Northeast Consortium

Summary of Completed Cooperative Research Projects Funded by The Northeast Consortium

January 2006

Dear Colleague,

The Northeast Consortium encourages and funds collaborative research and monitoring projects within the Gulf of Maine and Georges Bank, which involve effective, equal partnerships among fishermen, scientists, and other stakeholders. A central goal of the Northeast Consortium is that the results of cooperative research efforts be fully integrated into fisheries and ocean management through ensuring public accessibility to data, facilitating technical reviews of completed projects, and outreach to fishermen, scientists, and managers.

This annual publication summarizes funded cooperative research projects with final reports submitted to the Northeast Consortium. It is an easy reference guide that highlights the main conclusions and products of funded projects and what next steps are taking place or should take place. As this guide is published annually, it will grow each year as more projects are completed.

All interim and final reports and other project information are internet accessible through the Northeast Consortium's Project Information Database. In addition, the Fisheries and Oceans Data Management System serves as a means of access to data from cooperative research projects funded by the Northeast Consortium.

We hope that this publication will help to communicate the results and products of our collective effort to support and engage in cooperative research in the Northeast region.

Sincerely,

Chris Glass

Dr. Chris Glass
Director and UNH Representative

Northeast Consortium Website
www.northeastconsortium.org

Project Information Database
www.northeastconsortium.org/projects.shtml

Fisheries and Oceans Data Management System
www.northeastconsortium.org/data.shtml

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This publication was designed and edited by
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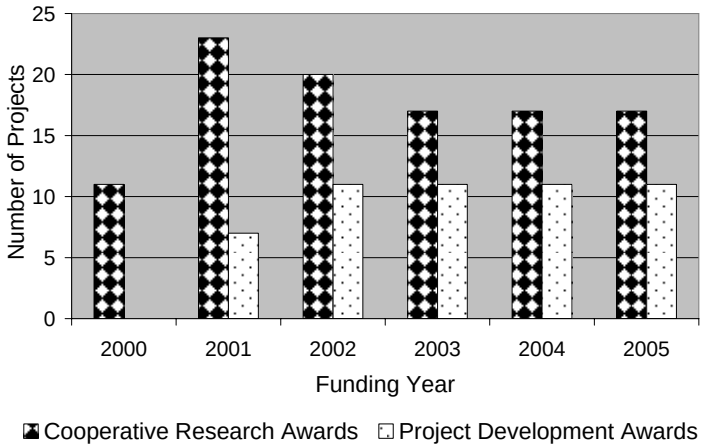
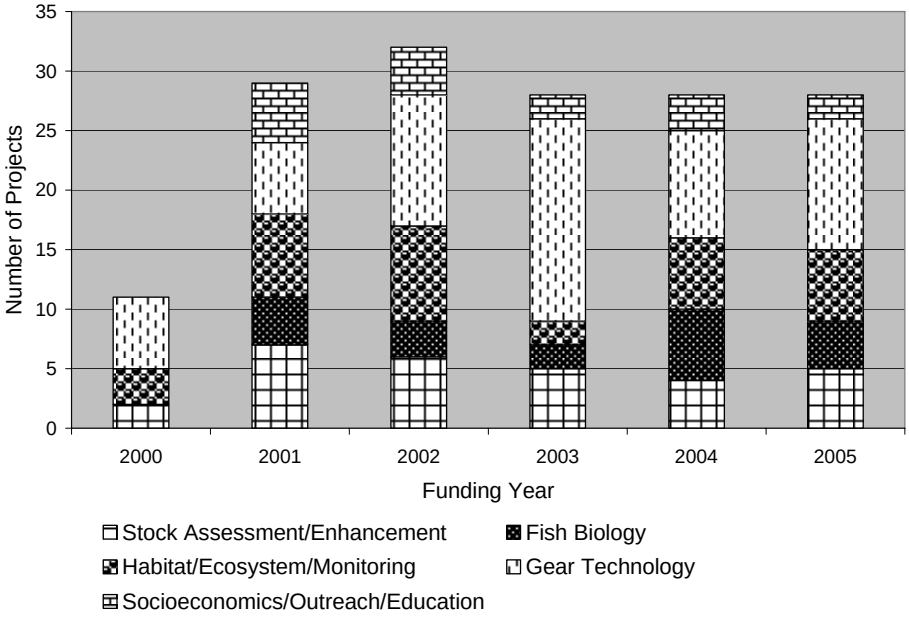
2000-2005 Overview

