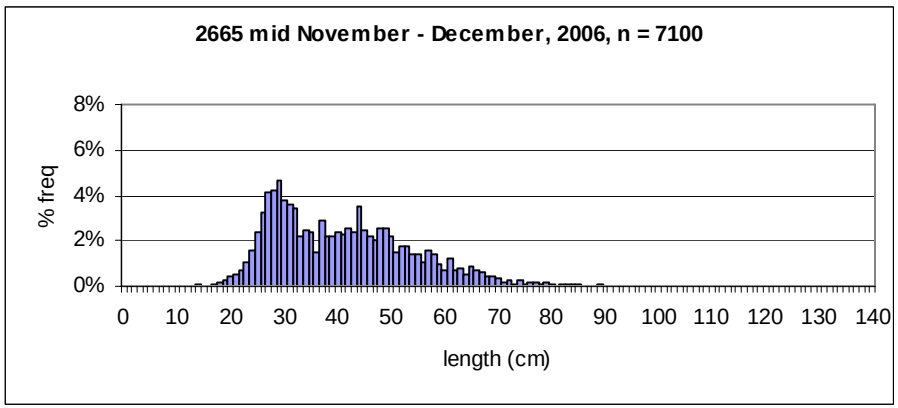
**Average number of fish at length for all tows

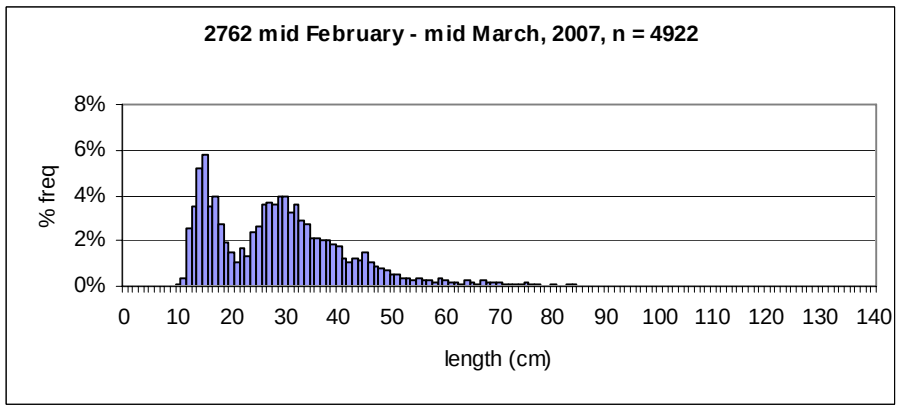
Atlantic Cod

2006 – 2007







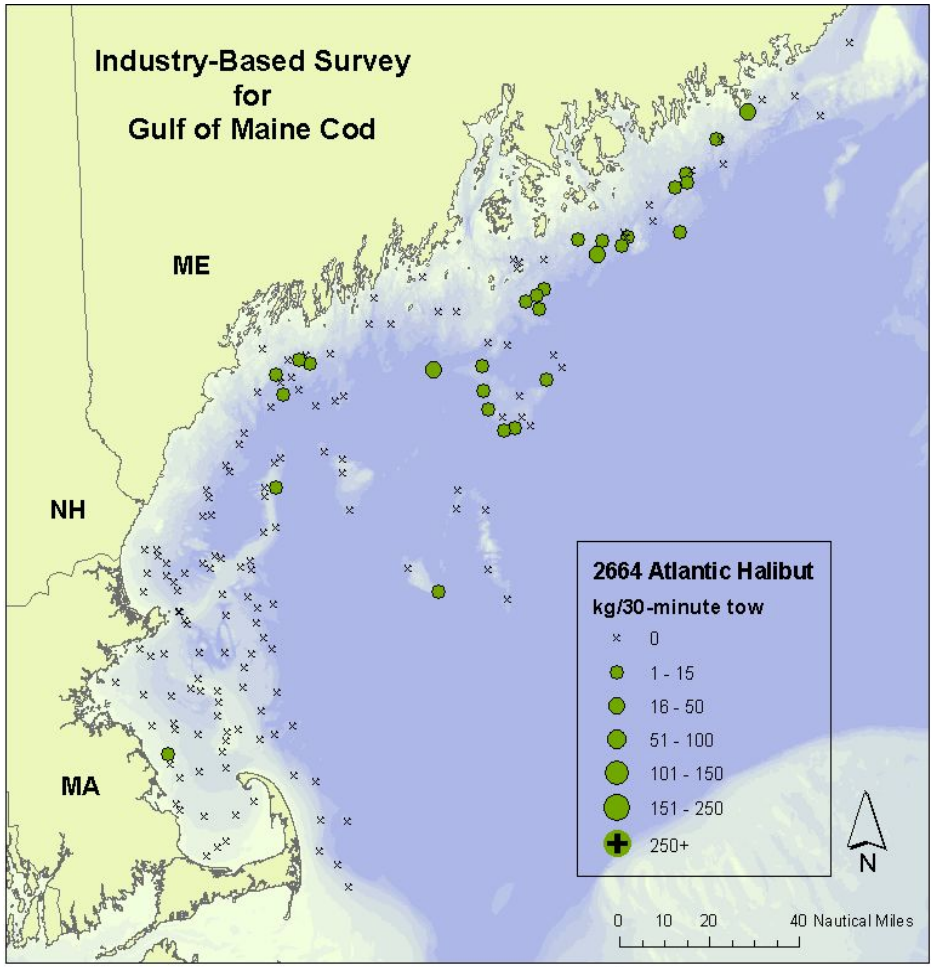


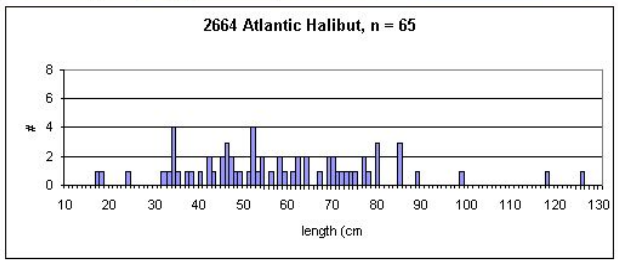
Industry-Based Survey for Gulf of Maine Cod

2006-2007 Survey Results

Atlantic Halibut

Spatial and temporal distribution by cruise, average number of fish at length where species were caught by cruise, and percent frequency at length by cruise



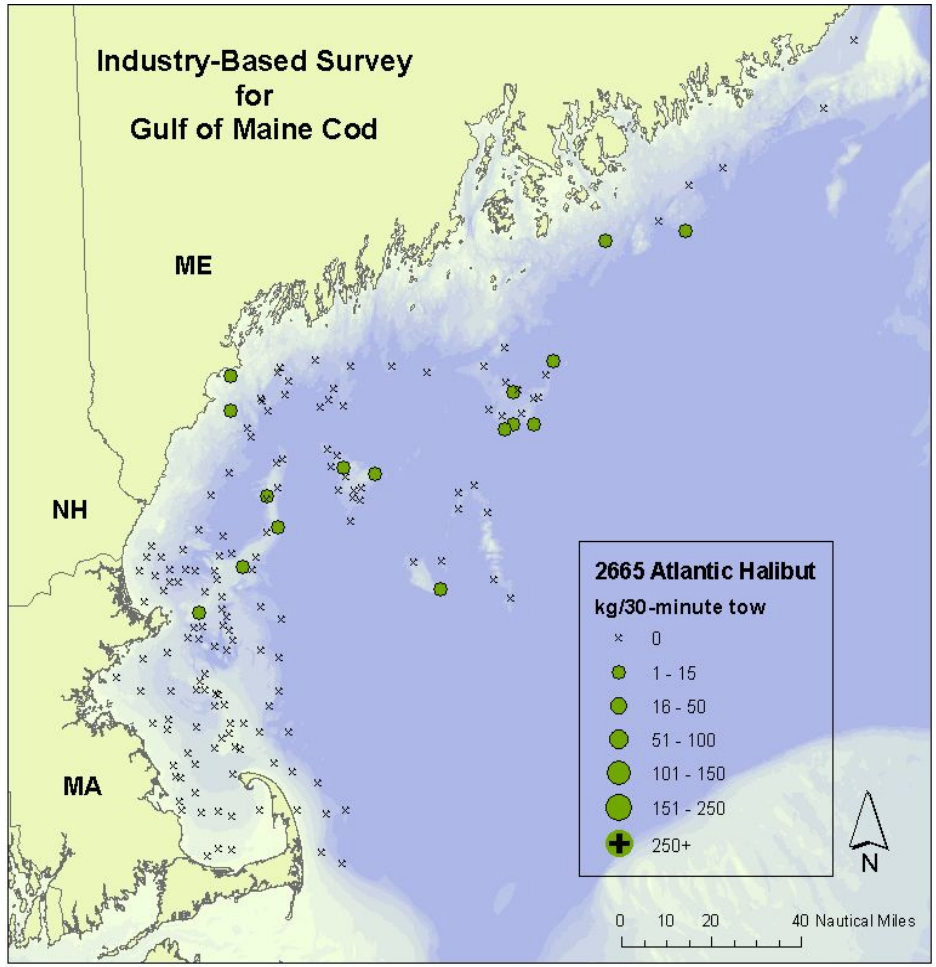


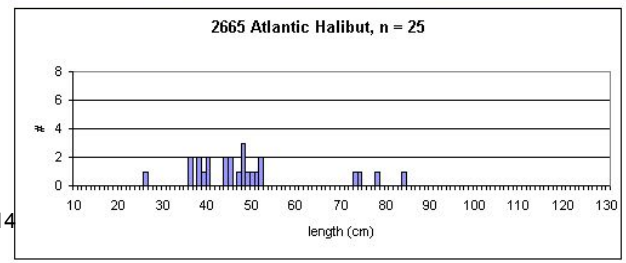
Atlantic Halibut
caught during the IBS for GOM cod survey

mid April - May
Year: 2006
Cruise: 2664

MarineFisheries

** Actual length frequency for all tows completed during cruise



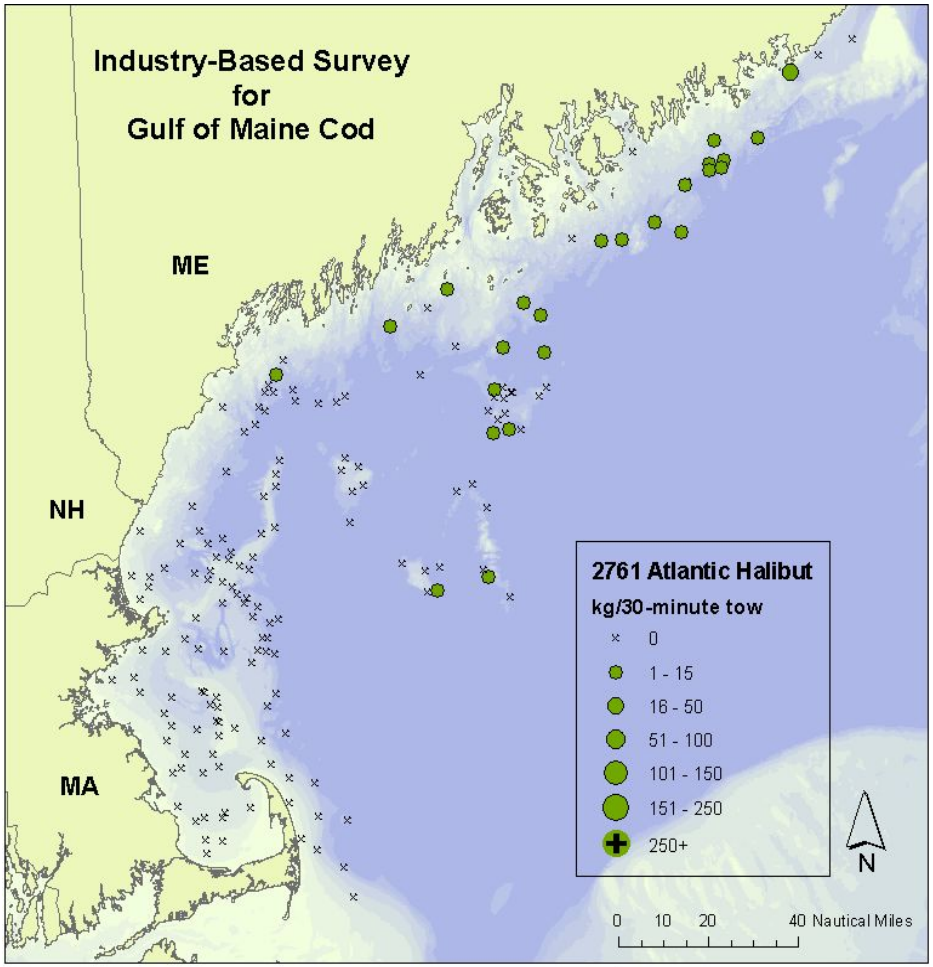


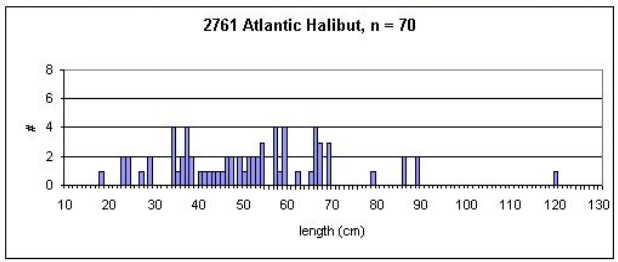
Atlantic Halibut
caught during the IBS for GOM cod survey

mid November - December
Year: 2006
Cruise: 2665

MarineFisheries

** Actual length frequency for all tows completed during cruise



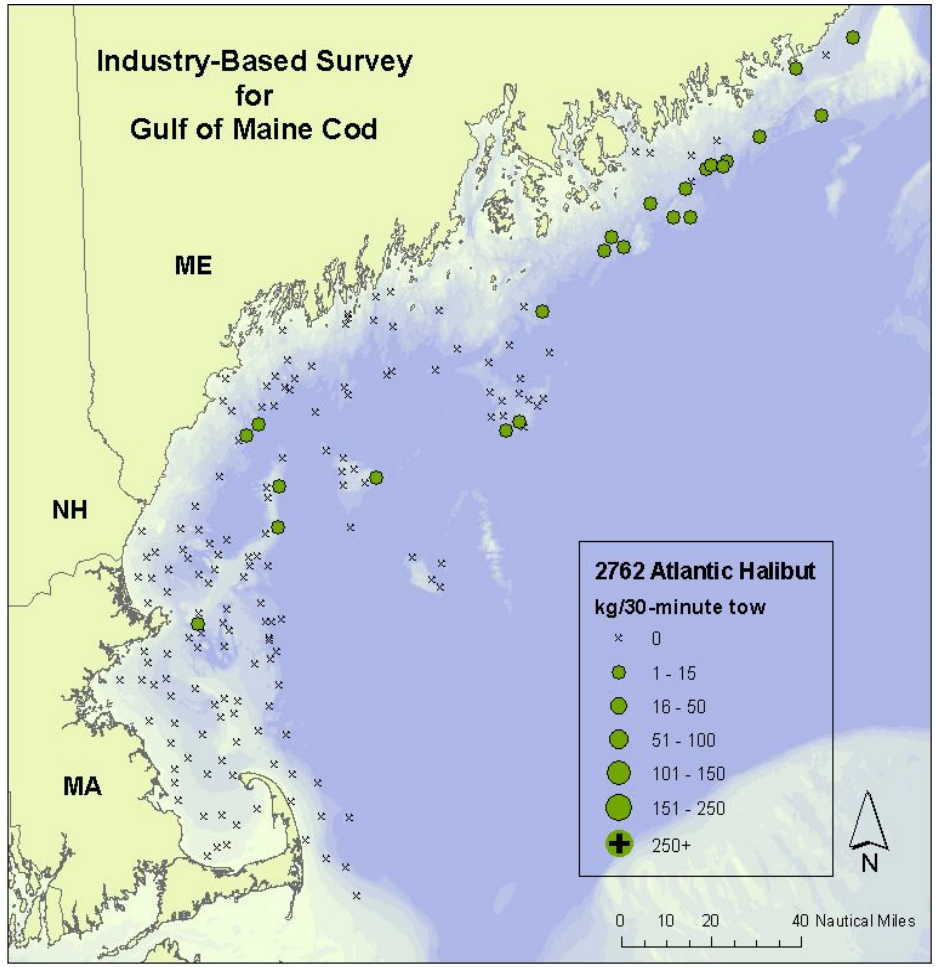


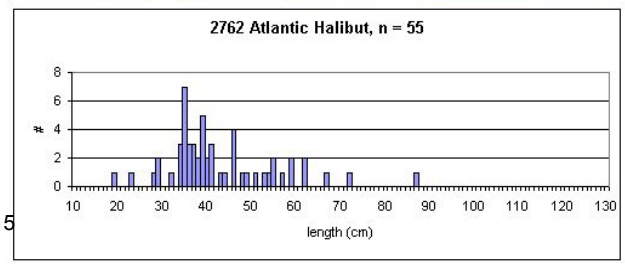
Atlantic Halibut
caught during the IBS for GOM cod survey

January - mid February
Year: 2007
Cruise: 2761

MarineFisheries

** Actual length frequency for all tows completed during cruise





Atlantic Halibut
caught during the IBS for GOM cod survey

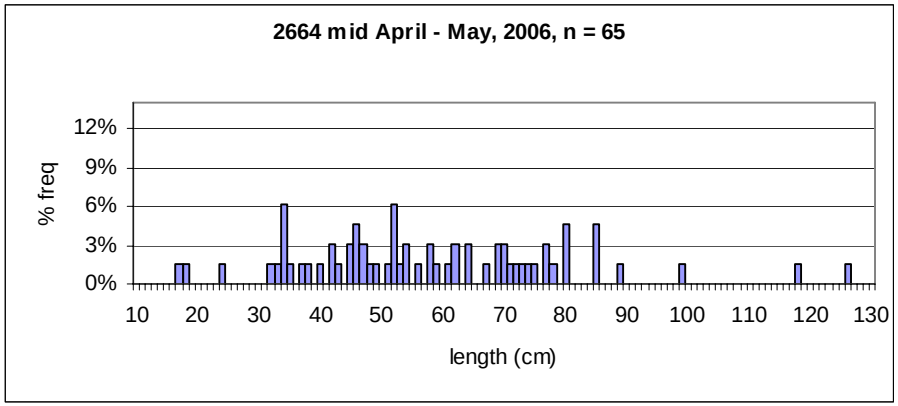
mid February - March
Year: 2007
Cruise: 2762

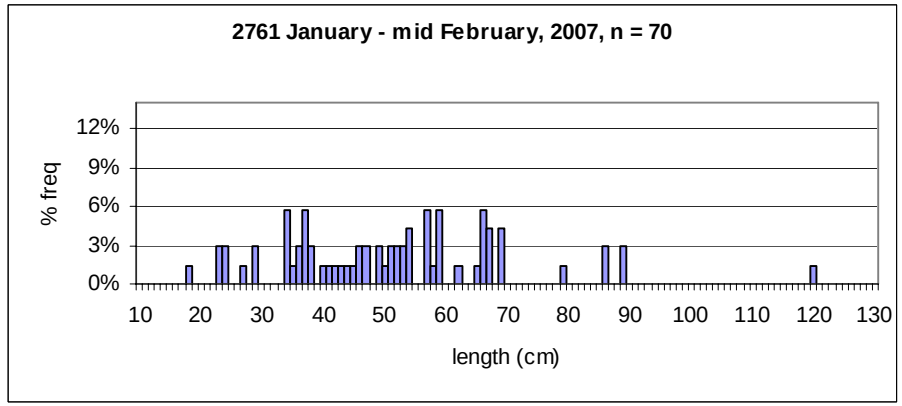
MarineFisheries

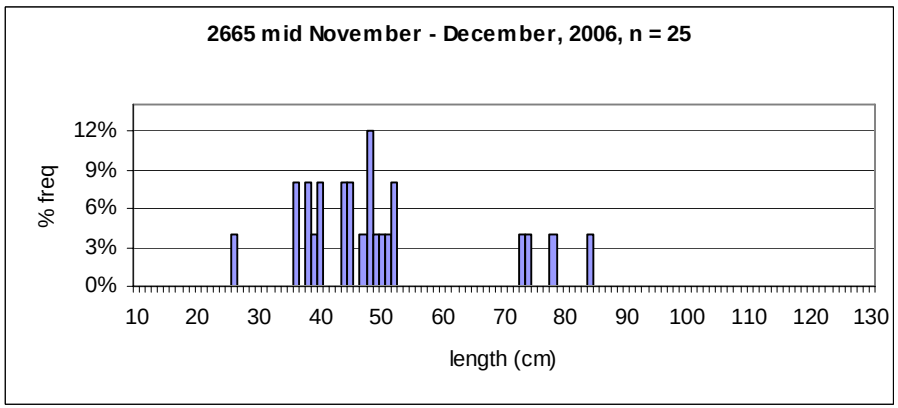
** Actual length frequency for all tows completed during cruise

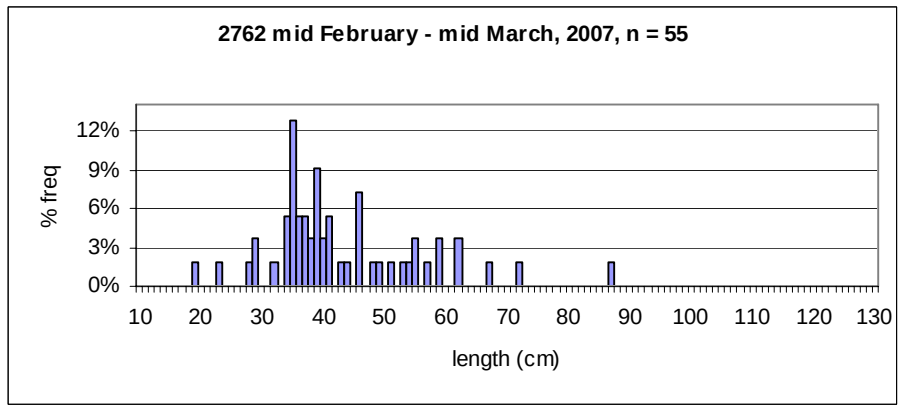
Atlantic Halibut

2006 – 2007







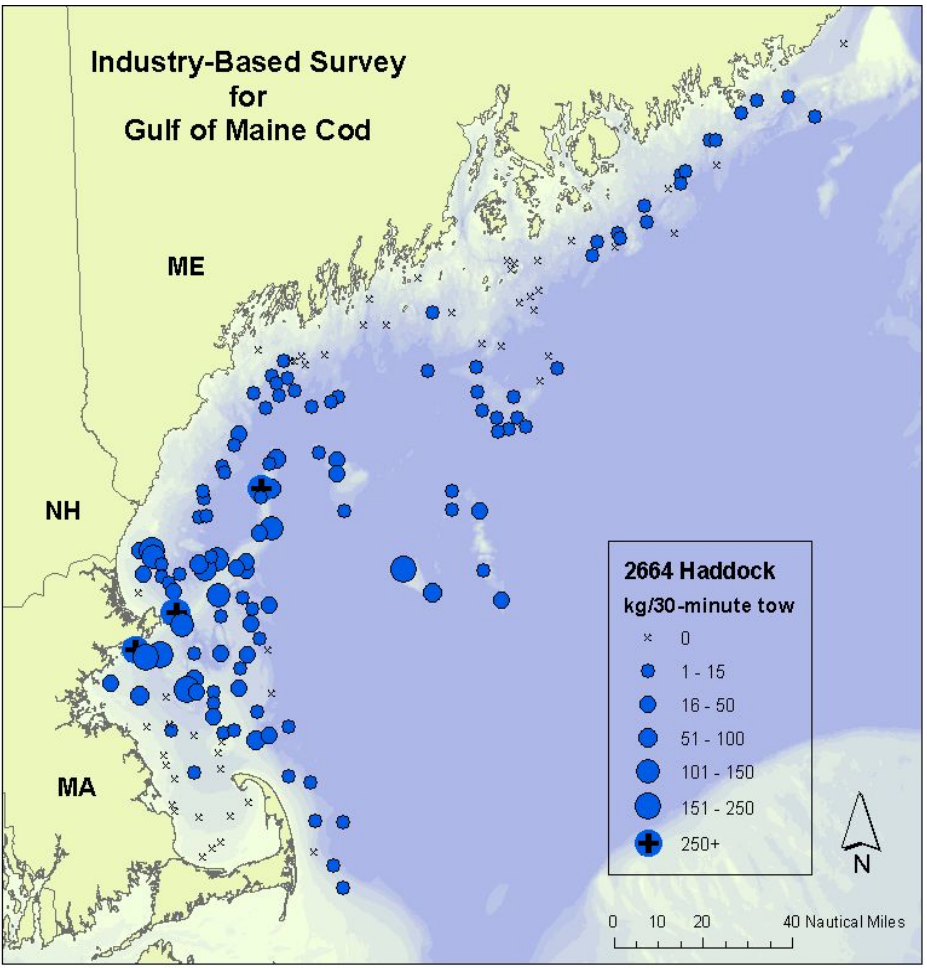


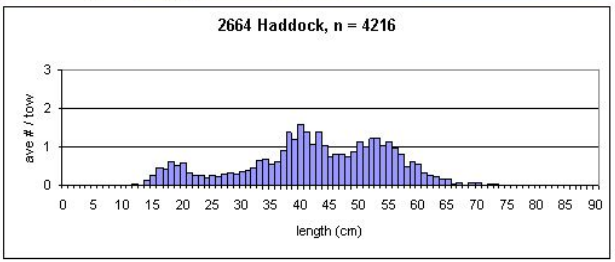
Industry-Based Survey for Gulf of Maine Cod

2006-2007 Survey Results

Haddock

Spatial and temporal distribution by cruise, average number of fish at length where species were caught by cruise, and percent frequency at length by cruise



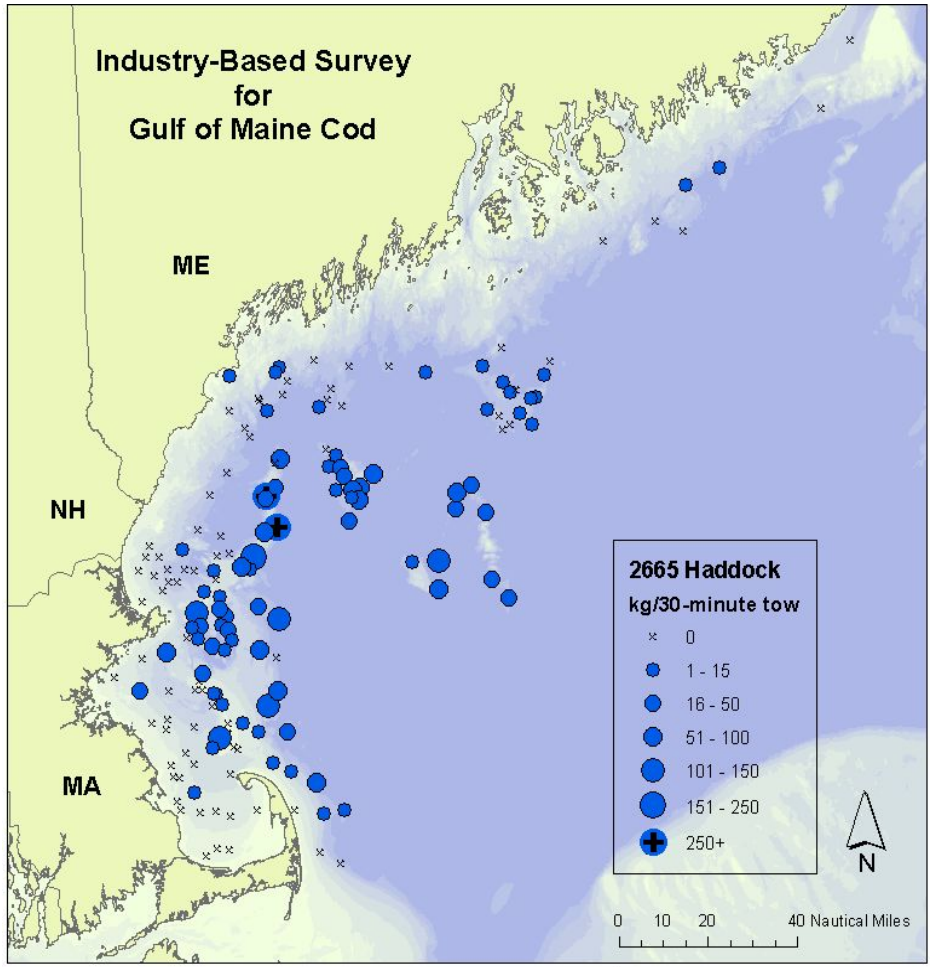


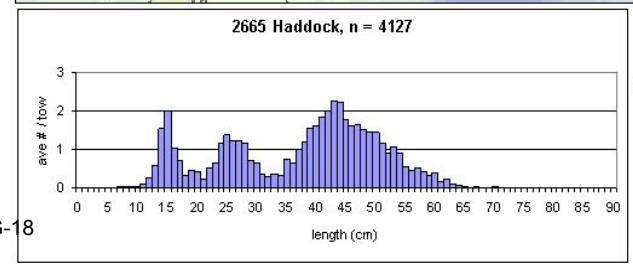
Haddock
caught during the IBS for GOM cod survey

mid April - May
Year: 2006
Cruise: 2664

MarineFisheries

**Average number of fish at length for all tows where species were caught



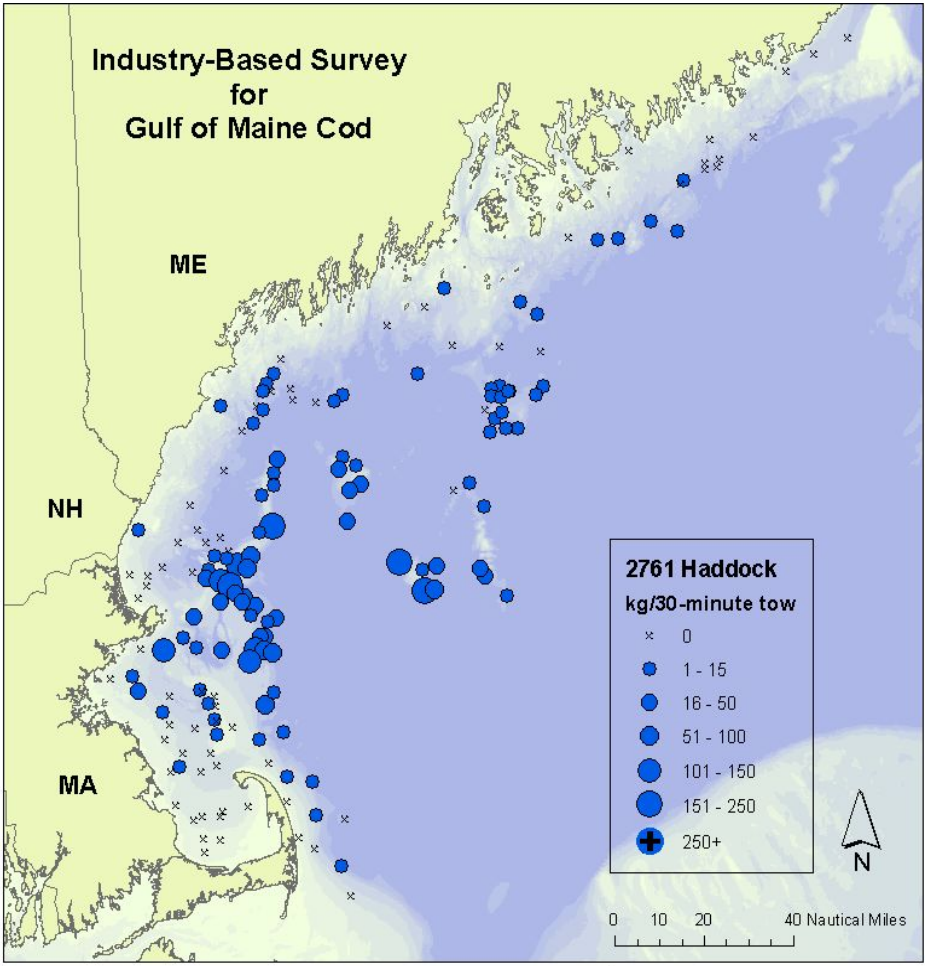


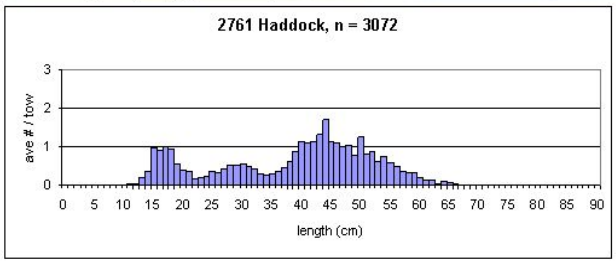
Haddock
caught during the IBS for GOM cod survey

mid November - December
Year: 2006
Cruise: 2665

MarineFisheries

**Average number of fish at length for all tows where species were caught



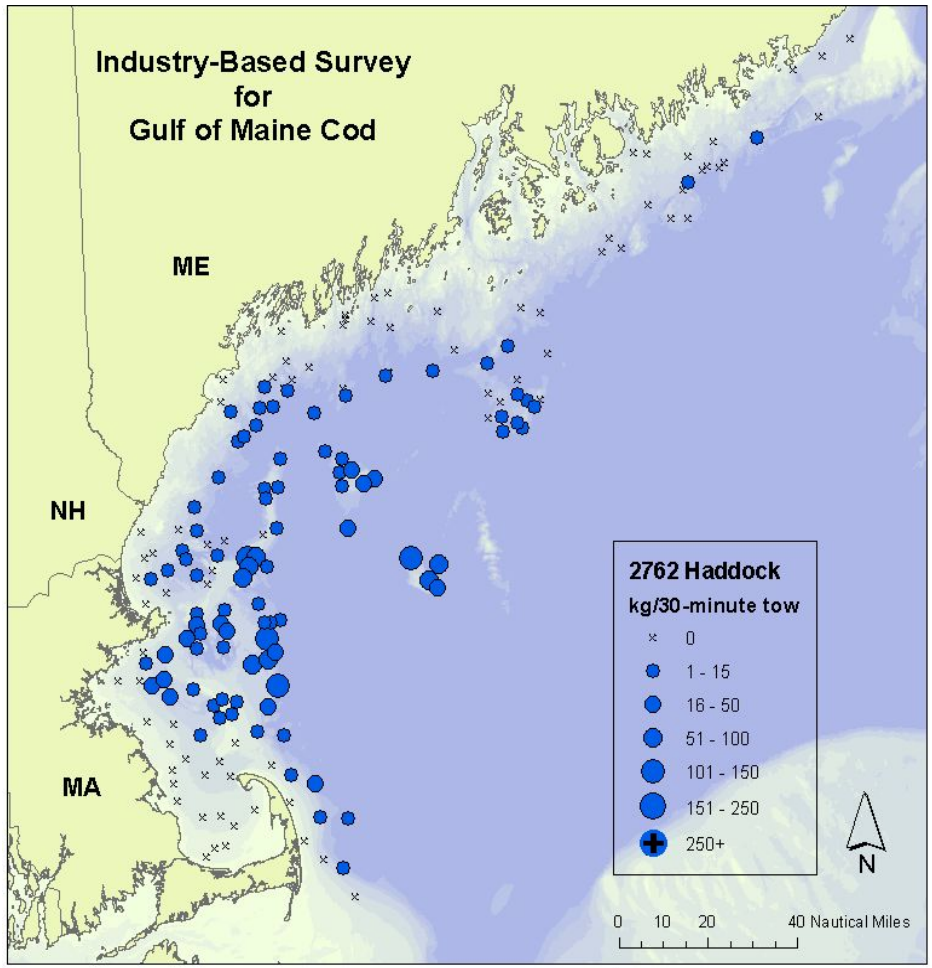


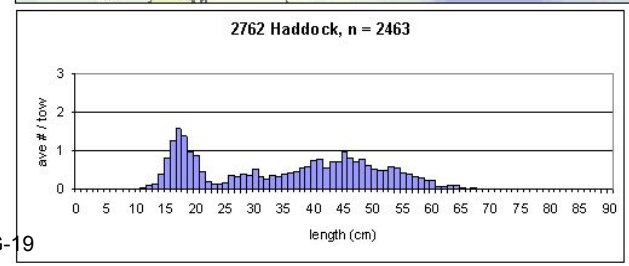
Haddock
caught during the IBS for GOM cod survey

January - mid February
Year: 2007
Cruise: 2761

MarineFisheries

**Average number of fish at length for all tows where species were caught





Haddock
caught during the IBS for GOM cod survey

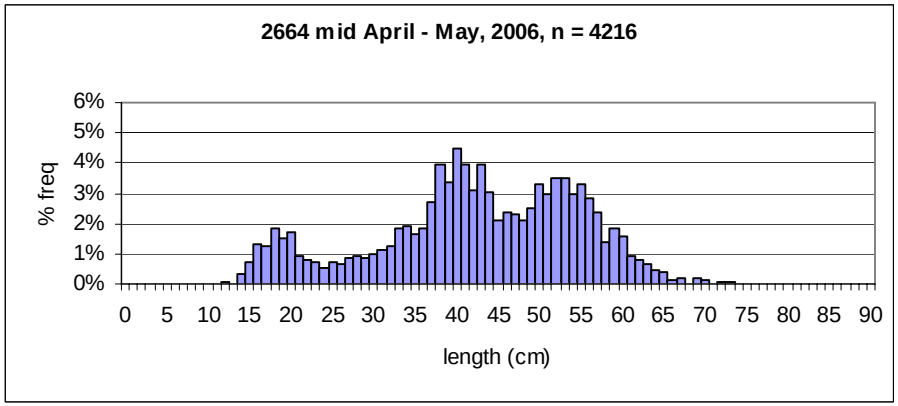
mid February - mid April
Year: 2007
Cruise: 2762

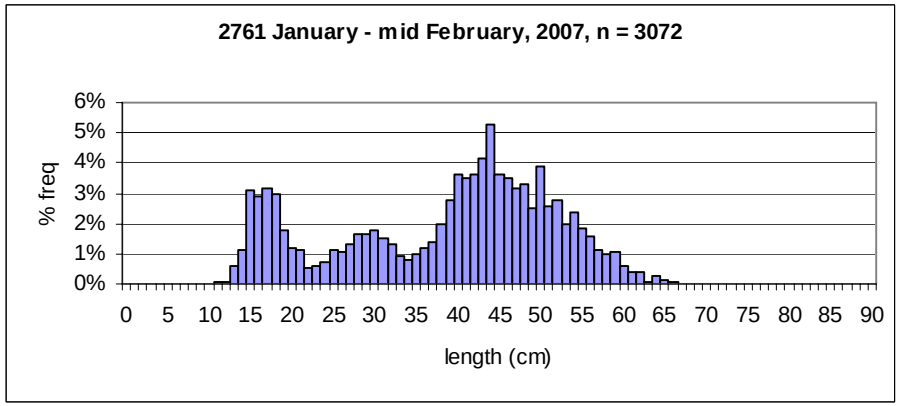
MarineFisheries

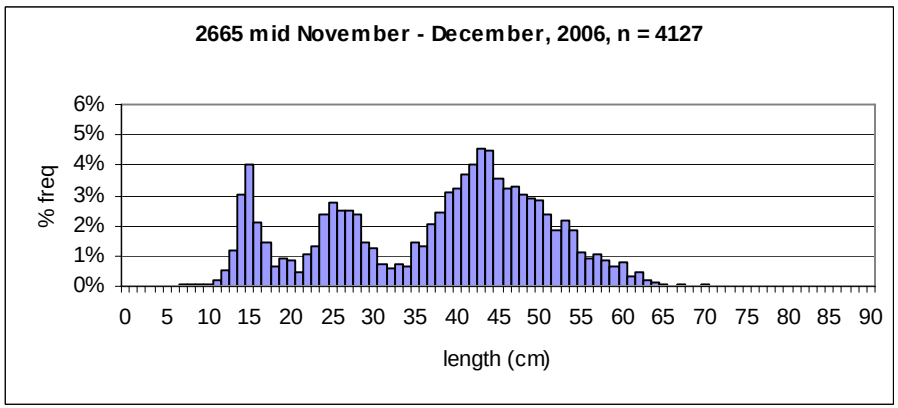
**Average number of fish at length for all tows where species were caught

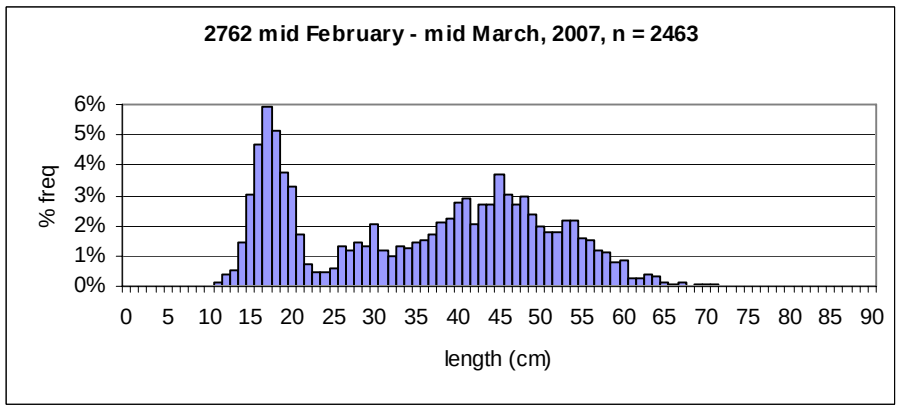
Haddock

2006 – 2007







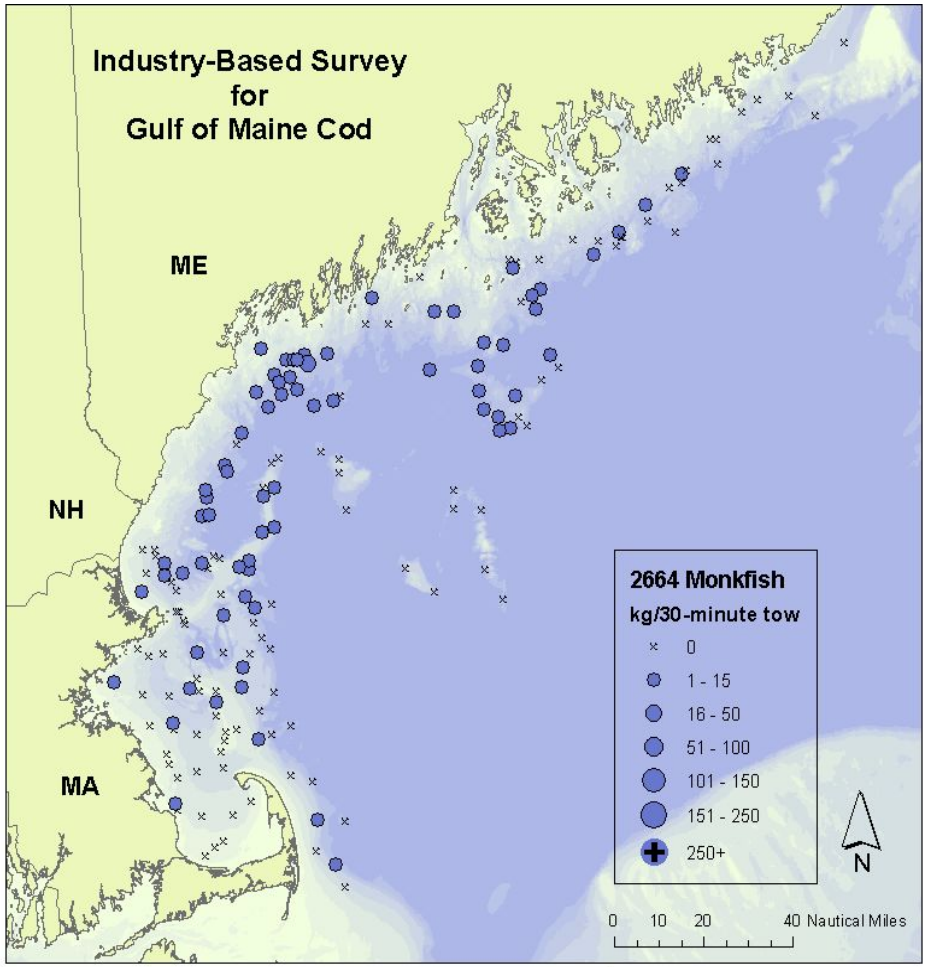


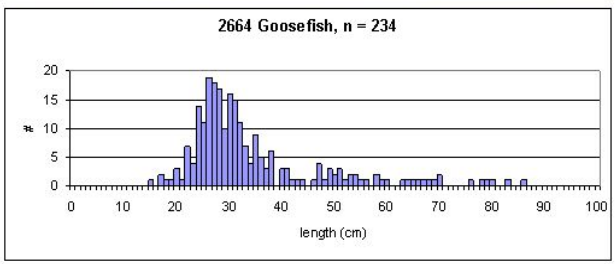
Industry-Based Survey for Gulf of Maine Cod

2006-2007 Survey Results

Monkfish

Spatial and temporal distribution by cruise, average number of fish at length where species were caught by cruise, and percent frequency at length by cruise



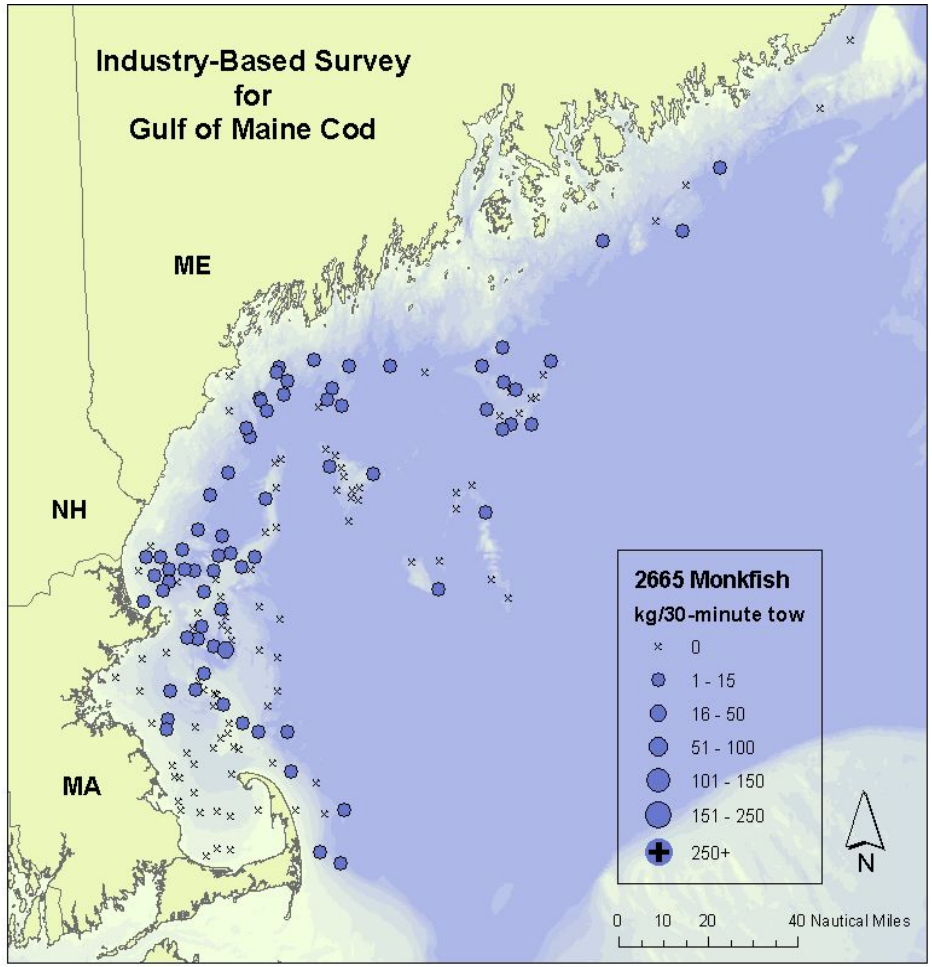


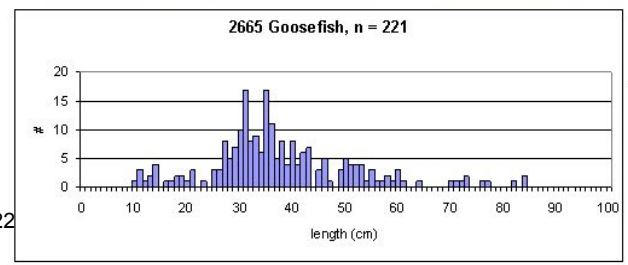
Monkfish
caught during the IBS for GOM cod survey

mid April - May
Year: 2006
Cruise: 2664

MarineFisheries

** Actual length frequency for all tows completed during cruise



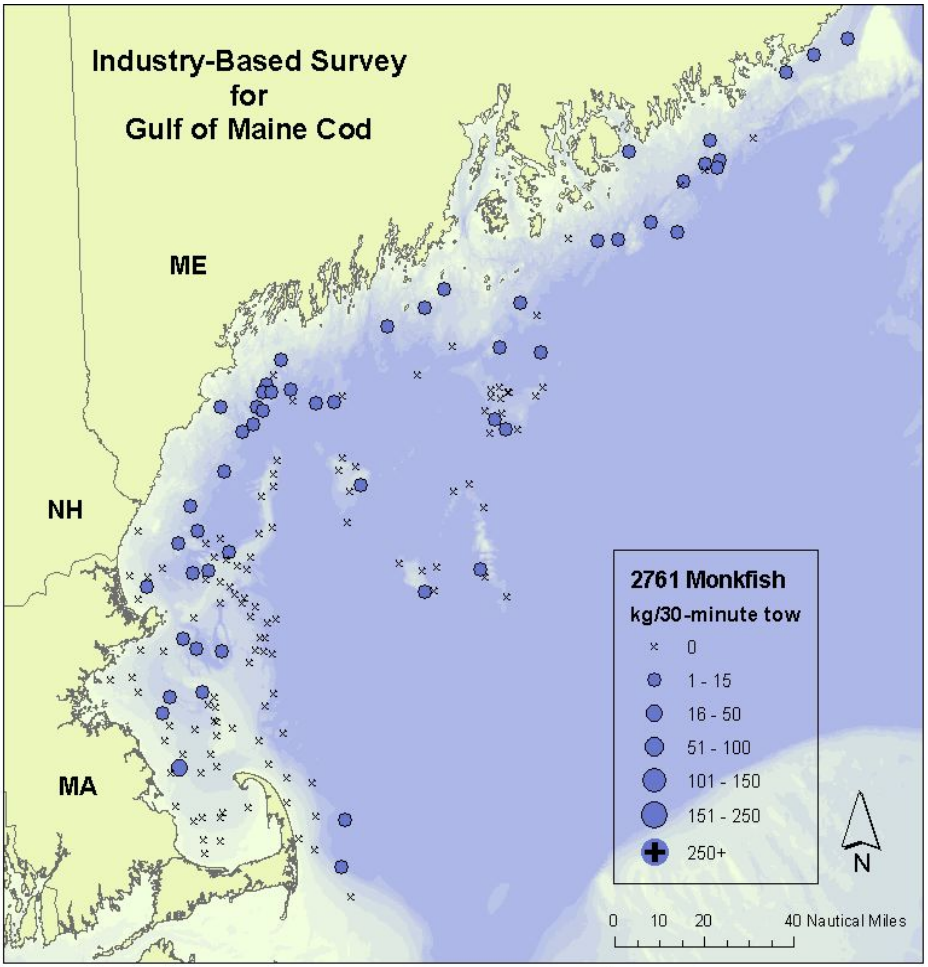


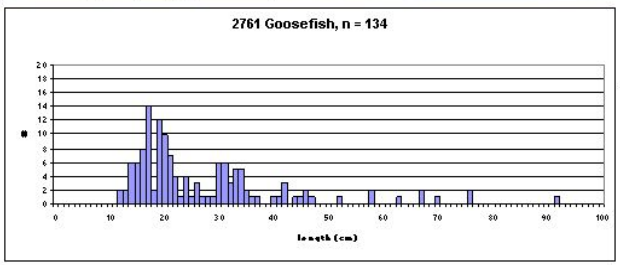
Monkfish
caught during the IBS for GOM cod survey