Since 1999, The Northeast Consortium has funded over 155 cooperative research projects since 2000, involving over 185 scientists, 335 fishermen, and 30 different fishing industry organizations or businesses. The charts below summarize project funding to date. The first shows the number of cooperative research and project development awards that have been funded. The second shows the number of projects funded each year in five general research topic areas.

The majority of the research funding goes to awards that are usually for one or two years' duration. Projects must include as key participants both one or more scientists and one or more commercial fishermen. The required funding allocation ratio is 25% to scientists and 75% fishermen. At the encouragement of its Advisory Committee, the Northeast Consortium established a project development award program in FY2001. Up to $25,000 per project can be used to test the feasibility of an idea, try out new gear, or otherwise lay the groundwork for future research. Project development awards are granted through an RFP and panel review process that occurs later in the year than the full award process.





Groundfish

Title: *A collaborative program to reduce bycatch and discard in Gulf of Maine otter trawl fisheries: effect of composite mesh codends on trawl selectivity*

Year Funded: 2000 - $148,750

Participants:
Chris Glass (Manomet Center for Conservation Sciences), Timothy Feehan (Manomet), Frank Mirarchi (F/V Christopher Andrew; Scituate, MA), Greg Morris (Manomet), Russell Sherman (F/V Lady Jane; Gloucester, MA), and Proctor Wells (F/V Tenacious; Phippsburg, ME)

Summary:
This project seeks to address the need for more information on the effectiveness of composite codends on bycatch reduction and on the variability due to seasonal and geographical variables, and the need to involve fishermen in research. Five different composite mesh codend configurations were tested, two of which showed promise during previous sea-trials, to determine their effectiveness in reducing bycatch and discard of key species. The codends were comprised of different configurations of 6" and 6.5" square and diamond mesh. Testing occurred using three different fishing vessels operating in different areas and a different times of year. Most sea trials were conducted using alternate tow techniques. Data was recorded at sea by NOAA Fisheries certified observers, following NMFS protocols. Videotape recordings of fish reaction behavior were be made throughout the duration of the program and later used to develop more effective species specific selection devices.

The investigators found differences in the selectivity of the different codends used. Composite mesh codends (that is codends fabricated with both square and diamond meshes) are effective in significantly reducing bycatch and discard of a range of groundfish species, including cod. These preliminary trials, while demonstrating great promise (e.g. a 62% decrease in capture of sub-legal cod when employing a composite mesh codend), also indicated seasonal variation in degree of effectiveness and were conducted with legal regulated mesh sizes (6" diamond and 6" square mesh) that are likely to be superseded by larger mesh regulations (6" diamond and 7" square).

The investigators received additional funding from the Northeast Consortium in 2002 to continue the study. The effectiveness of two novel, composite mesh codends (constructed with the proposed increased minimum mesh sizes, 6" and 7" diamond and 7" square mesh netting) will be tested for reducing bycatch and discard in Gulf of Maine Groundfish fisheries. Their selective efficiency is being compared with codends constructed with current minimum mesh sizes (6" diamond and 6" square) and projected minimum mesh sizes (6" diamond and 7" square).

Title: *Commercial trials of flexible trawling devices including soft trawl doors*

Year Funded: 2000 - $200,000

Participants:
Cliff Goudey (Massachusetts Institute of Technology) and Robert Kohl (F/V Glenna & Jacob; Marston's Mills, MA)

Summary:
This project capitalized on results from a Massachusetts Institute of Technology Center for Fisheries Engineering Research (CFER) project that applied flexible hydrodynamic devices as a way to control the shape and depth of trawls. These preliminary tests were done at the Marine Institute's flume tank in St. Johns, Newfoundland, and revealed significant potential benefits for trawl fishermen, including: 1. reduced habitat impacts by relying less on heavy weight and rigid doors, 2. trawl shape and depth that is independent of towing speed, 3. wider mesh openings for improved selectivity, 4. reduced cost and maintenance requirements for trawl gear, and 5. less risk on deck from heavy doors and sweeps.