Mid November - December
Year: 2006
Cruise: 2665

MarineFisheries

** Actual length frequency for all tows completed during cruise



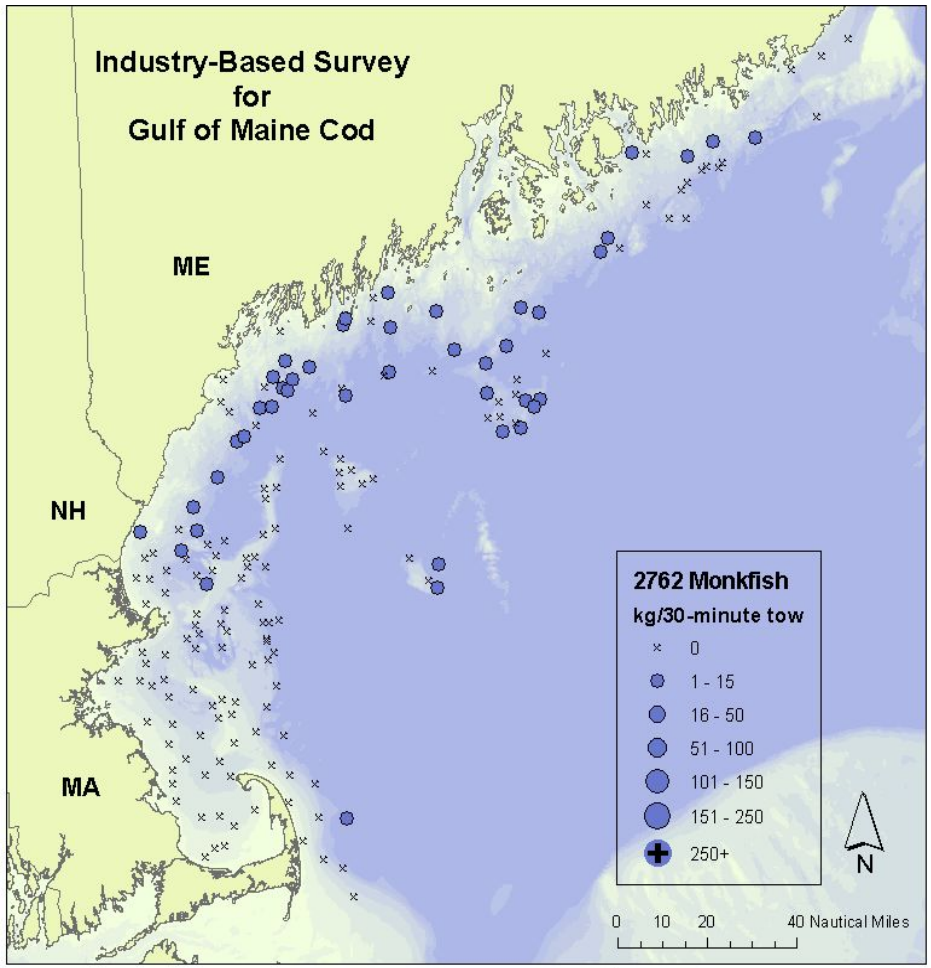


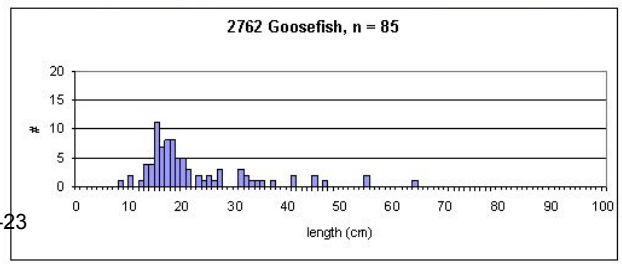
Monkfish
caught during the IBS for GOM cod survey

January - mid February
Year: 2007
Cruise: 2761

MarineFisheries

** Actual length frequency for all tows completed during cruise





Monkfish
caught during the IBS for GOM cod survey

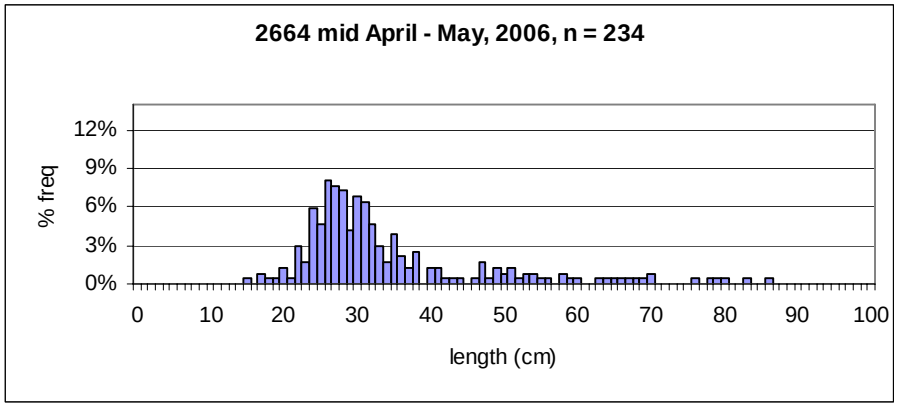
mid February - mid March
Year: 2007
Cruise: 2762

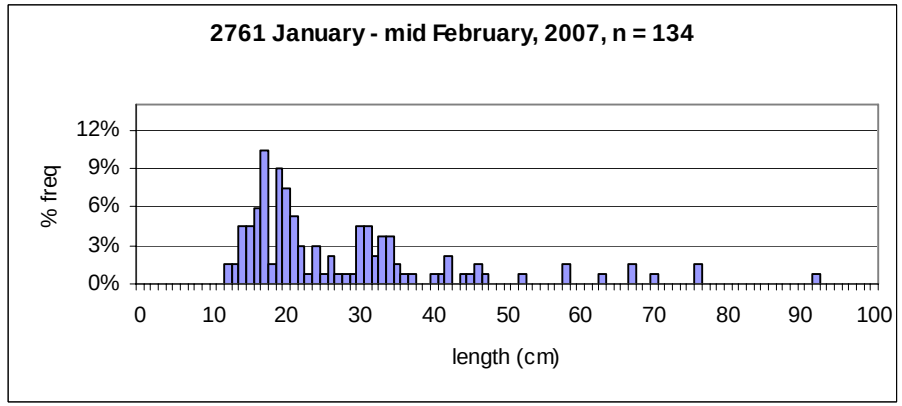
MarineFisheries

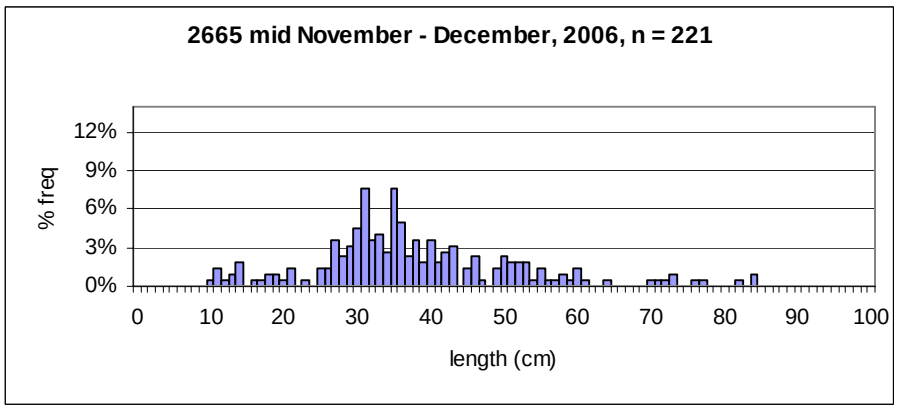
** Actual length frequency for all tows completed during cruise

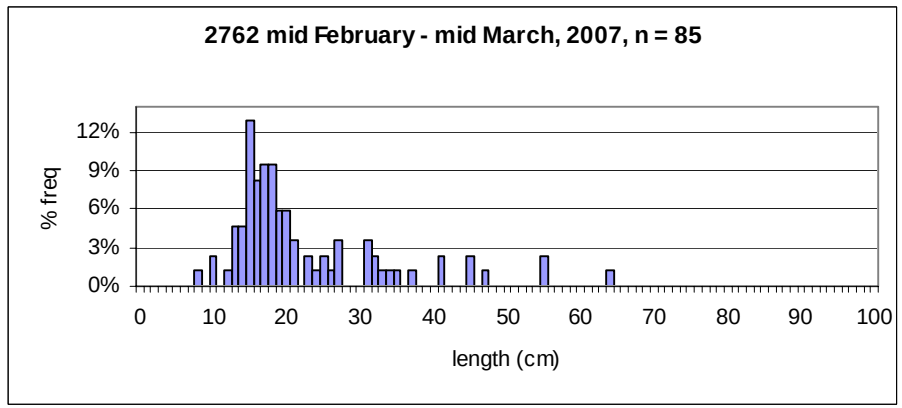
Monkfish

2006 – 2007







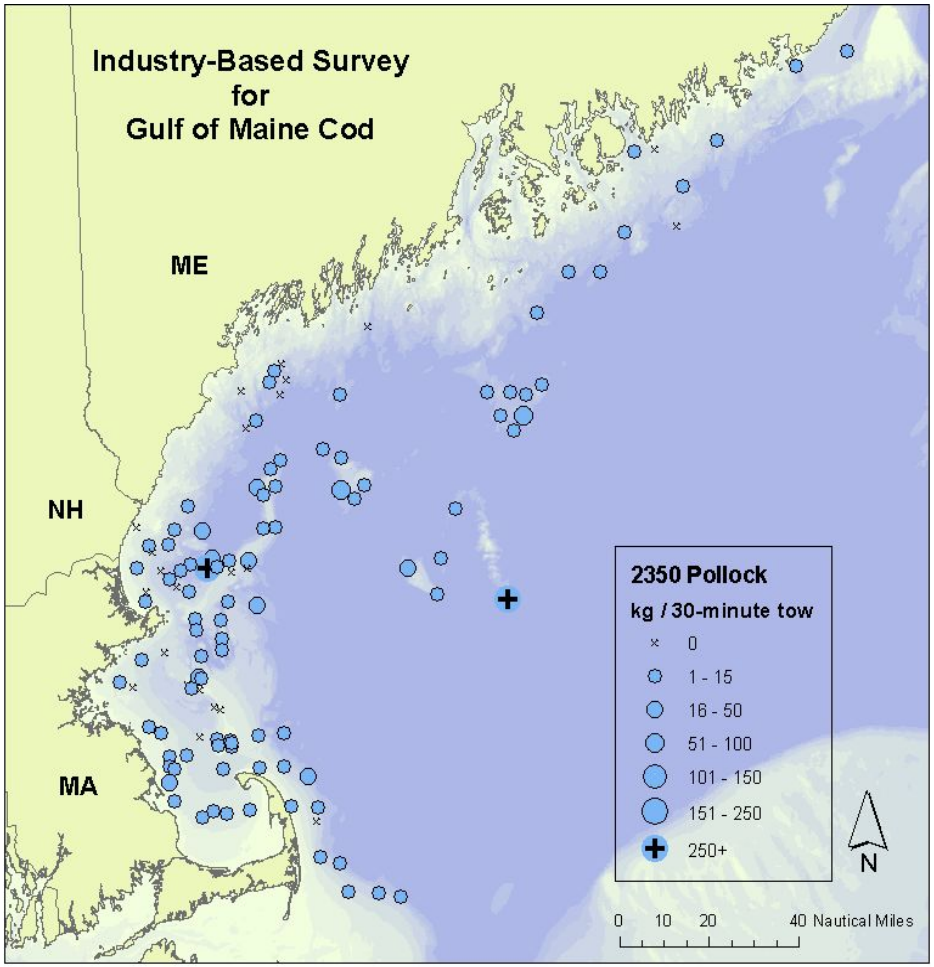


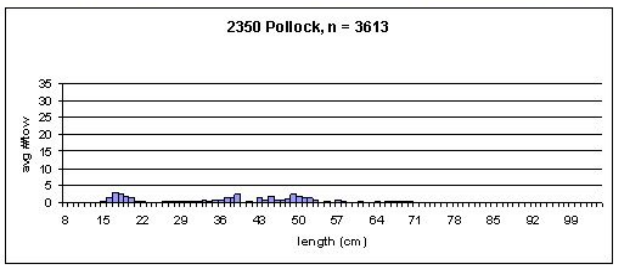
Industry-Based Survey for Gulf of Maine Cod

2006-2007 Survey Results

Pollock

Spatial and temporal distribution by cruise, average number of fish at length where species were caught by cruise, and percent frequency at length by cruise



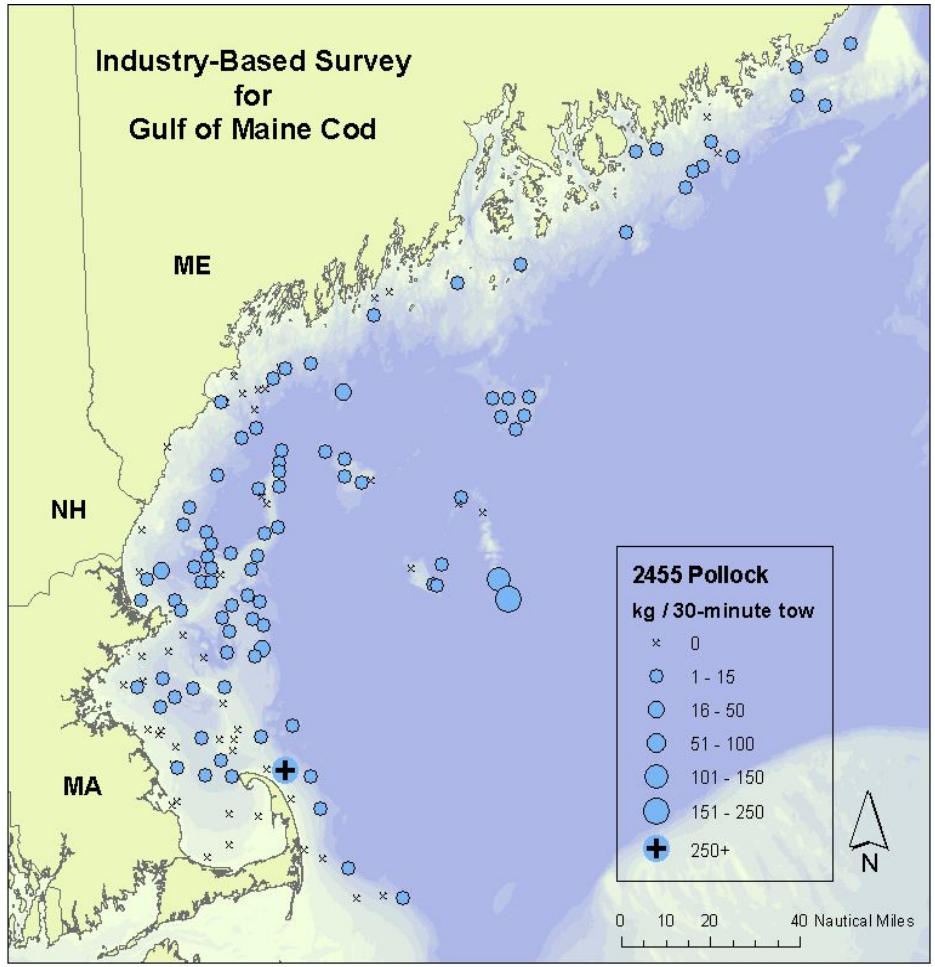


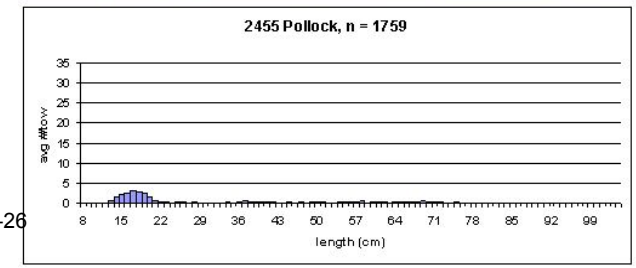
Pollock
caught during the IBS for GOM cod survey

mid November - December
Year: 2003
Cruise: 2350

MarineFisheries

**Average number of fish at length for all tows where species were caught



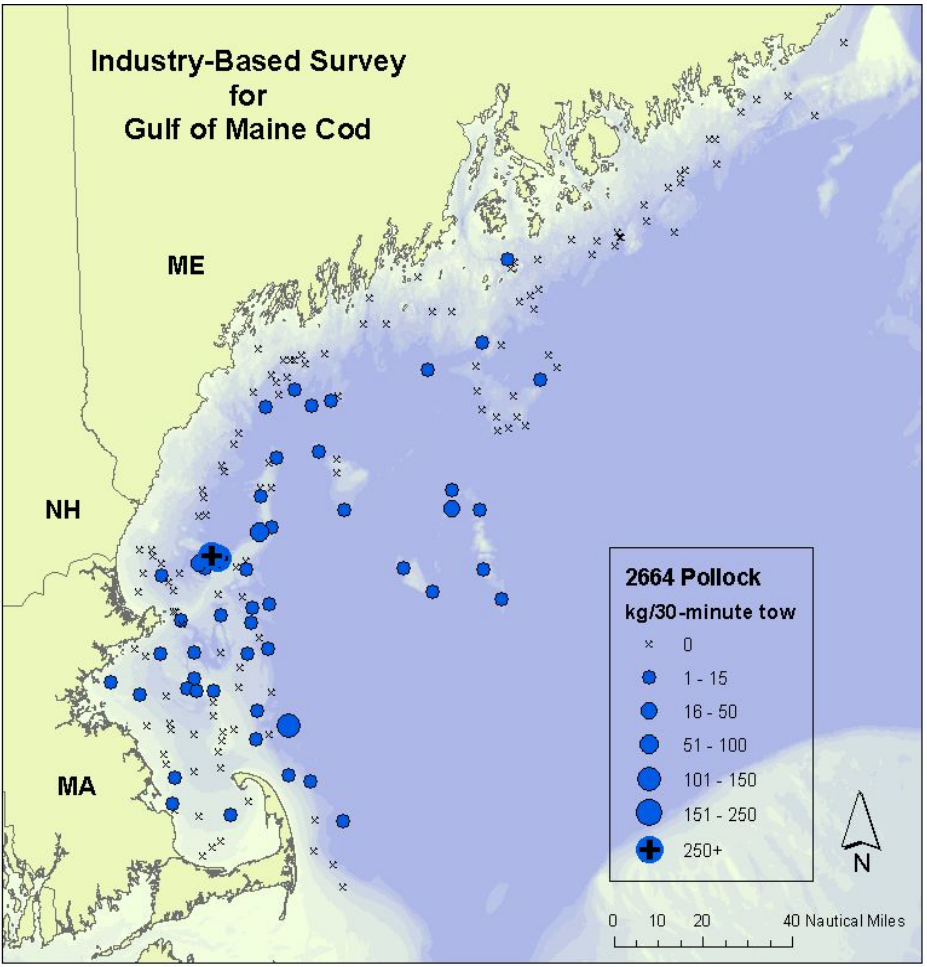


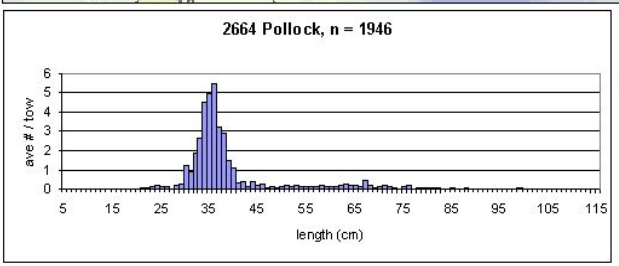
Pollock
caught during the IBS for GOM cod survey

January - Mid February
Year: 2004
Cruise: 2455

MarineFisheries

**Average number of fish at length for all tows where species were caught



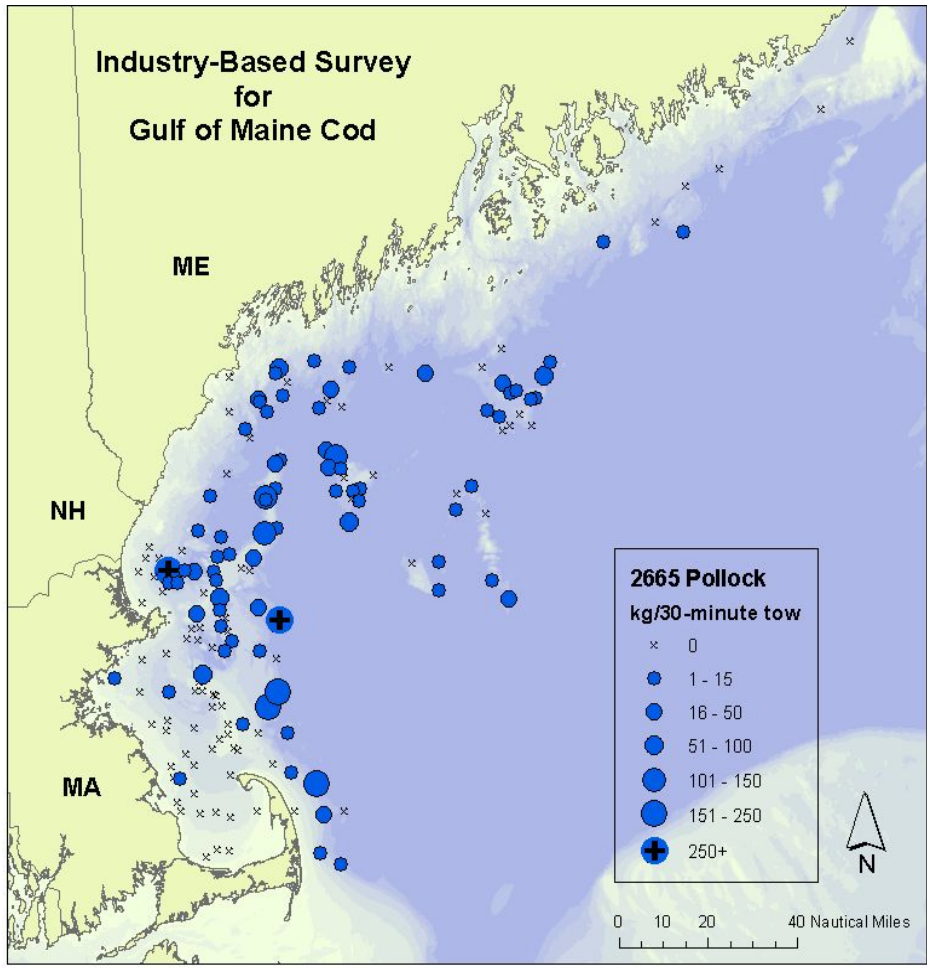


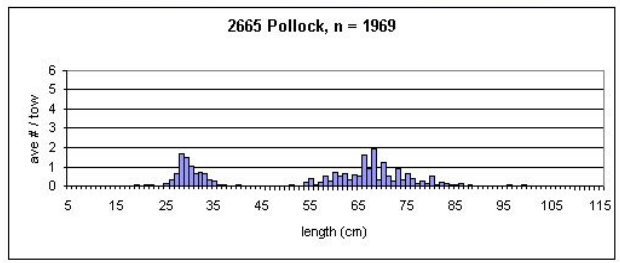
Pollock
caught during the IBS for GOM cod survey

mid April - May
Year: 2006
Cruise: 2664

MarineFisheries

**Average number of fish at length for all tows where species were caught





Pollock
caught during the IBS for GOM cod survey

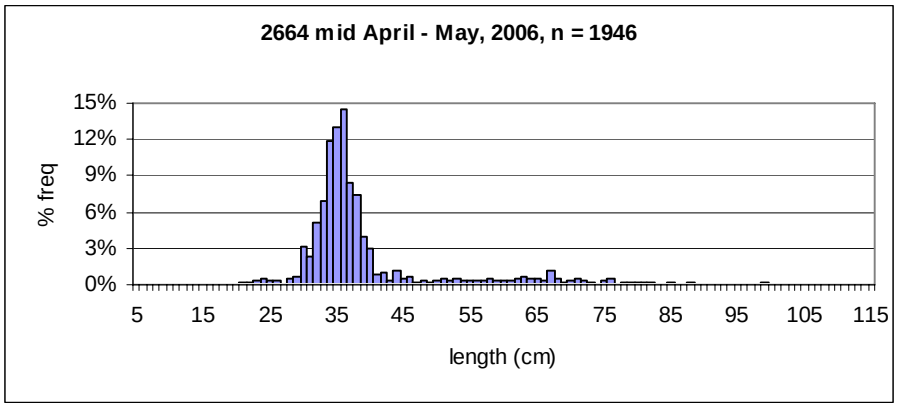
mid November - December
Year: 2006
Cruise: 2665

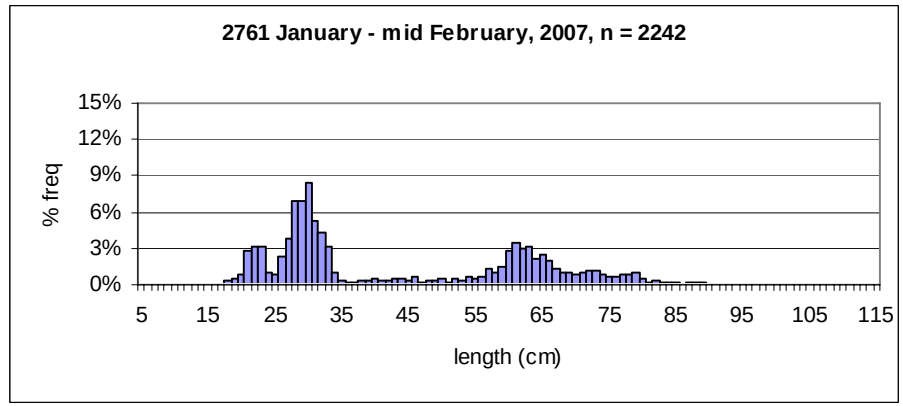
MarineFisheries

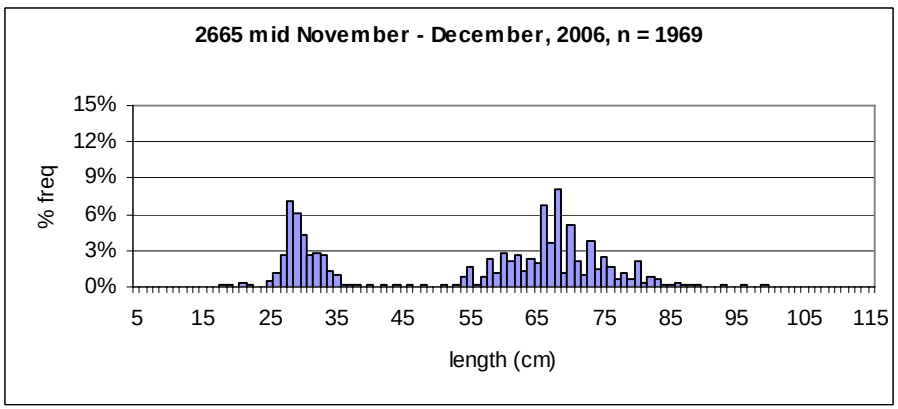
**Average number of fish at length for all tows where species were caught

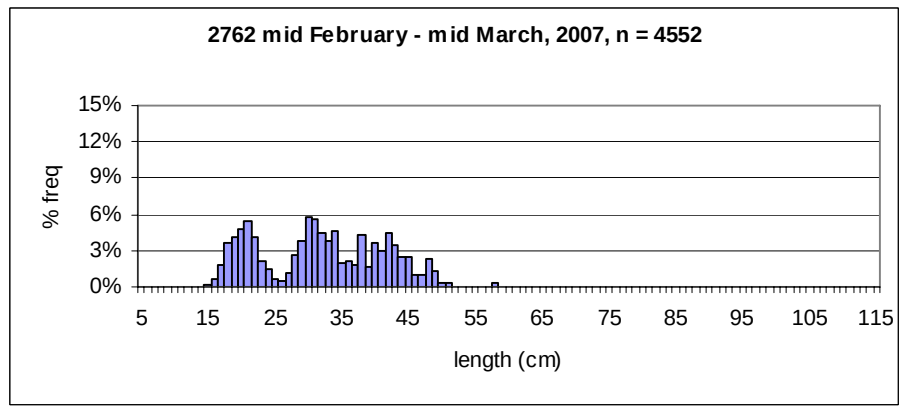
Pollock

2006 – 2007







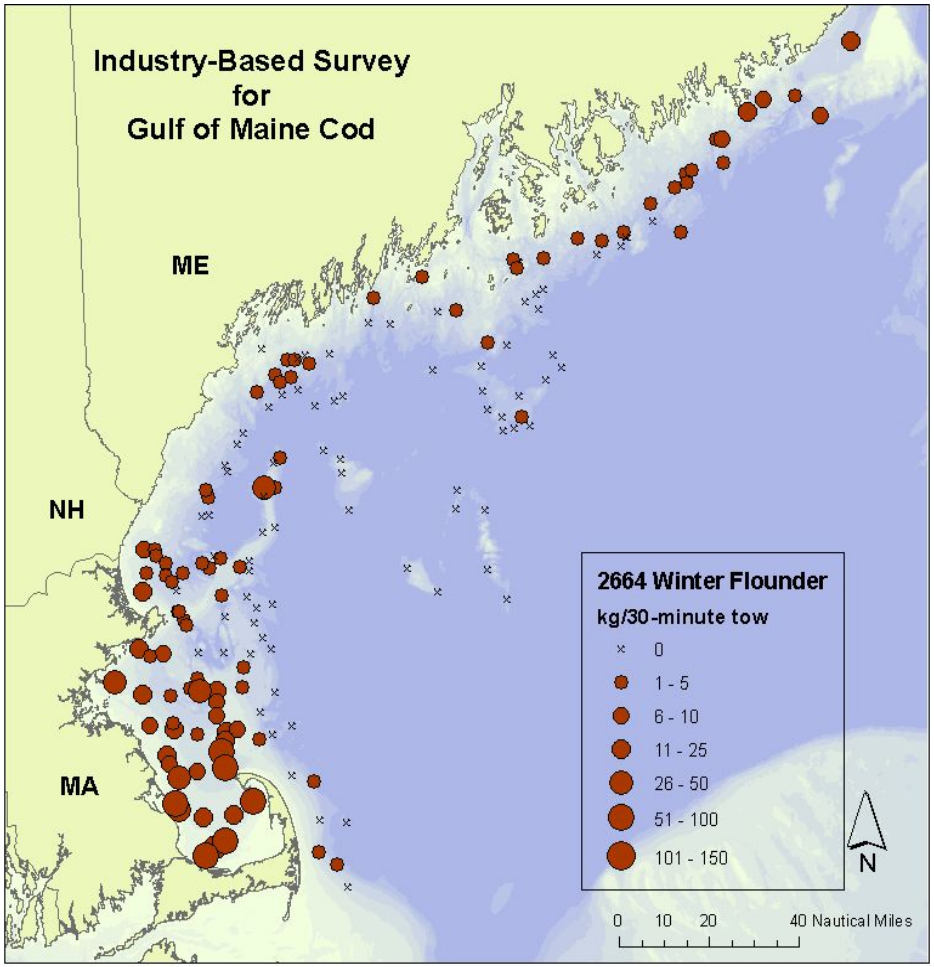


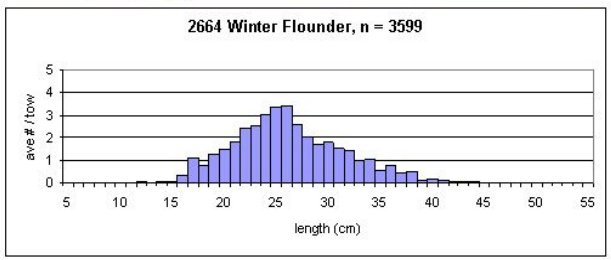
Industry-Based Survey for Gulf of Maine Cod

2006-2007 Survey Results

Winter Flounder

Spatial and temporal distribution by cruise, average number of fish at length where species were caught by cruise, and percent frequency at length by cruise



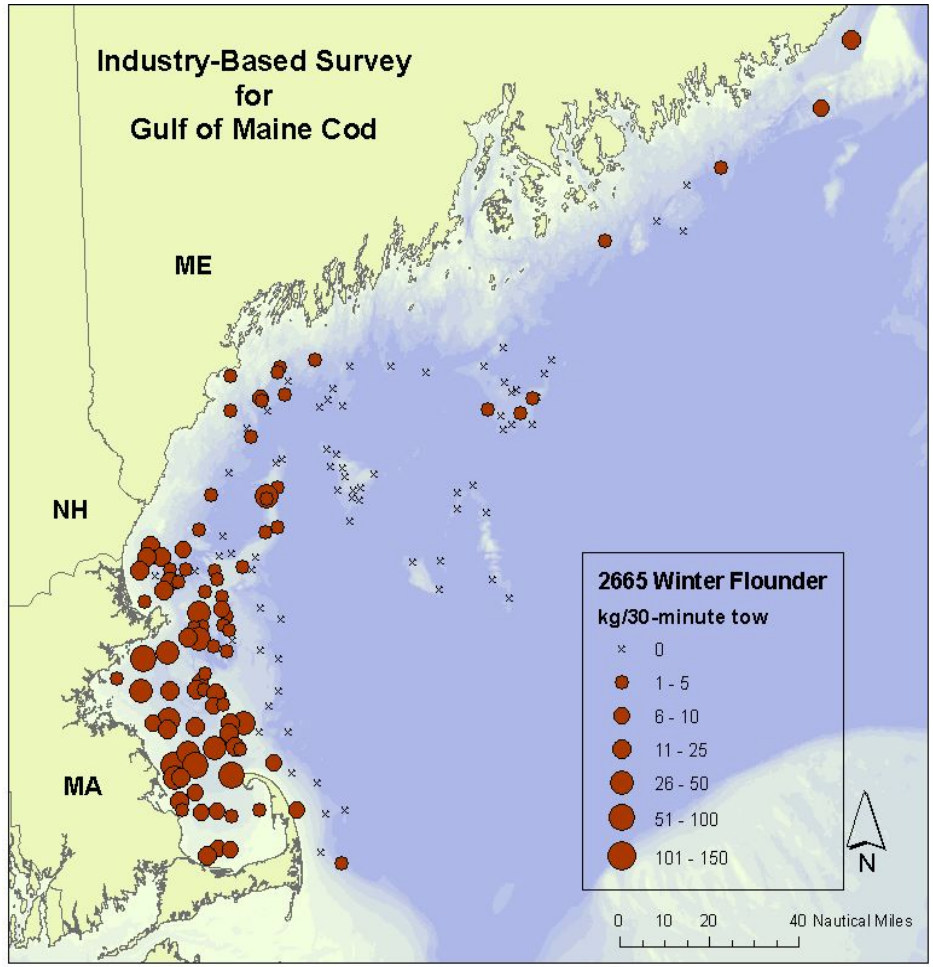


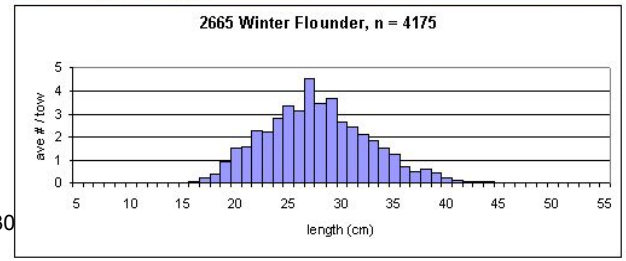
Winter Flounder
caught during the IBS for GOM cod survey

mid April - May
Year: 2006
Cruise: 2664

MarineFisheries

**Average number of fish at length for all tows where species were caught.
n= number of fish measured



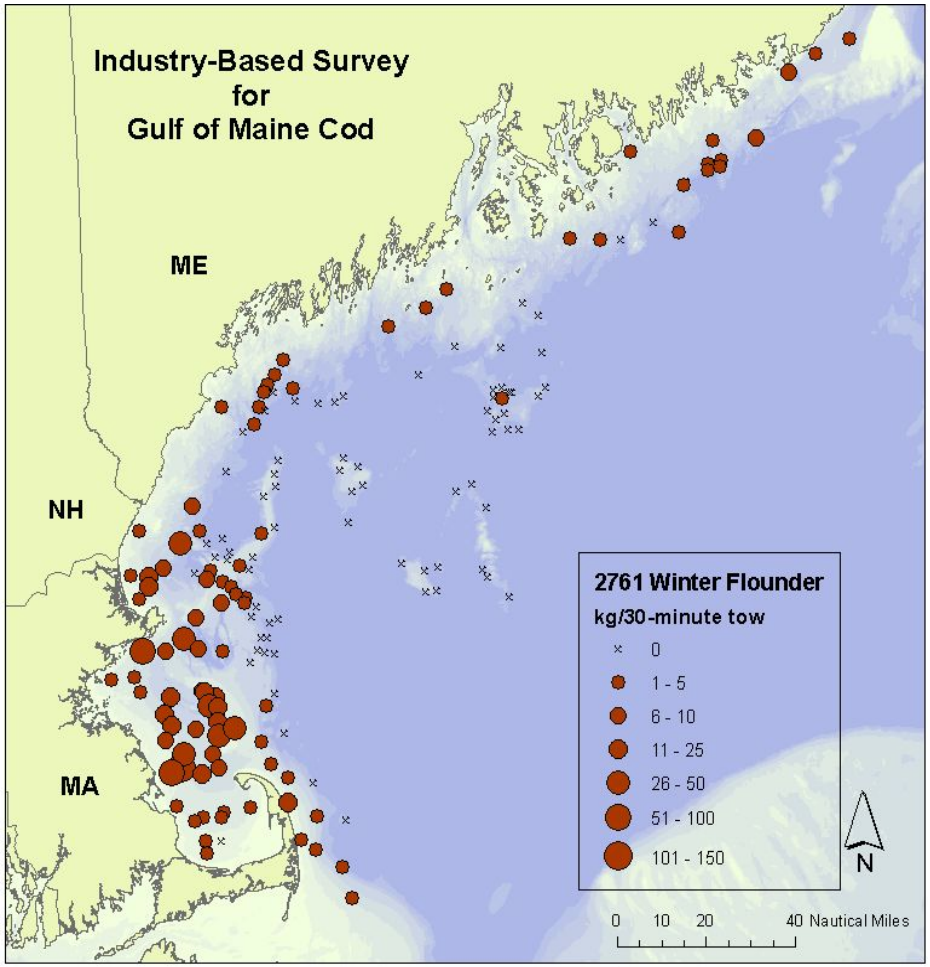


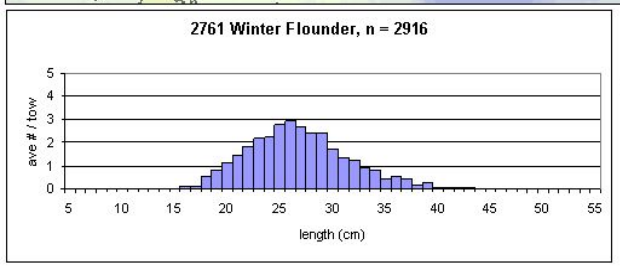
Winter Flounder
caught during the IBS for GOM cod survey

mid November - December
Year: 2006
Cruise: 2665

MarineFisheries

**Average number of fish at length for all tows where species were caught.
n= number of fish measured



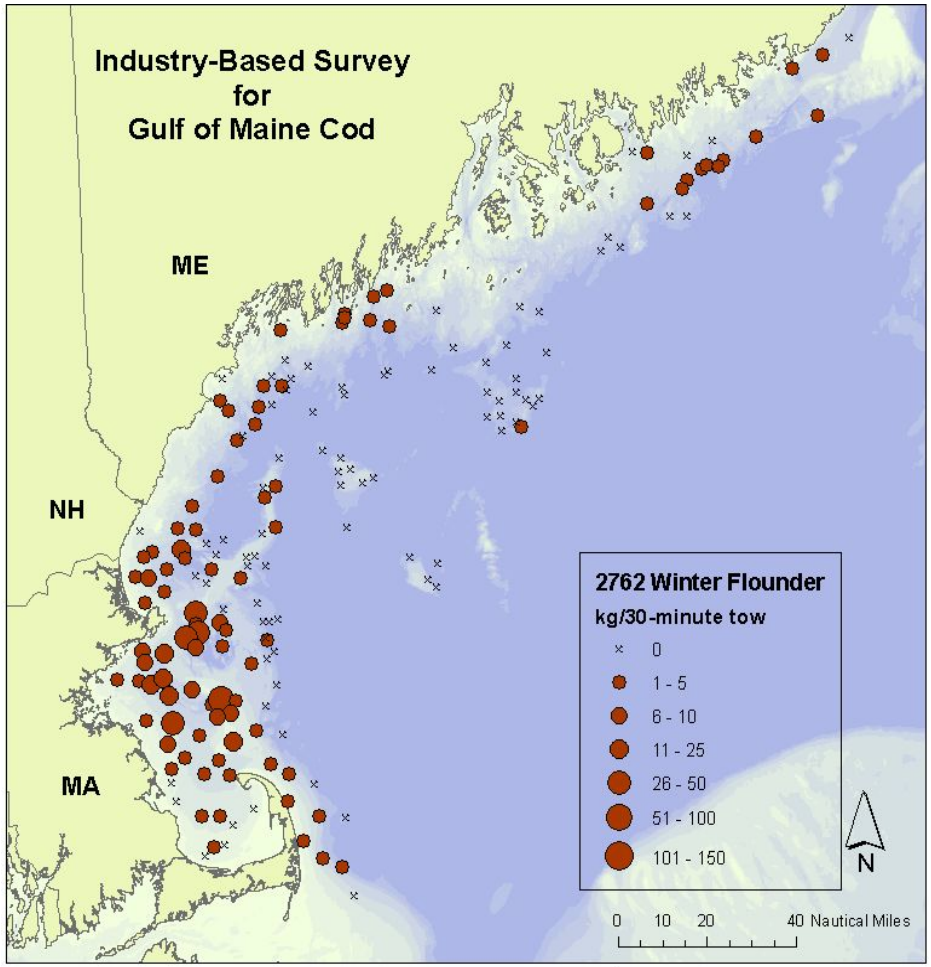


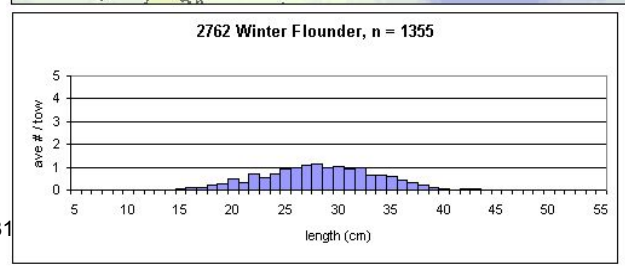
Winter Flounder
caught during the IBS for GOM cod survey

January - mid February
Year: 2007
Cruise: 2761

MarineFisheries

**Average number of fish at length for all tows where species were caught.
n= number of fish measured





Winter Flounder
caught during the IBS for GOM cod survey

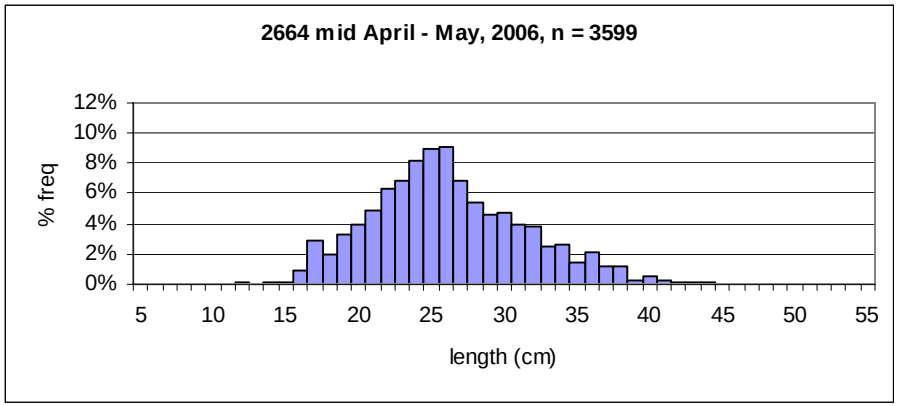
mid February - mid March
Year: 2007
Cruise: 2762

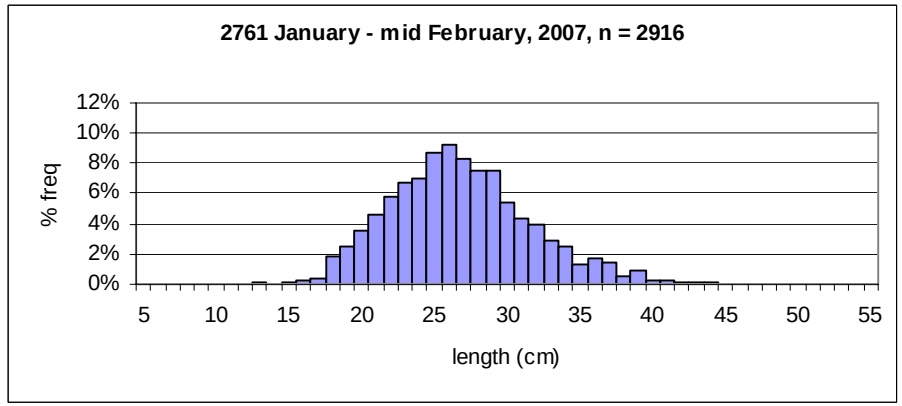
MarineFisheries

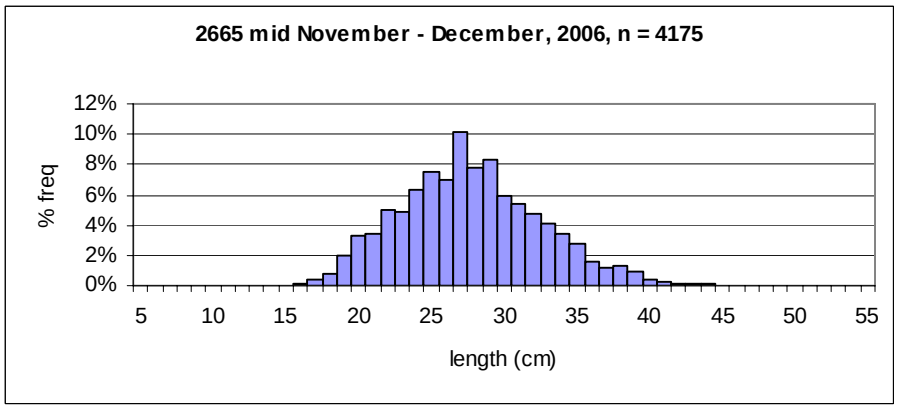
**Average number of fish at length for all tows where species were caught.
n= number of fish measured

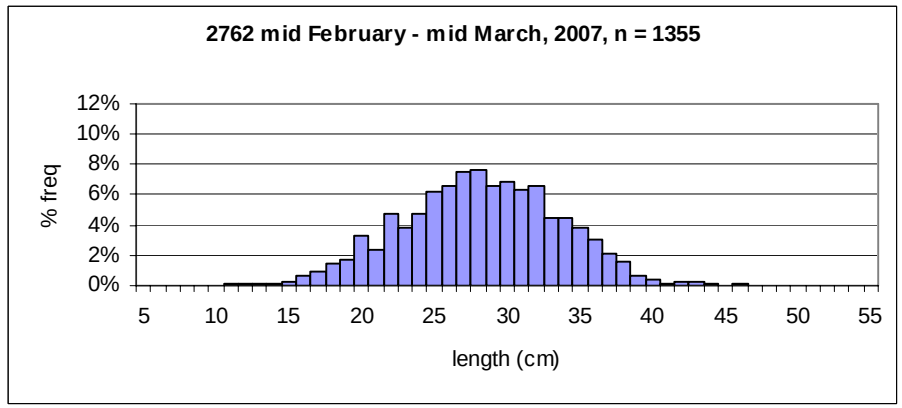
Winter Flounder

2006 – 2007







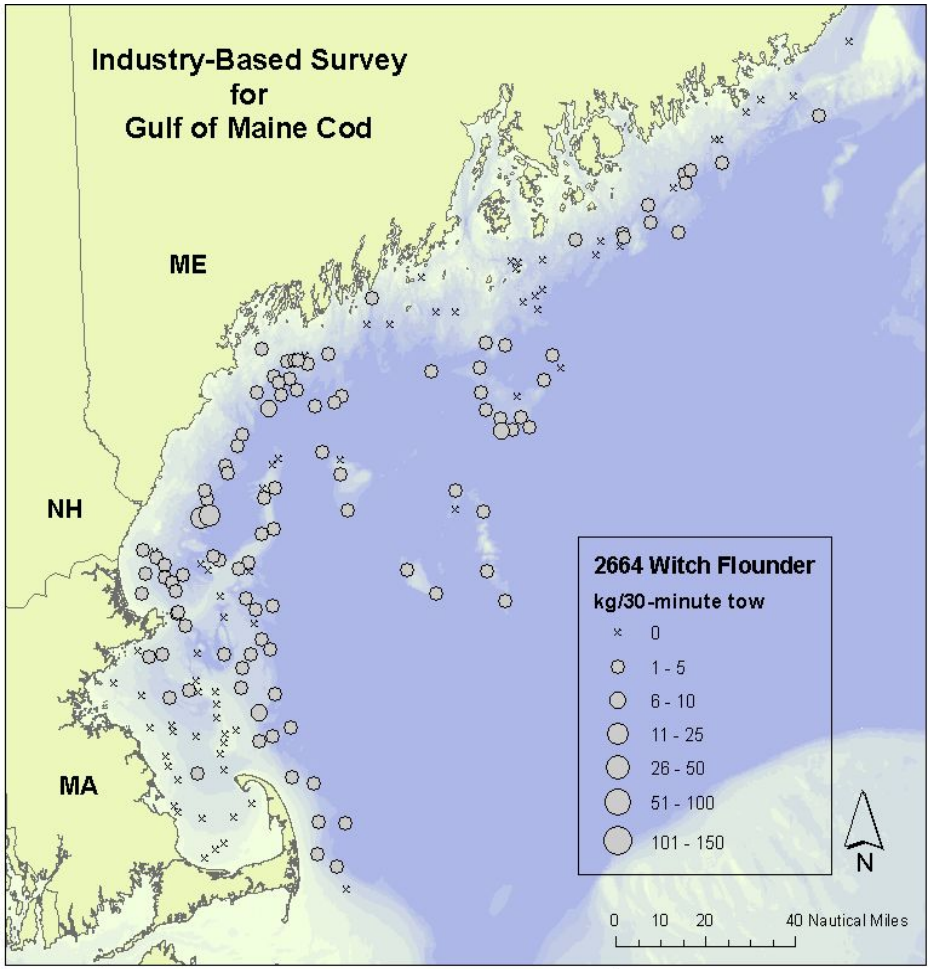


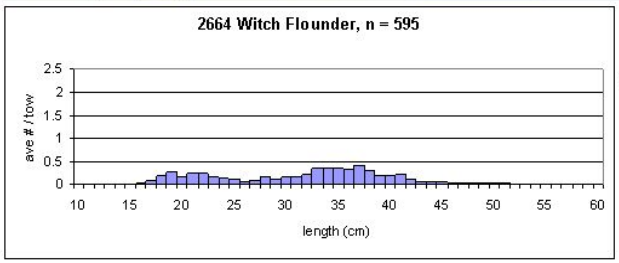
Industry-Based Survey for Gulf of Maine Cod

2006-2007 Survey Results

Witch Flounder

Spatial and temporal distribution by cruise, average number of fish at length where species were caught by cruise, and percent frequency at length by cruise



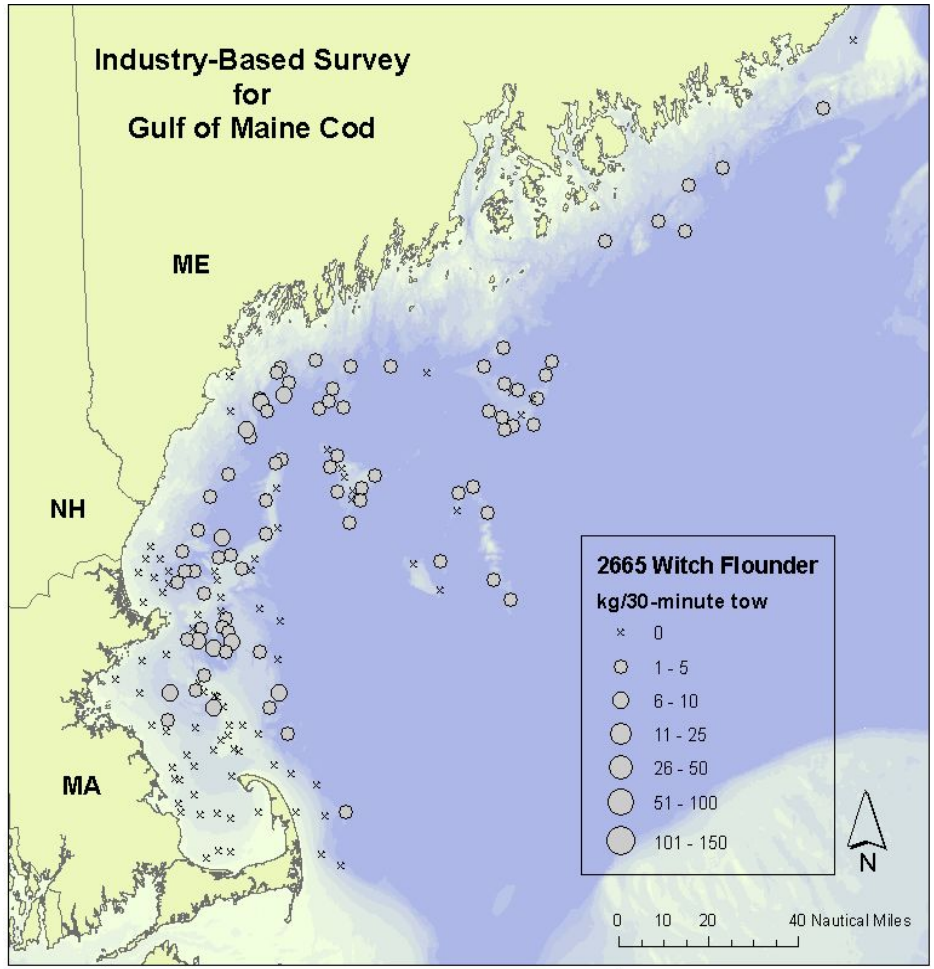


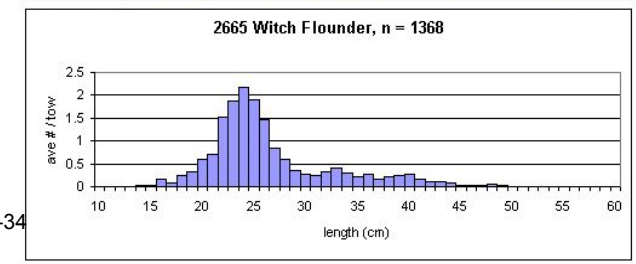
Witch Flounder
caught during the IBS for GOM cod survey

mid November - December
Year: 2006
Cruise: 2664

MarineFisheries

**Average number of fish at length for all tows where species were caught





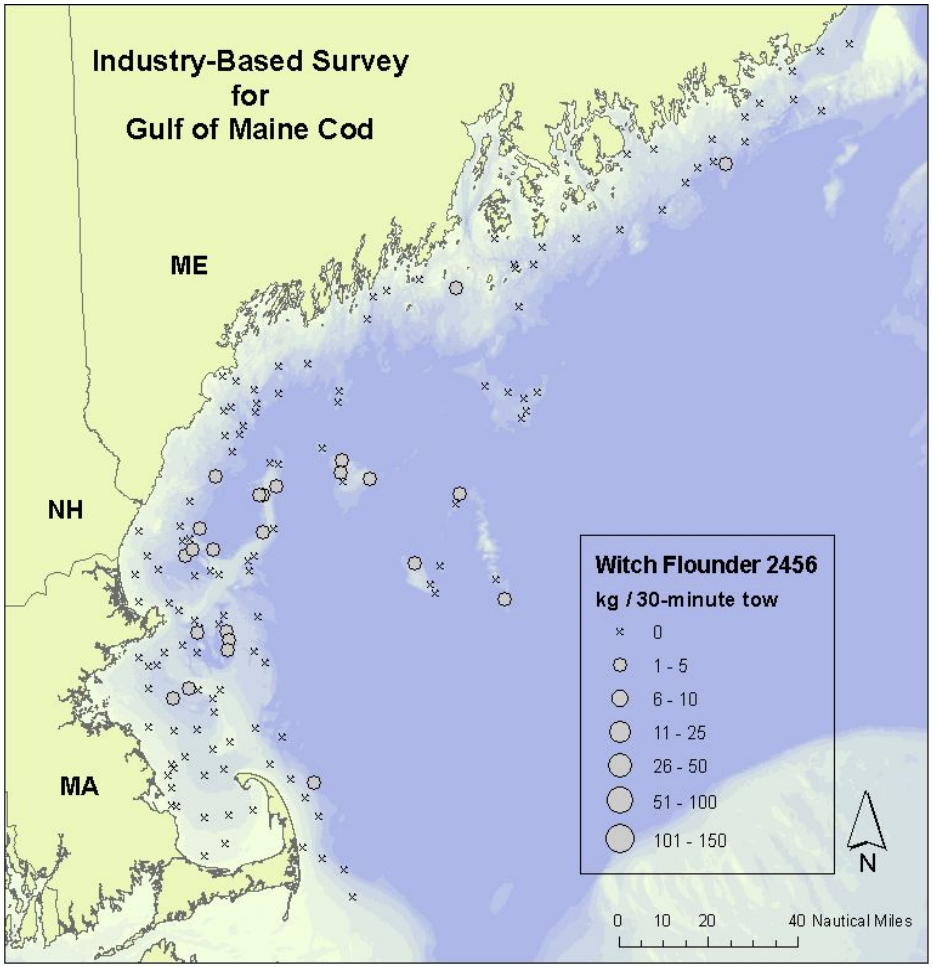
Witch Flounder
caught during the IBS for GOM cod survey

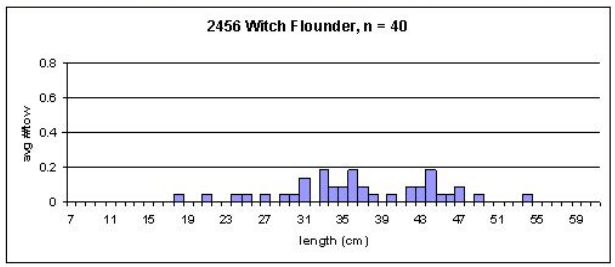
mid November - December
Year: 2006
Cruise: 2665

MarineFisheries

**Average number of fish at length for all tows where species were caught

Appendix G. Witch Flounder



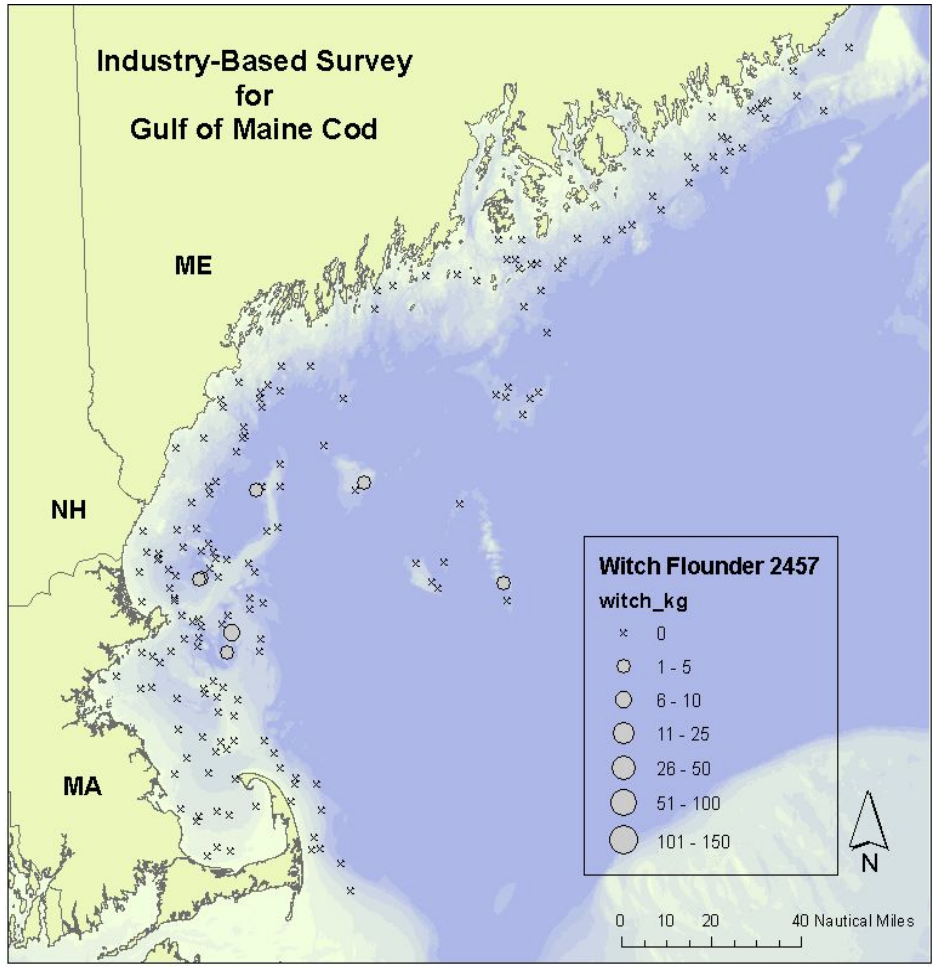


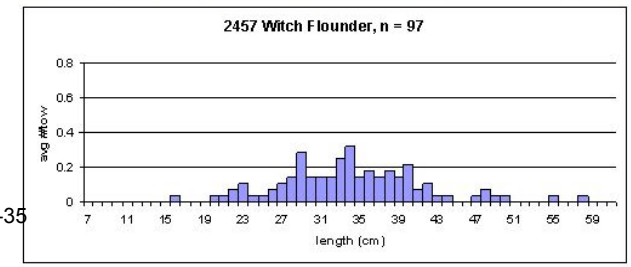
Witch Flounder
caught during the IBS for GOM cod survey

mid February - mid March
Year: 2004
Cruise: 2456

MarineFisheries

**Average number of fish at length for all tows where species were caught





Witch Flounder
caught during the IBS for GOM cod survey

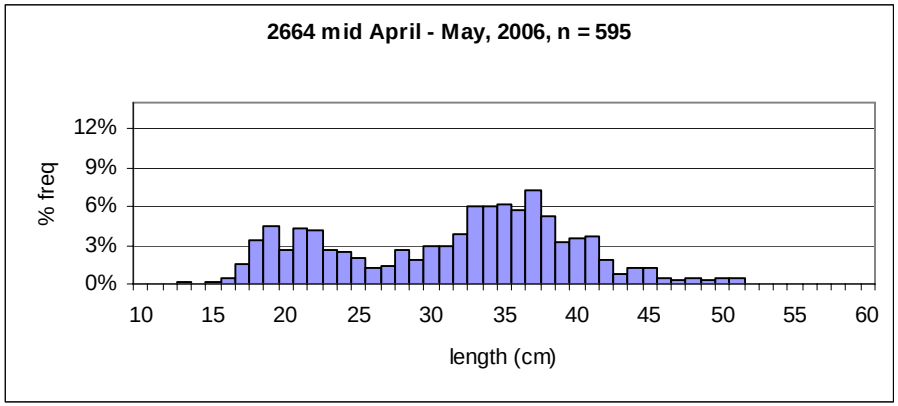
mid March - mid April
Year: 2004
Cruise: 2457

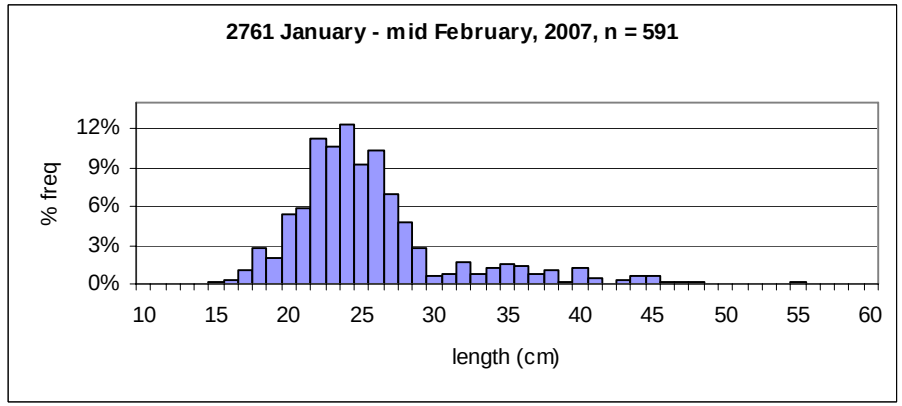
MarineFisheries

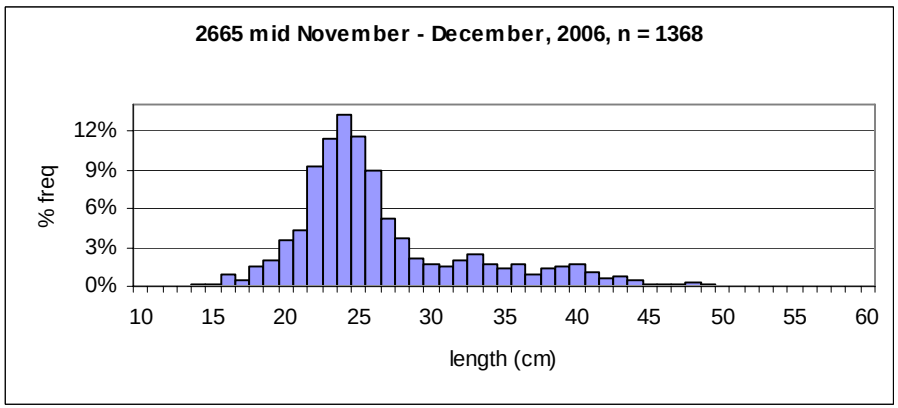
**Average number of fish at length for all tows where species were caught

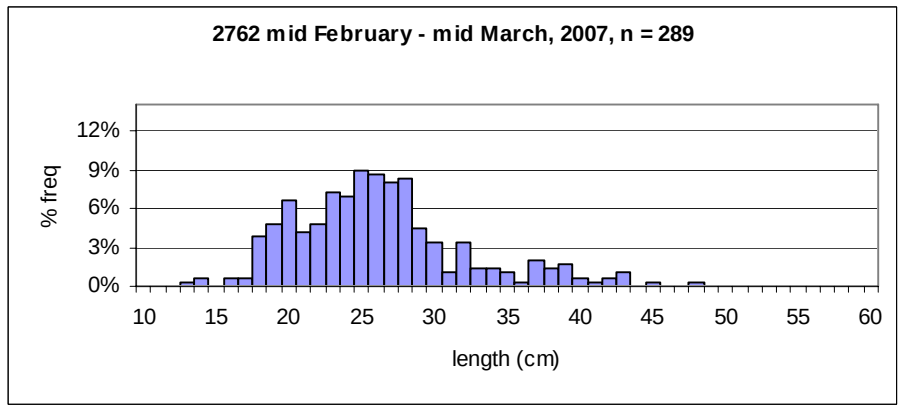
Witch Flounder

2006 – 2007







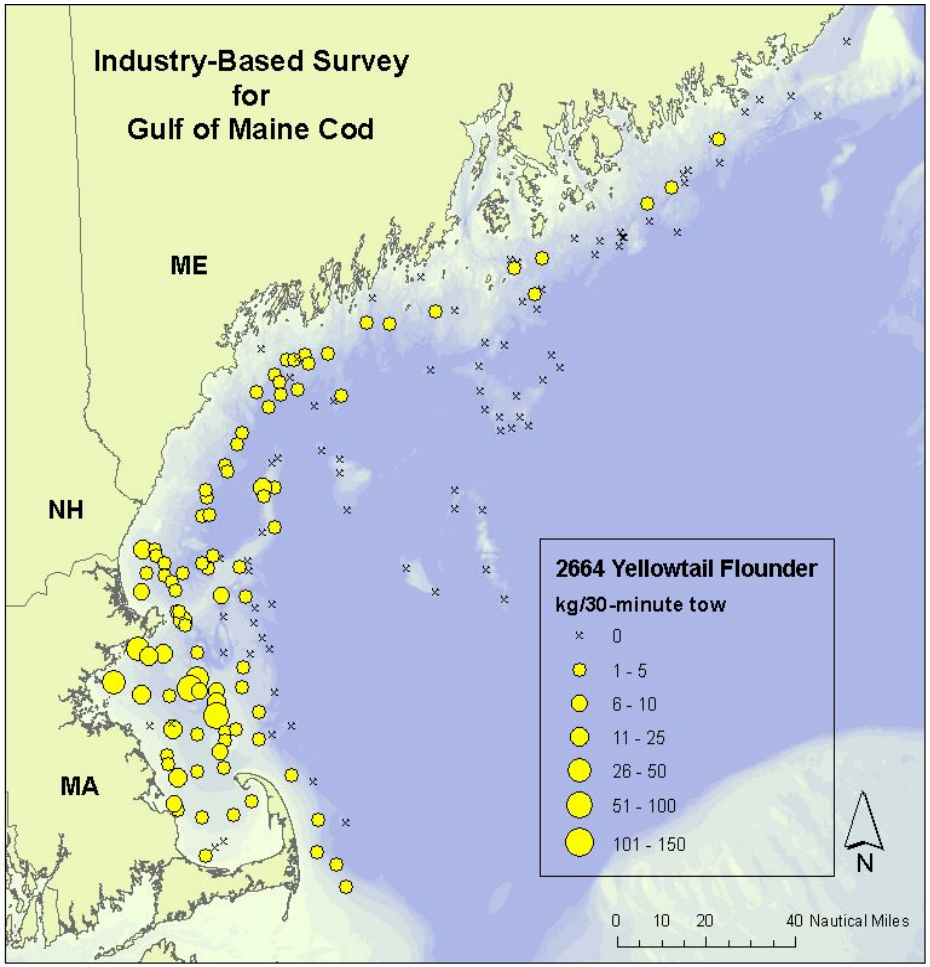


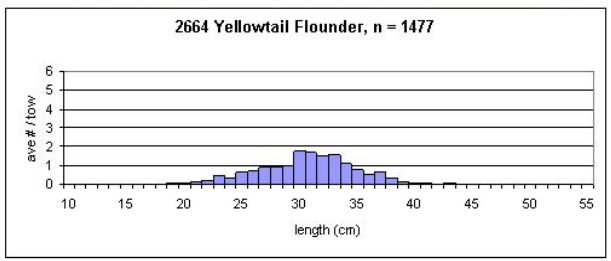
Industry-Based Survey for Gulf of Maine Cod

2006-2007 Survey Results

Yellowtail Flounder

Spatial and temporal distribution by cruise, average number of fish at length where species were caught by cruise, and percent frequency at length by cruise



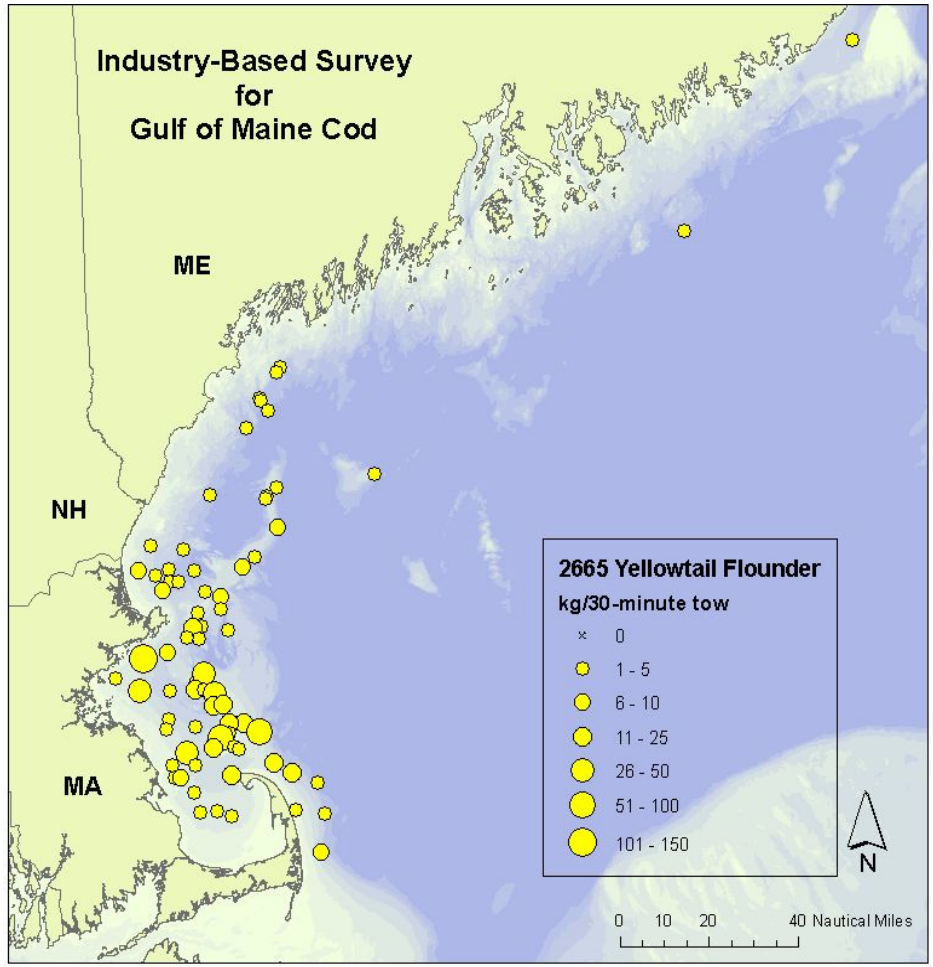


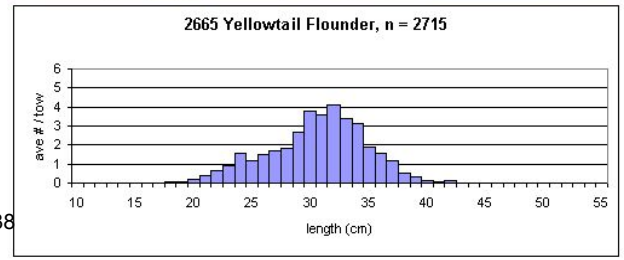
Yellowtail Flounder
caught during the IBS for GOM cod survey

mid April - May
Year: 2006
Cruise: 2664

MarineFisheries

**Average number of fish at length for all tows where species were caught.
n= number of fish measured





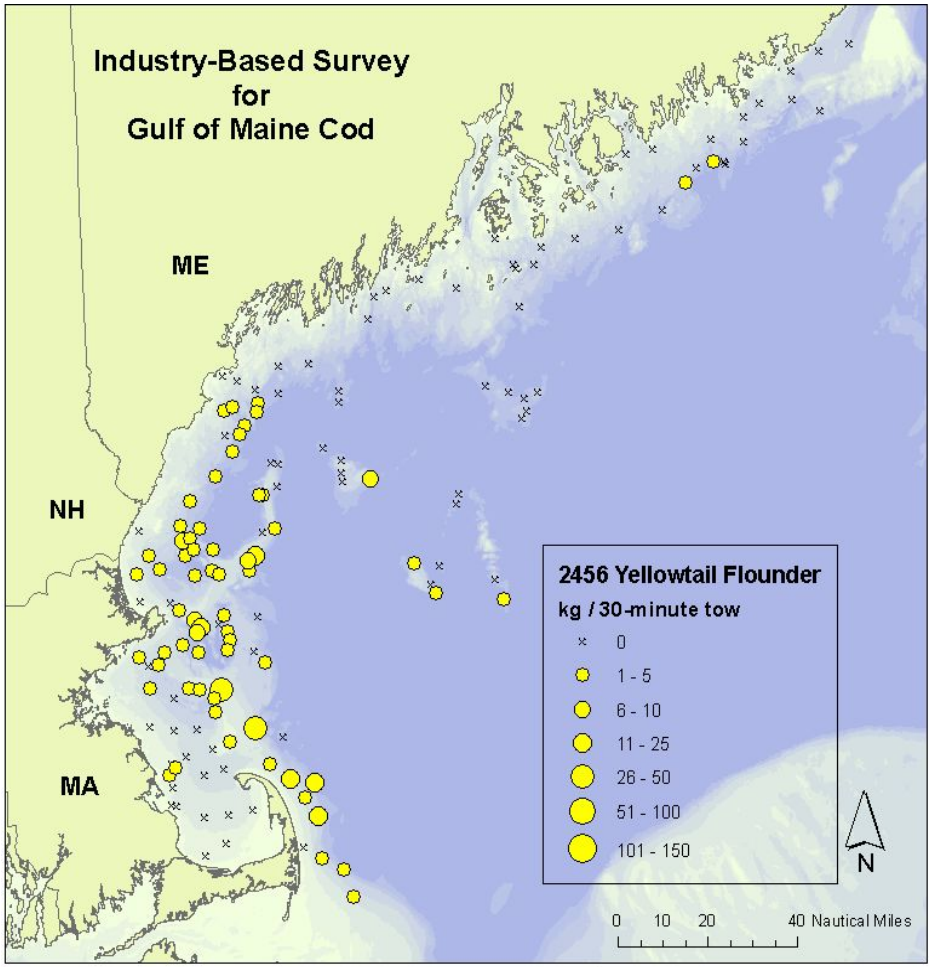
Yellowtail Flounder
caught during the IBS for GOM cod survey

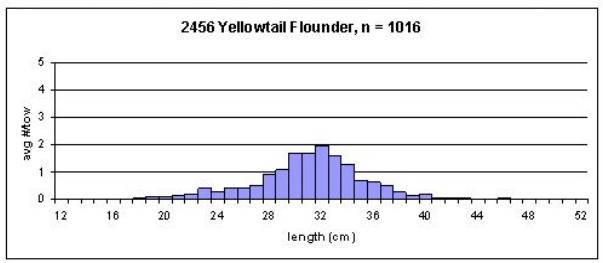
mid November - December
Year: 2006
Cruise: 2665

MarineFisheries

**Average number of fish at length for all tows where species were caught.
n= number of fish measured

Appendix G. Yellowtail Flounder



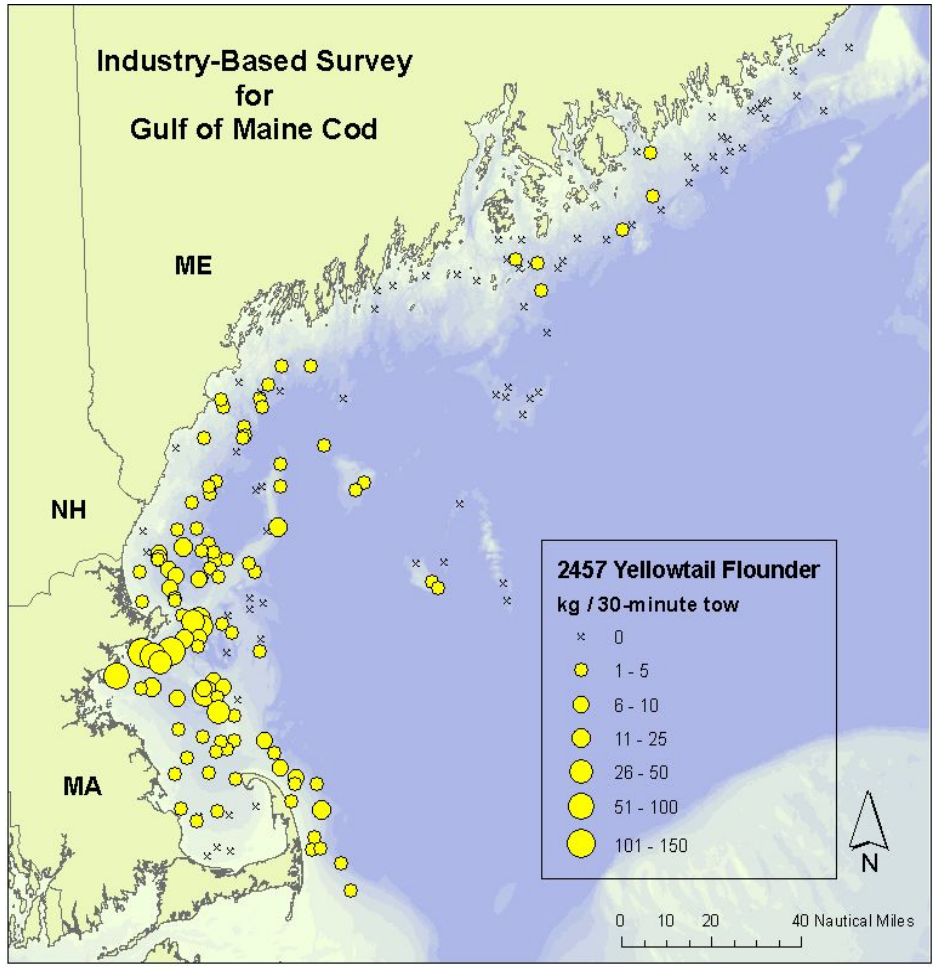


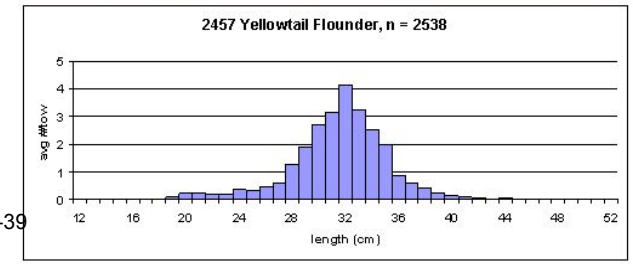
Yellowtail Flounder
caught during the IBS for GOM cod survey

mid February - mid March
Year: 2004
Cruise: 2456

MarineFisheries

**Average number of fish at length for all tows where species were caught.
n= number of fish measured





Yellowtail Flounder
caught during the IBS for GOM cod survey

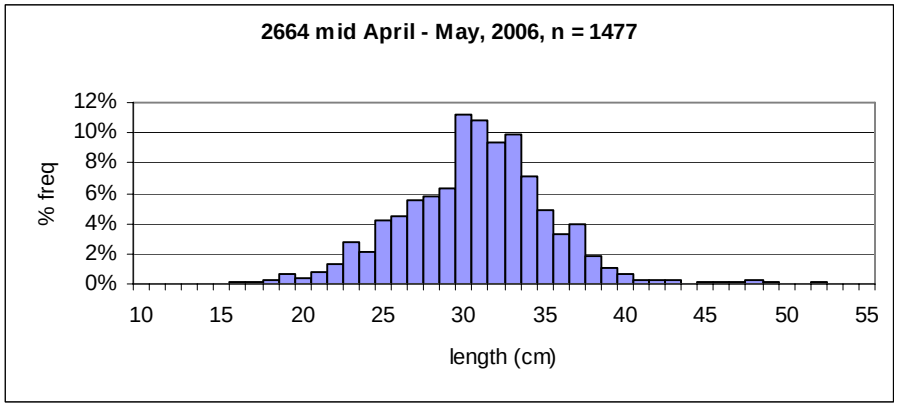
mid March - mid April
Year: 2004
Cruise: 2457

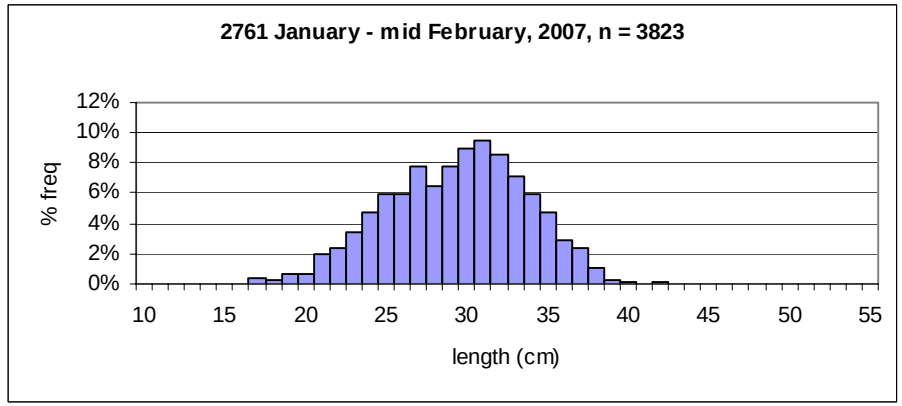
MarineFisheries

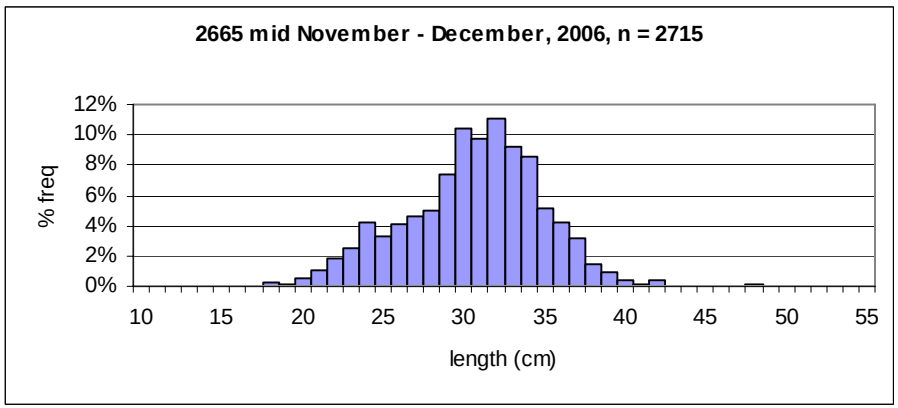
**Average number of fish at length for all tows where species were caught.
n= number of fish measured

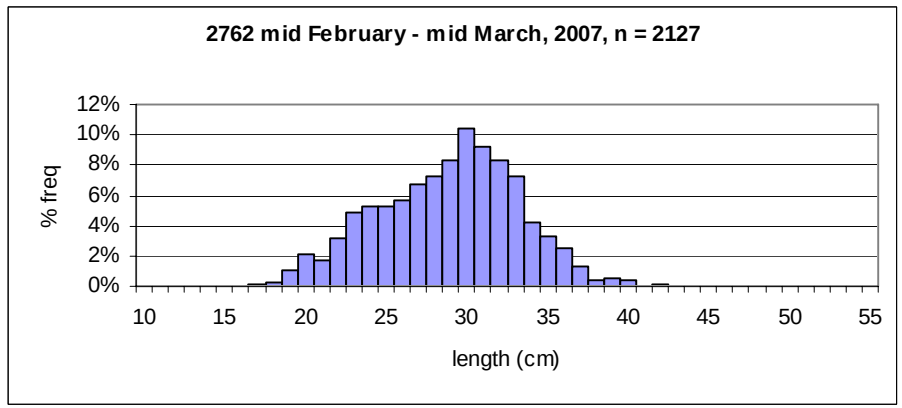
Yellowtail Flounder

2006 – 2007







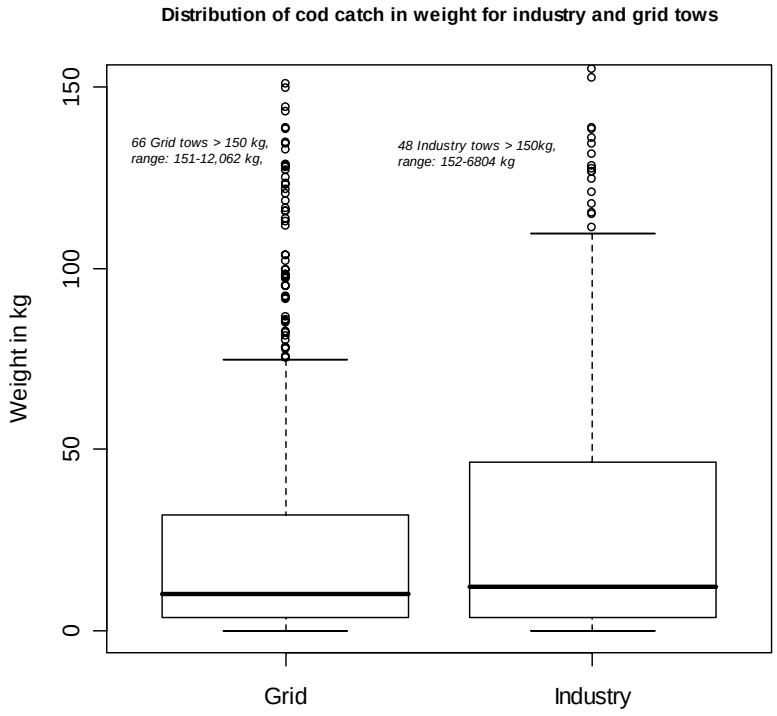


Appendix H

Industry-Based Survey
for
Gulf of Maine Cod
Pilot Study

A Comparison of Catch Rates of Industry Stratified Random Grid Tows Verses Systematic Grid Tows

Figure 1. Distribution of cod catch in weight for industry and grid tows in the IBS survey (all years, strata and months pooled). Top figure: Catches on arithmetic scale. Note that catches greater than 150 kg are not shown. Bottom figure: Log transformed catch in weight.



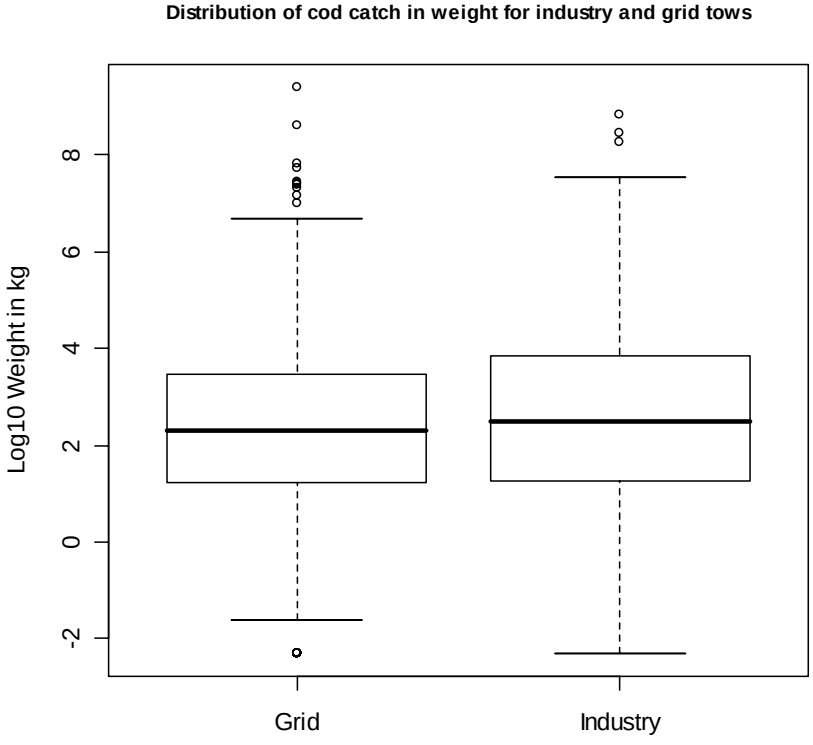
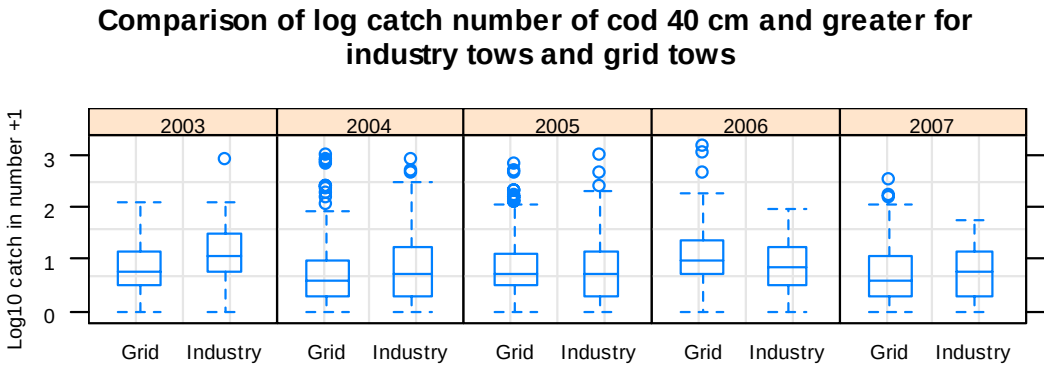
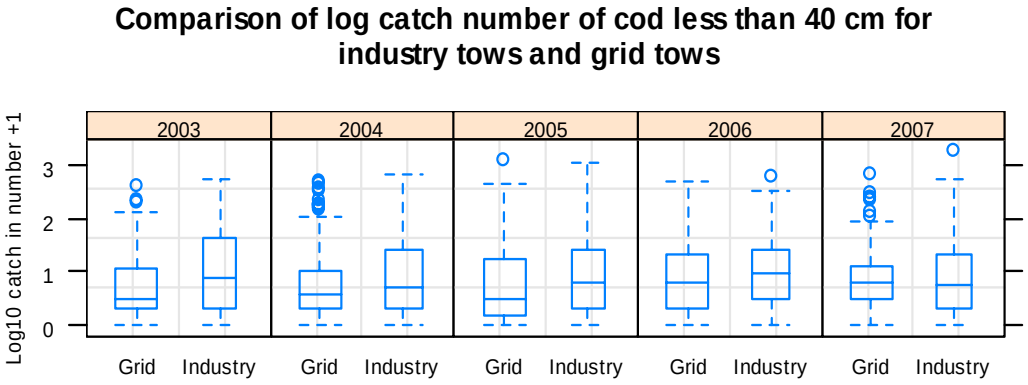


Figure 2. Comparison of catch distributions for industry and grid stations by year. Top figure: catch in log numbers of large cod (40 cm). middle figure: catch in log numbers of cod < 40 cm length. Bottom figure: catch in log weight (kg) all cod. Year is calendar year. Years are not comparable due to differences in survey design among years.





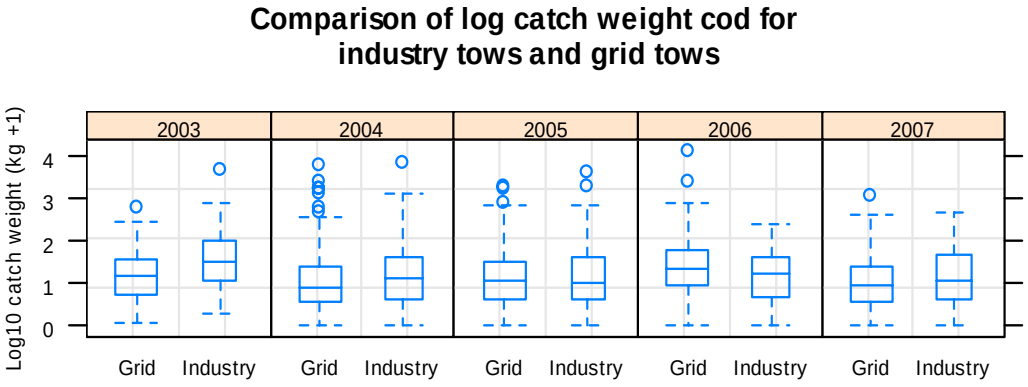
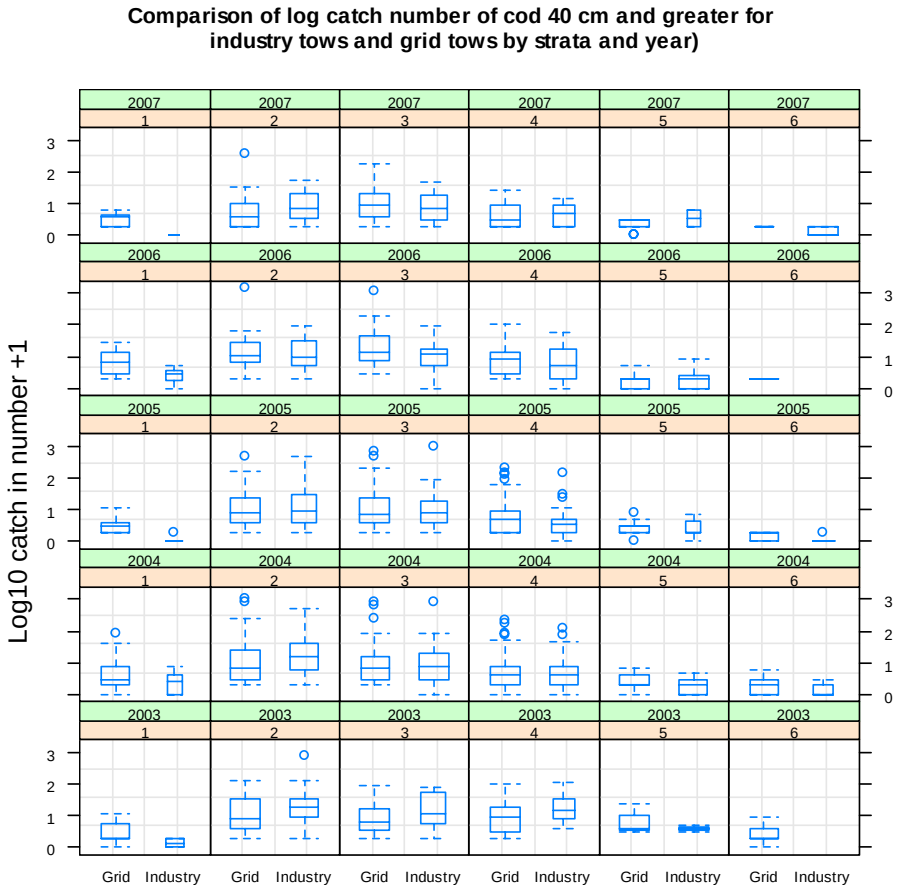


Figure 3. Comparison of catch distributions for industry and grid stations by year and strata. Top figure: catch in log numbers of large cod (40 cm). Middle figure: catch in log numbers of cod < 40 cm length.



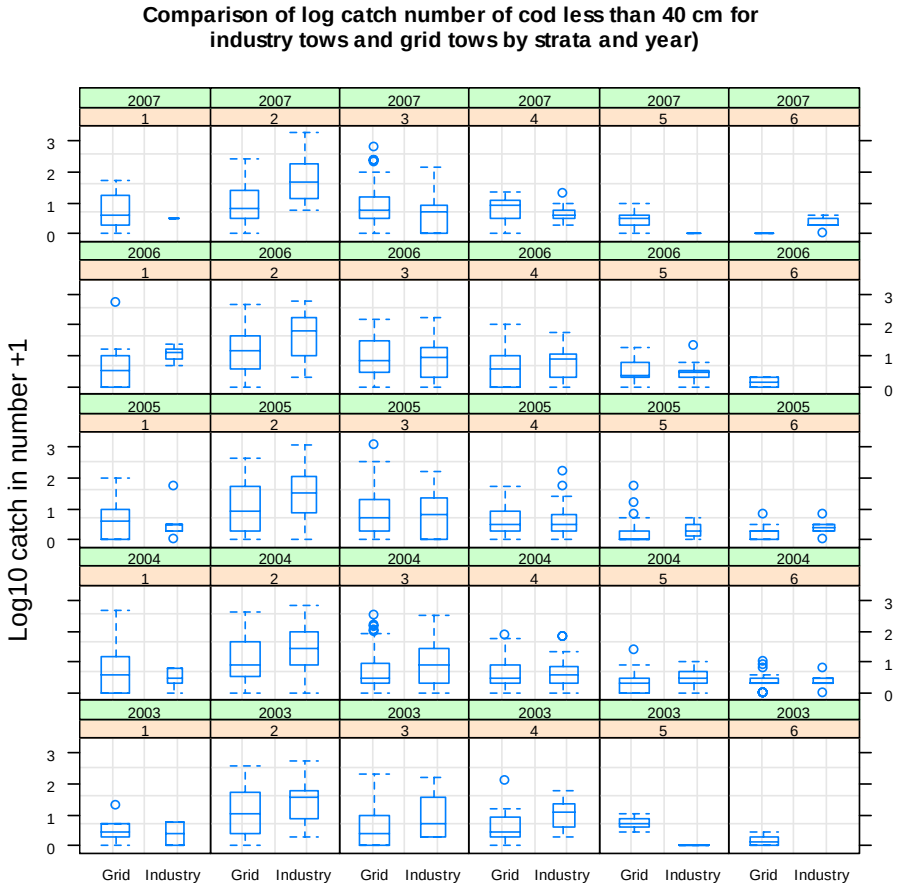


Figure 4. Comparison of catch distributions for industry and grid stations by year and strata. Catch in log weight (kg) all cod.

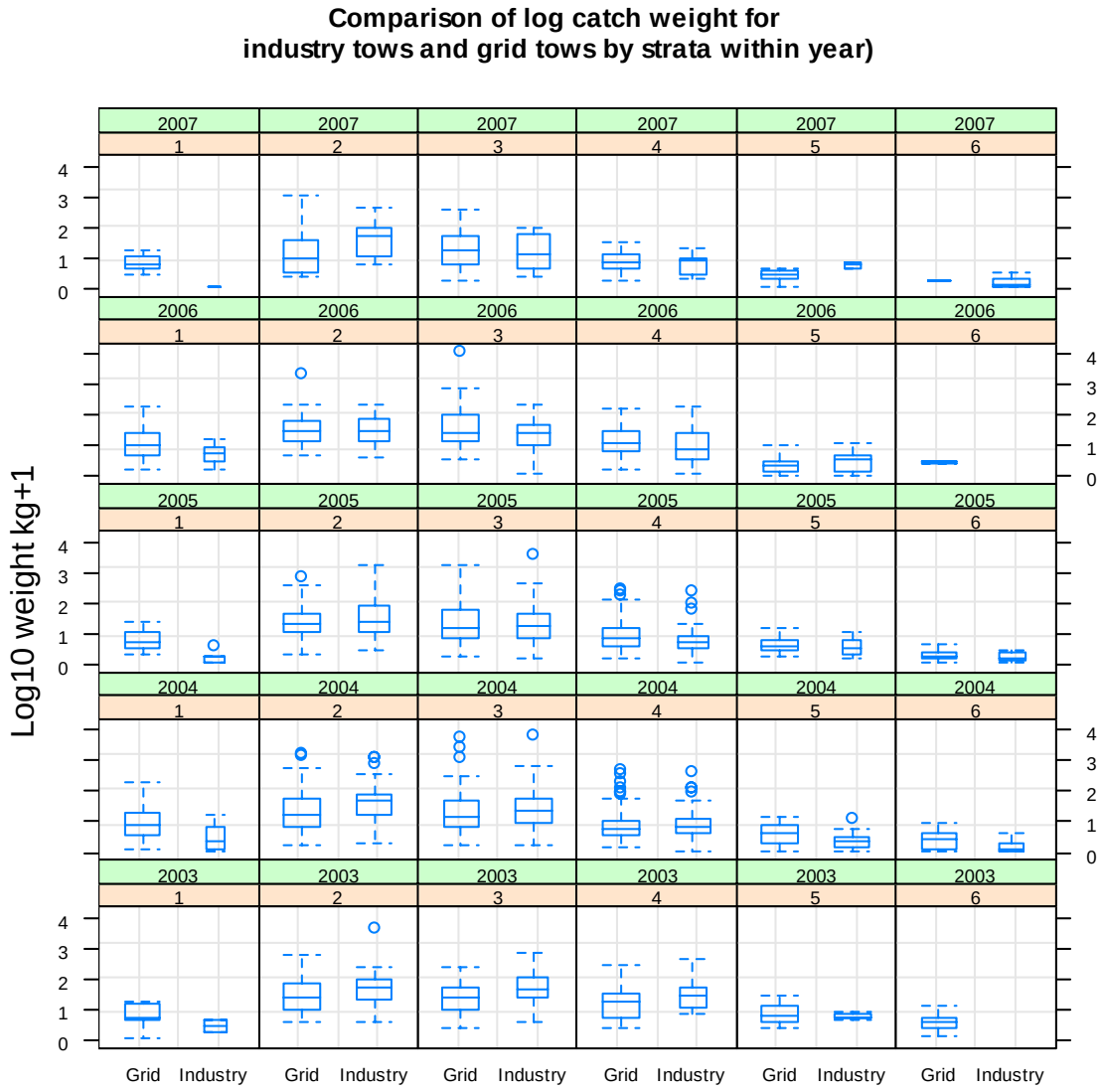
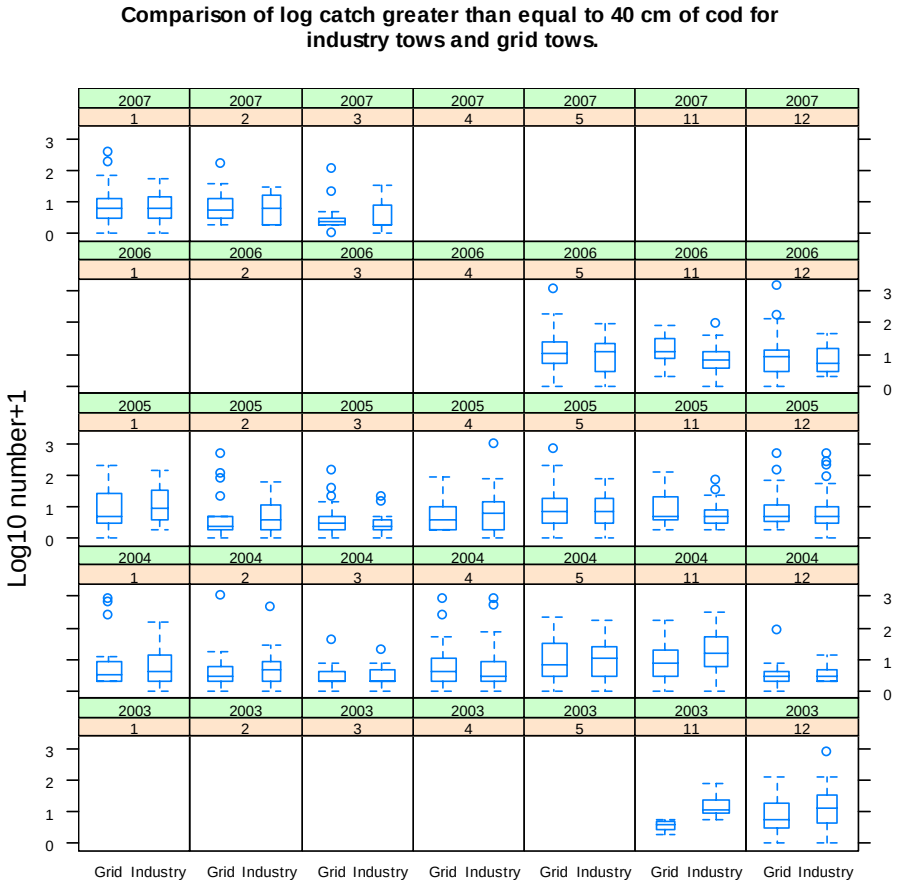


Figure 5. Comparison of catch distributions for industry and grid stations by year and month. Top figure: catch in log numbers of large cod (40 cm). Bottom figure: catch in log numbers of cod < 40 cm length.



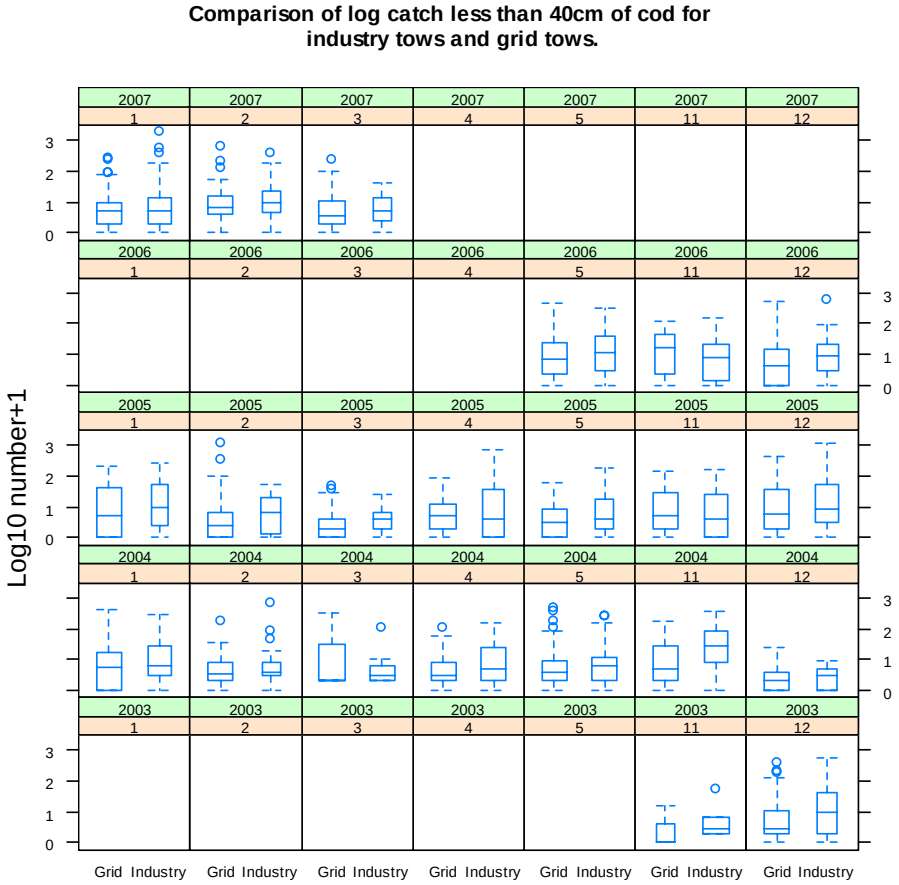
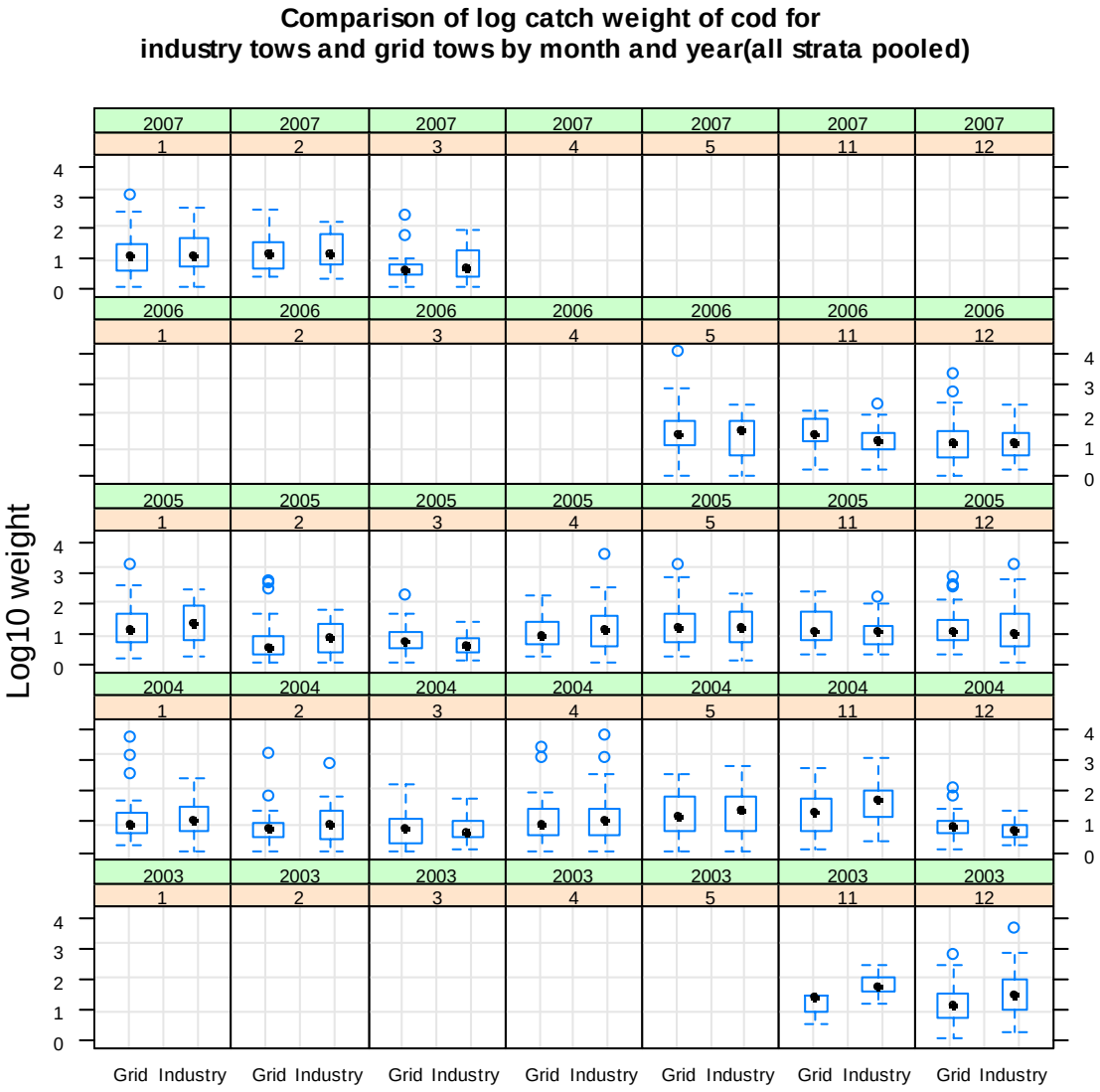


Figure 6. Comparison of catch distributions for industry and grid stations by year and month. Catch in log weight (kg) all cod.

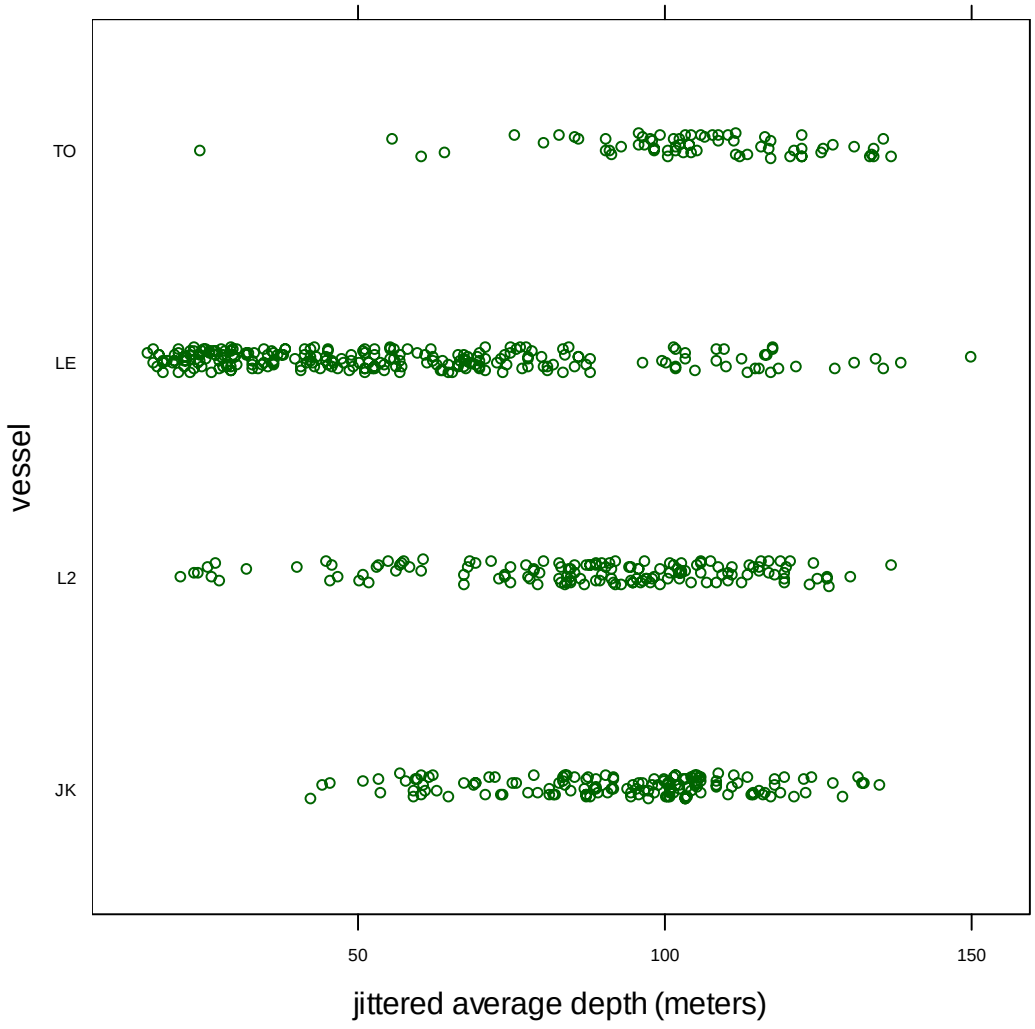


Appendix I

Industry-Based Survey
for
Gulf of Maine Cod
Pilot Study

Summary of Gear Mensuration Results

Figure 1. Distribution of average depth by vessel.



TO = F/V Titan
LE = F/V Lady Jane
L2 = F/V Lisa Ann II
JK = F/V Jocka

Figure 2. Relationship between door spread and average depth for all vessels combined. Loess line is set with span = 0.5 and degree = 1.

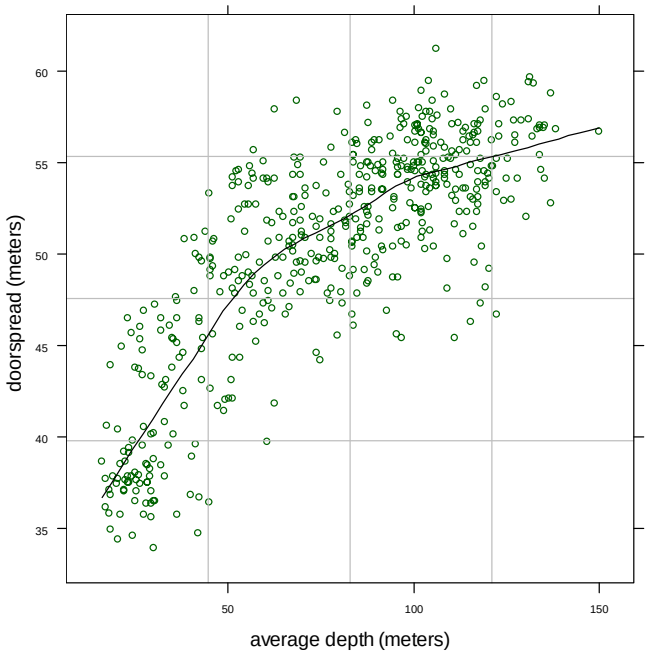


Figure 3. Residual door spread after fitting with loess. Note more variance at shallower depths.

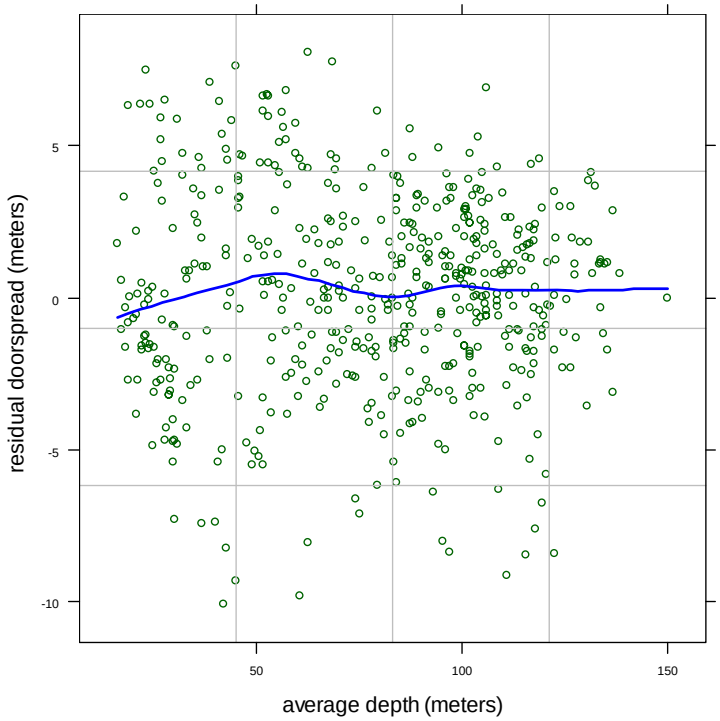


Figure 4. Headrope height at average depth by vessel.

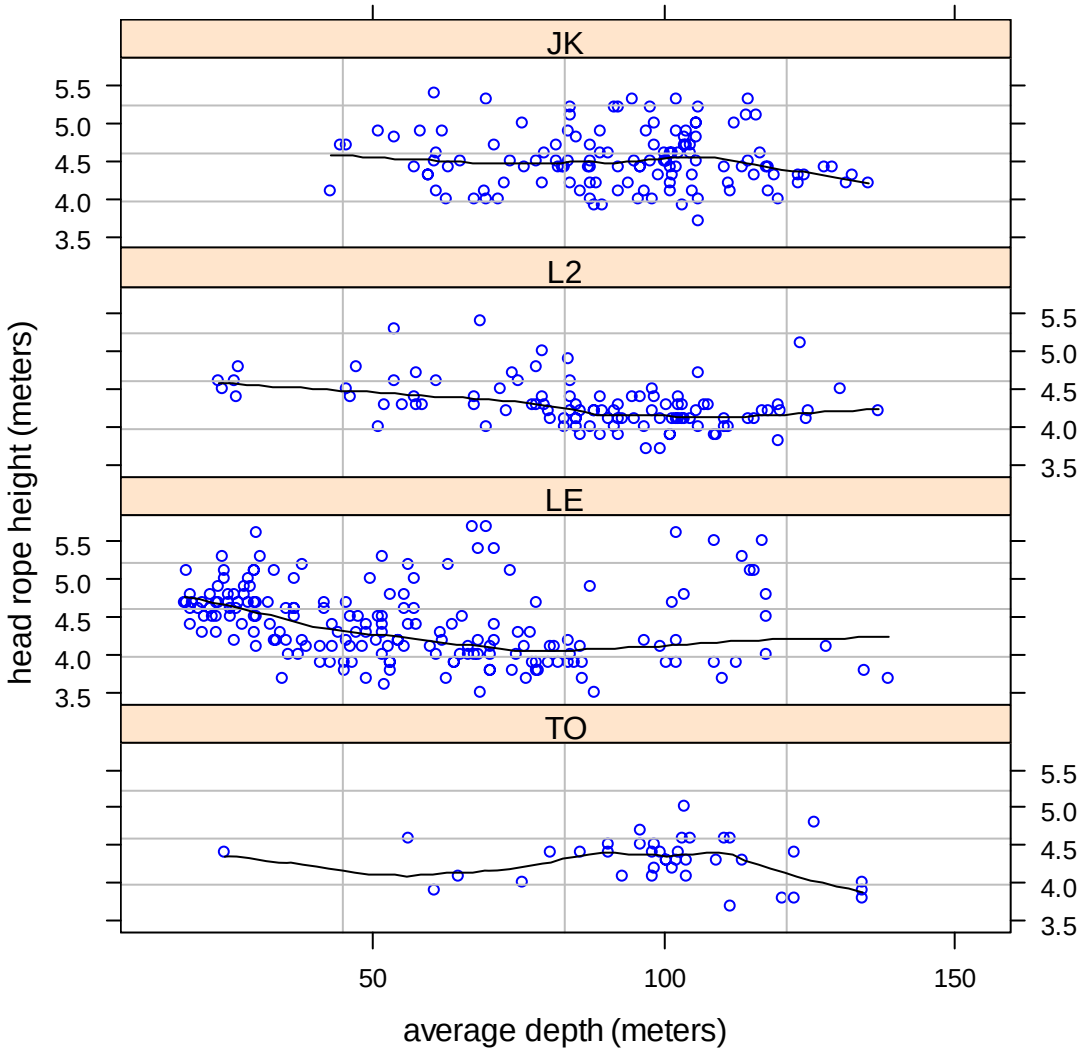
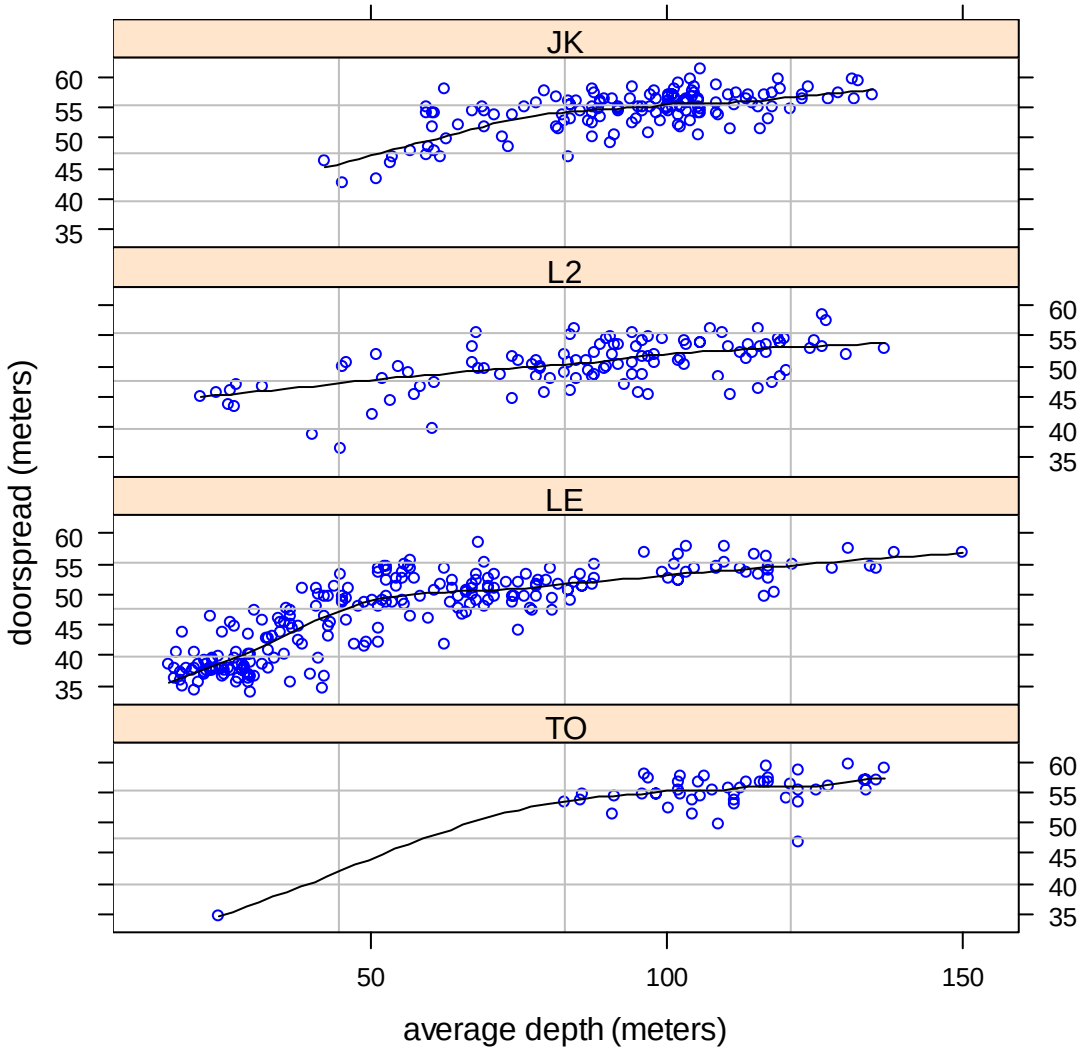

JK
L2
LE
TO
head rope height (meters)
average depth (meters)
5.5
5.0
4.5
4.0
3.5
50
100
150

Figure 5.


JK
L2
LE
TO
doorspread (meters)
average depth (meters)
35
40
45
50
55
60
50
100
150

Appendix J

Industry-Based Survey
for
Gulf of Maine Cod
Pilot Study

Technical Peer Review Report
August 2006

Peer Review of Industry-Based Survey for Gulf of Maine Cod

August 29-30, 2006, Portsmouth, NH
Ghislain Chouinard, Ken Weinberg, and Jack McGovern

Introduction

The following report is a review of a cod industry-based survey (Cod IBS) designed to examine the distribution and demographics of the cod stock in the Gulf of Maine. The survey design utilized a standardized grid as well as randomly selected locations provided by fishermen. An additional objective of the study was to provide information on the age and length structure of cod within rolling closure areas. An external panel was invited to review the technical aspects of this survey following the terms of reference provided in Appendix 1. The organization of this report follows the terms of reference. Participants at the review are listed in Appendix II.

It should be noted that the review was originally intended to also examine the southern New England yellowtail flounder industry-based survey; however, no presentation of the information could be made at the meeting and that review was dropped from the agenda.

Main Findings and Conclusions of the Panel

- The Cod IBS represented an enormous amount of work for the investigators, cooperating fishermen, and NCRPP. Much care was taken in the development of the survey design and gear. An outreach program designed to keep the fishing community and general public aware of survey activity was initiated consuming considerable time and energy. The panel commends the survey team for their thoroughness and dedication.
- The Cod IBS provides valuable information on cod in the Gulf of Maine when no other sources of data are available. The Cod IBS is a good example of a cooperative project.
- The survey provides high resolution information on the spatial and temporal distribution, size composition, maturity and potentially age of cod and augments existing surveys.
- There is some concern that the lack of sampling of cod in water deeper than 75 fathoms may not provide a complete picture of cod distribution particularly during the winter.
- Survey data are useful in determining the location and timing of cod in spawning condition as well as the coincidence of spawning cod with rolling closures.
- It is assumed the efficiency of the four commercial vessels providing data is the same; however, inter-vessel comparisons would be desirable.
- The data presented provide a qualitative spatio-temporal view for a number of parameters; however, further statistical analyses are required to determine if there are significant differences.
- While it may be possible to use the data collected during the survey to derive indices of stock abundance for specific species, a significant number of issues would first need to be examined and resolved.
- Survey design is very good for the objective of examining cod distribution but the mixed design is not easily adaptable for other types of common survey analyses.

1. ***Design and Execution***. *The review panel should evaluate the statistical and scientific validity of the two survey designs relative to the program goals and objectives, highlighting strengths, weaknesses, and potential biases. In particular:*
    a. *evaluate the temporal and spatial design elements relative to survey objectives,*

The Cod IBS utilized two independent designs to address their primary and secondary objectives of providing a high-resolution temporal view of cod distribution in the Gulf of Maine in conjunction with rolling closures and provide information on other commercially important groundfish resources. The survey area extended from the Canada-U.S. border south to 41˚30' N. latitude and appears to adequately cover the geographic boundaries (excluding Georges Bank) of the Gulf of Maine. The survey area encompasses a depth range of 10 to 75 fathoms and may fall short of describing the entire cod distribution believed to occur out to depths of 90 fathoms, particularly in winter when cod are found in deeper waters. Detailed size composition and maturity data provided an excellent view of the size and maturity distributions of the cod stock from this region. Although collected age structures have not been processed to date, once read, they will provide valuable information on the age composition of the Gulf of Maine resource. Data provided fills gaps in NMFS surveys by sampling different periods as well as inshore areas. Maturity information also fills temporal gaps in data provided by the inshore surveys conducted by the state of Massachusetts and the Maine-New Hampshire inshore cod survey. There is potential for this survey to provide valuable information on cod recruitment but would require further analyses. A secondary objective of the Cod IBS was met by providing quality size composition data throughout the study area for a number of other commercially important groundfish species; although, further improvements in sampling are suggested below.

During each year of the Cod IBS, five cruises spanning the survey area were conducted, providing investigators with adequate opportunity to compare cod distributions temporally. However, due to conflicts with fixed gear and/or encountering untrawlable bottom several stations were dropped during some or all cruises. Users of the data will want to consider this when making direct comparisons between cruises.

The survey area was overlaid with a systematic or "fixed" grid background consisting of 9-minute blocks having a sampling station centered in each block. Sampling density achieved under this grid design would be considered high by most bottom trawl surveys used for stock assessment purposes. While a more random approach to sampling populations is often used, systematic grid designs are effectively employed elsewhere to assess and describe fish distributions. The Cod IBS included a second layer of sampling effort based on advice from industry to ensure the centers of cod abundance were sampled. These "industry tows" were placed in 3-minutes cells over 16 strata that overlapped selected portions of the background systematic grid, forming a pool of stations that were randomly drawn from on each cruise. It is important to note that industry stations available between cruises within a survey year varied based on fishers' perception of cod availability. Sampling effort was apportioned between these two designs with 64% of the effort expended on fixed tows and the remaining 36% on industry tows. The combination of both designs was useful for evaluating rolling closure

areas. However, the usefulness of industry tows for other purposes such as analyses involving size and age composition or for computing indices of relative abundances is questionable and combining the data from the two designs does not appear outwardly appropriate for routine statistical analyses.

The Cod IBS originally covered depths ranging from 10 to 60 fathoms during the first year of sampling but was later extended to 75 fathoms based on advice from an external review committee to improve sampling of large mature and spawning cod, particularly during winter. Consideration was given to cover depths out to 90 fathoms, but given financial constraints and the negative impact the additional fixed grid tows would have on reduction of industry tows, a decision was reached to keep sampling within 75 fathoms. The Panel felt, for the purpose of a pilot survey, sampling of the Gulf of Maine Cod stock between the depths of 10-75 fathoms was adequate and in part supported by NEFSC survey findings. However, sampling in water deeper than 75 fathoms may prove worthwhile and should be considered if the survey is continued, even at the expense of losing industry tows.

b. evaluate random versus industry selected sample stations,

An ad hoc presentation of the catch comparison between fixed grid and industry tows showed similar distributions. The data from fixed grid tows are appropriate for most standard statistical analyses. The Panel recognizes that a genuine attempt to randomize tows within industry strata was made; however, the inferred area these tows may represent is unclear and likely limited. The Panel recommends further analyses and comparisons between grid and industry tows be made but also notes the outcome may be contrary to industry expectations. The use of industry tows in future surveys may not be warranted. The Panel felt the characterization of cod size and age distribution for the entire area is better accomplished by using only the fixed grid tows.

c. evaluate the estimation of survey area as it relates to absolute biomass estimates and the validity of such estimates,

Estimating absolute abundance was not a stated objective of the Cod IBS. Accordingly, the review panel was asked not to address this term of reference as stated, but instead, to offer an opinion as to whether these data could be useful for determining relative indices of abundance. Inter-vessel comparisons would be desirable before using data for this purpose. Should funding be limited, side-by-side comparisons between vessels could be performed in an area of high abundance and varied depths in lieu of obtaining samples from a low productive stratum such as in the east where both station completion and cod distribution was low. In some cases, but not all, fishing power corrections are appropriate on a species-by-species basis. A decision rule on when to apply fishing power correction factors is described by Munro (1998) and may be applicable to these data.

Standardization in the gear and methodology used to conduct bottom trawl surveys is essential for a correct interpretation of catch per unit of effort as a measure of relative abundance. The Panel recommends protocols on station search patterns and fishing operations be clarified, tightened, and targeting of fish sign as is commonly practiced in

"commercial style" towing be monitored constantly and prevented to ensure catch efficiency remains constant between samples. Stations should be assigned randomly between participating vessels rather than having vessels working in different areas and depths. The Panel also expresses concerns over the potential for fish loss during tows sustaining variable magnitudes of net damage and the inclusion of these tows in analyses. Further refinement in the standardization process for tow acceptance is needed and more detailed accounting of questionable tows should be contained in metadata files.

The net mensuration data indicated some vessel differences in the spread of the trawl gear, particularly for the smaller vessel used in the survey. For this reason, area-swept methodology for estimating CPUE, taking into account curvature of the tows, may be preferable to estimates based on time X speed methodology, or at the very least, CPUE could be based on distance fished from GPS (also taking into account curvature of the tows) if net mensuration data were missing for a large number of tows. Perhaps fitting a regression to net spread and wire length data can be used to estimate the area swept for tows without net mensuration data. The use of net mensuration equipment on all tows is highly recommended for future surveys.

A stratified random survey design could be considered to replace the Cod IBS mixed survey design, given the difficulty of obtaining some fixed station samples each year and the analytical problems associated with using industry-selected tows. Fisher acceptance of such a survey design might be explored by presenting the distribution of tows from the surveys completed to date and those resulting from a stratified random selection, which may adequately cover hot spots and address concerns about the lack of sampling of potentially high abundance areas.

d. *evaluate sampling protocols, sub-sampling procedures and onboard processing of biological materials and total catch, and*

The Cod IBS utilized 4 commercial vessels of similar class, skippered by 4 captains having adequate trawling experience. The survey gear seemed appropriate given the objectives of the survey. Each vessel utilized the same survey gear from the doors aft (no information on trawl wire specifications was provided). Assurances of proper gear maintenance was given to the Panel; however, it is understood that trawls sustaining repetitive damage in the range of 10-30% would be difficult to maintain to survey standards while at sea. It was unclear as to the standards used for proper wire measurement or if monitoring of differential wire lengths by side was regularly performed. Detailed descriptions of the process used to set and retrieve the gear, critical to the use of multi-vessel surveys, were also absent from the report, although they were briefly touched upon in the presentation.

Catch sampling protocols were appropriate paralleling those employed by the NEFSC. Maturity and age information collections were adapted to new levels as recommended by outside sources during the second year but may have been excessive. Collection rates for maturity and age should be further evaluated should the Cod IBS be continued. If a smaller sample size is needed more time can be spent on collecting information from other species. The use of high precision Marel basket scales to calculate total catch

weight and catch weight by species is commendable. Small amounts of fish and individual fish weights were taken with a spring scale but could be improved by using a smaller capacity Marel scale. Subsampling methodology was good. Subsampling tows having large numbers of cod could potentially make more time available for the collection of data on other species.

To make the survey more useful, the collection of comprehensive data for other species should be done more consistently. This would imply establishing minimal sampling levels and/or cyclical sampling levels based upon life history. Otoliths must still be processed and interpreted so that the temporal and spatial distribution of ages can be examined.

e. *evaluate data post-processing procedures and archival policy.*

Attention to detail was adequately applied during all phases of the data editing process as described to the Panel during the presentation of survey results. Both manual and automated processes were used. The data were provided to the NEFSC for archival with appropriate measures taken for control of its use. A metadata file describing protocols, towing and catch sampling procedures and anomalies to the data contained in the database (particularly for tows sustaining varied degrees of net damage) should be developed and stored along with the database. This would be useful in data interpretation over the long term.

2. ***Data Utility***. *The review panel should evaluate the surveys' utility in assessing:*
   a. *the efficacy of fishery closure areas,*

The Cod IBS has provided additional data on cod in locations and during times when data are not available from any other fishery-dependent or fishery-independent sources. The Cod IBS has also provided good data on the temporal coincidence of spawning cod and rolling closures; therefore, potentially providing information on the adequacy of these closure in reducing fishing mortality and protecting spawning individuals.

The utility of the Cod IBS data relative to the fishery closure areas (rolling closures) lies mostly in the identification of the areas containing spawning fish during specific times of the year. Generally, the monthly closed areas matched well with the areas where the highest catches of spawning fish could be found. In that respect, the survey data are useful to determine the location and timing of cod in spawning condition.

During the winter, the utility of the survey to identify areas containing spawning fish would likely be enhanced by extending the Cod IBS to deeper waters. It was also noted that the presence of spawning fish in May suggests cod in spawning condition may also be present in the area during summer months.

No data were presented on the assessment of the efficacy of the fishery closure areas. However, it was noted the objectives of the fishery closure areas remain somewhat unclear. The original objective of the fishery closure areas was to reduce fishing mortality by displacing fishing effort to areas and periods of lower aggregation. A perceived objective is that the fishery closure can lead to improved recruitment by

avoiding potential negative effects of fishing activity on spawning behavior and/or spawning success. If the objectives and rationale for the fishery closures were confirmed, an assessment of the efficacy of the fishery closures relative to the objectives could be attempted. The Panel considered this assessment would require data on a broader scale as well as data of a different type (e.g. fishing mortality or estimates of spawning success depending on the objectives) than those provided by the Cod IBS in the Gulf of Maine. The utility of the Cod IBS would be limited for the evaluation of the efficacy of fishery closure areas.

b. stock abundance,

The Cod IBS was not designed to estimate stock abundance. It has the potential to provide an index of abundance for cod in the future. However, some modification of the survey would probably be needed to meet the needs of assessment biologists. At the outset, the main objective of the Cod IBS was 'to define a broad scale distribution of cod aggregations in the Gulf of Maine, in space and time, by age and size composition'. The survey was; therefore, not designed to produce indices of stock abundance.

While it may be possible to use the data collected during the survey to derive indices of stock abundance for specific species, a significant number of issues would first need to be examined and resolved. One of the first issues to be considered is the survey area encompasses the entire distribution (or at least a high and constant proportion) of the species stock under consideration. Secondly, the current mixed design of the survey (grid stations and industry stations selected on a stratified random basis) is not amenable to the calculation of an index of abundance using traditional statistical techniques. An index derived from the grid stations only could be valid but, given that a number of grid stations could not be fished during each survey, the construction of an abundance index would require the same common set of stations be used from year to year. Using the same common set of grid stations may mean a significant portion of the species distribution is not sampled which may invalidate the use of the series as an index of abundance.

It was noted that it may be possible to derive valid indices of abundance for particular species with the existing data using geospatial techniques (e.g. kriging). The panel recommends that this be investigated if it is desired to derive abundance indices while maintaining the current survey design. Alternatively, the design of the survey could be changed to a stratified random design such as that used in the NEFSC, Maine-NH and Massachusetts surveys.

c. *migratory or movement patterns,*

The Cod IBS was not designed specifically to examine migratory or movement patterns. The data collected during the survey appear to provide some insights into the migratory patterns of a number of species. For example, the data provided suggested that cod and witch flounder appear to move to deeper waters while winter flounder does not appear to exhibit a significant migration. However, the absence of coverage in waters deeper than 75 fathoms limits the interpretation of survey results in that regards. It should be noted that seasonal surveys are an indirect way of inferring migratory patterns. Validation of the patterns uncovered through direct methods such as tagging programs is desirable. In that regard, a separate tagging study for cod in the Gulf of Maine has been conducted.

d. *reproductive demographics,*

The Cod IBS is successful in describing the spatial and temporal distribution of mature as well as spawning male and female cod with respect to time period and stratum. Currently, the Cod IBS is the only source of maturity information for Gulf of Maine cod. The seasonal nature of the Cod IBS also provides opportunities to collect samples for studies of reproductive dynamics (fecundity, egg viability, etc.).

e. and other biological characteristics such as age and growth parameters.

The temporal and spatial distribution of age and growth of cod cannot be described because otoliths have not been processed and interpreted by the NEFSC. In general, the utility of the survey for this purpose is potentially high for cod. It is noted that individual lengths and weight of cod have been collected and these data could be used to examine the spatio-temporal variation in fish condition in the area. Ageing material collected during the spring and fall Cod IBS could particularly be useful to augment the sample size for larger fish in aged-length keys.

3. ***Consistency***. *The review panel should evaluate the consistency and comparability among temporal and spatial sampling frames in relation to field procedures, gear selection and maintenance, vessel comparability, data acquisition, and analysis.*

The Cod IBS experienced some problems affecting the consistency of annual sampling. Completion rates of the expected number of tows was lowest during the first year of sampling due to inexperience of the samplers, problems with the identification of towable bottom, and the presence of fixed gear. The presence of fixed gear in sampling grids, particularly off Maine has continued to pose an impediment to the completion of the specified number of stations during Years 2 and 3. As a result, some of the nine-minute grids have not been completed each year. However, despite these problems, the survey has obtained a very good picture of the spatio-temporal distribution of cod in the Gulf of Maine. Shorter tows off Maine might reduce interaction with fixed gear as well as hard bottom.

The same gear type has been used throughout the study period. Furthermore, the same protocol has been used in deployment of the gear by different vessels. However, protocol

could be enhanced to ensure that if different skippers or vessels were used in the future data would not be compromised.

Although the investigators have made efforts to ensure data are collected in a consistent manner among vessels, a vessel comparability study has not been conducted. The cost of conducting such an effort would affect the number of samples collected. One possible method to obtain the needed information would be to forego sampling in a less productive stratum (i.e. stratum 1 or 6) and thereby enable side-by-side comparisons in a more productive stratum (i.e stratum 2 and 3). While data would be lost for one season in a stratum, the small study would help ensure data between vessels were being consistently collected and are comparable.

The data have been collected in a fairly consistent manner by the investigators. All cod are weighed and measured. Occasionally large samples of age 1 cod are subsampled for length. One change made in data collection procedures was to increase the number of cod retained for biological sampling from 1 per centimeter to 3 per centimeter. This change was based on a recommendation from a subcommittee who qualitatively determined sample size should be increased. However, it might be better to quantitatively estimate the appropriate sample size for age and maturity data. The current number of age and maturity samples might be adequate, more than needed, or less than needed. If fewer biological samples are needed from cod, then more emphasis could be placed on obtaining length information and biological samples from other species taken on tows.

Originally the Cod IBS sampled out to depths of 60 fathoms for cod. The Cod IBS provides good information on cod distribution, reproductive state, length and age structure within depth range of sampling, particularly during winter when there are no fishery independent data collected. However, the distribution of cod during the winter extends deeper than the original 60 fathom boundary of the Cod IBS design. Therefore, a change was made to the program to expand sampling from 60 fathoms out to 75 fathoms. There is some concern that there may be some cod as deep as 90 fathoms during winter. Expansion of sampling into deeper water would reduce the number of inshore stations that could be sampled and the vessel expense of sampling in deeper water would be greater. However, by not sampling in water deeper than 75 fathoms, the Cod IBS may not completely meet its primary objective of evaluating the spatial and temporal distribution of cod in the Gulf of Maine. Data from the NEFSC trawl survey could be compared to Cod IBS data to determine potential for cod in water deeper than 75 fathoms.

Sampling is somewhat inconsistent for species besides cod. Although samples are usually obtained for all species on a tow, a standard protocol should be identified for sampling species besides cod especially when catches are very large. Data are examined in a consistent manner; however, some statistical analyses are needed to determine if apparent differences in various parameters are significant. Comparisons of length frequency data are presented by stratum and time period. However, these comparisons include data pooled from grid and industry based stations. Before these data are pooled, the data from the different surveys should be analyzed to determine if they are

statistically significant. Furthermore, length frequency comparisons between strata and time period should be analyzed to determine if there are significant differences.

4. ***Quantitative Analysis***. *The review panel should evaluate quantitative analysis techniques, measures of statistical precision, and recommend design or analytical processes that will improve the utility of existing survey data.*

Quantitative analysis of the data is lacking for the Cod IBS. Results presented appear to be qualitatively different with respect to time period and stratum; however, it is unknown if these apparent differences are significant. Comparisons could be made to determine if CPUE of cod from grid and industry sampling designs are significantly different. Comparisons between designs could be made within a stratum. Furthermore, similar comparisons could be made for lengths and age (once available) between grid and industry based tows. Once this is established, statistical comparisons of these parameters can be made between strata and time period.

Based on discussions at the workshop, it was unclear to the Panel whether expanded rather than raw tow data were contained within the database. The best practice would be to have raw data within the database to enable expansion through programming. Furthermore, it was not clear if all data contained in the field logs were contained within the database. Efforts should be made to ensure all data from field logs are entered into the database. Building maximum flexibility in the database would be obtained by recording and coding as much information as possible.

5. ***Cost Effectiveness***. *The review panel should compare the cost effectiveness of the IBS program relative to the costs of the NEFSC Bottom Trawl Survey.*

Few data were provided to examine the cost effectiveness of the Cod IBS program as compared to the NEFSC bottom trawl survey. The investigators indicated the commercial vessel cost is $4,844/day. These costs are somewhat higher than the 70-90' long industry vessels used by the NWFSC bottom trawl surveys on the west coast and lower than the 120-160' long chartered commercial trawlers used by the AFSC. The investigators also indicated the owners provided the vessel at a lower cost than they would to charter because this sampling task was put out for competitive bid and the vessel owners wanted to ensure they obtained the long term support of the IBS program. Federal vessels are higher in cost per day when annual maintenance, fuel and salaries are factored in, but NMFS Centers do not incur a charge for their use.

6. ***Integration***. *The review panel should evaluate the potential for integrating the IBS surveys with NMFS or other inshore trawl surveys or fishery independent monitoring programs. This includes interoperability and comparability of NEFSC current (R/V Albatross IV) and future (R/V Bigelow) bottom trawl surveys and states' near shore trawl survey programs. The panel should also evaluate the potential of integrating fixed fishing gear in the IBS program.*

The terms of reference were revised at the meeting and this item was dropped.

7. ***Future of IBS and Other Initiatives***. *The review panel should be prepared to make recommendations concerning the continuation of IBS program and development of future fishery independent programs under NCRPP*.

The terms of reference were revised at the meeting and this item was dropped.

References

Munro, P. T. 1998. A decision rule based on the mean square error for correcting relative fishing power differences in trawl survey data. Fish. Bull., U. S. 96:538-546.

Appendix 1

DRAFT Terms of Reference for Technical Peer Review of the NCRPP Industry Based Survey (IBS) Program

1. **Design and Execution**. The review panel should evaluate the statistical and scientific validity of the two survey designs relative to the program goals and objectives, highlighting strengths, weaknesses, and potential biases. In particular:
    a. evaluate the temporal and spatial design elements relative to survey objectives,
    b. evaluate random versus industry selected sample stations,
    c. evaluate the estimation of survey area as it relates to absolute biomass estimates and the validity of such estimates,
    d. evaluate sampling protocols, sub-sampling procedures and onboard processing of biological materials and total catch, and
    e. evaluate data post-processing procedures and archival policy.

2. **Data Utility**. The review panel should evaluate the surveys' utility in assessing:
    a. the efficacy of fishery closure areas,
    b. stock abundance,
    c. migratory or movement patterns,
    d. reproductive demographics,
    e. and other biological characteristics such as age and growth parameters.

3. **Consistency**. The review panel should evaluate the consistency and comparability among temporal and spatial sampling frames in relation to field procedures, gear selection and maintenance, vessel comparability, data acquisition, and analysis.

4. **Quantitative Analysis**. The review panel should evaluate quantitative analysis techniques, measures of statistical precision, and recommend design or analytical processes that will improve the utility of existing survey data.

5. **Cost Effectiveness**. The review panel should compare the cost effectiveness of the IBS program relative to the costs of the NEFSC Bottom Trawl Survey.

6. **Integration**. The review panel should evaluate the potential for integrating the IBS surveys with NMFS or other inshore trawl surveys or fishery independent monitoring programs. This includes interoperability and comparability of NEFSC current (R/V Albatross IV) and future (R/V Bigelow) bottom trawl surveys and states' near shore trawl survey programs. The panel should also evaluate the potential of integrating fixed fishing gear in the IBS program.

7. **Future of IBS and Other Initiatives**. The review panel should be prepared to make recommendations concerning the continuation of IBS program and development of future fishery independent programs under NCRPP.

Appendix II:
List of participants at the Industry Based Survey Peer Review Meeting Portsmouth, New Hampshire, August 29-30, 2006, Convened by: Earl Meredith, NMFS/NERO

Review Panel

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Tuesday, August 29, 2006

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