The project was designed to explore at a commercial scale the potential of flexible lifting devices as a way to control the performance of trawl nets. Potential applications to be considered include sweep kites, annular foil kites, mesh kites, and parafoil trawl doors.

In collaboration with industry collaborators, the annular foil kite was identified as being most promising. At-sea trials were conducted with mixed results. The potential for the device was clear, but conditions during the trials made documentation difficult.

Headrope kites developed by CFER have become standard gear aboard many midwater trawlers fishing in southern New England. With additional development efforts, the utility of flexible devices should be possible in other aspects of trawling such as controlling trawl shape, keeping meshes open, and in place of rigid hoops such as used in experimental cod end covers or associated with separator grids.

Title: *Construction and operational efficiency of a two-seam 200 mesh x 30 cm monkfish trawl*

Year Funded: 2003 - $25,000 (PD Award)

Participants:
Allyson Jordan (Jordan Maritime Industries, Ltd.; Portland, ME), Jeff Flagg (Portland Trawler Supply), Greg Turner (F/V Theresa & Allyson; Portland, ME), and Manomet Center for Conservation Sciences

Summary:
This project was designed to provide solid data on the efficiency of a large mesh (10") codend built specifically to target monkfish and minimize bycatch. The net was constructed following the guidelines requested by the New England Fishery Management Council for a two-seam 200 mesh x 30 cm monkfish trawl. Sea trials were in the Wilkinson Basin area over two days for a total of 10 hauls. The experimental codend had an overall bycatch rate equal to 5% of the total catch. Monkfish below the m.l.s. of 40 cm total length (based on the regulatory tail m.l.s. of 11") made up 1% of the monkfish catch in weight. These promising results are worth further exploration, in order to assess and quantify the potential to achieve a clean monkfish fishery.

Title: *Determining groundfish species movement patterns in closed areas, including the Western Gulf of Maine Area Closure*

Year Funded: 2000 - $214,640
2002 - $134,243

Participants:
Hunt Howell (University of New Hampshire), Vincent Balzano (F/V North Star; Portland, ME); Carl Bouchard (F/V Stormy Weather; Exeter, NH), Jim Ford (F/V Lisa Ann II; Newburyport, MA), David Goethel (F/V Ellen Diane; Hampton, NH), Frank Mirarchi (F/V Christopher Andrew; Scituate, MA), and Mike Morin (UNH)

Summary:
Two cod tagging projects have been funded, one that examines the effectiveness of the western Gulf of Maine rolling closures as a management tool (FY2000) and another that focuses on cod movements in and around the Western Gulf of Maine Area Closure (WGoMAC) (FY2002). Mark and recapture techniques were used for both.

During the first project, 91 tagging trips were conducted, making 555 tows in the 4 rolling closure areas. A total of 17,860 cod were tagged, as well as 1,138 haddock, 840 American plaice, 79 pollock, 41 wolf fish, 28 yellowtail flounder, 12 winter flounder, and 7 gray sole. A total of 1,086 cod (6.1%) were recaptured with enough information (exact location and date of recapture) to be usable in the study. All data have been entered, and the analyses have been completed. Results from the project formed the basis of a thesis prepared by Mike Morin, and a manuscript for publication is currently in review. Overall, movement of Atlantic cod in the western Gulf of Maine appears to be associated with spawning. In the spring, cod were observed to move from offshore areas and aggregate inshore (area 133) to spawn. Post-spawning movements began in June and were characterized as a general dispersion offshore away from the spawning grounds. Cod were again observed to move inshore for spawning in December-January, suggesting the possibility of two distinct spawning groups. These spawning events were each associated with movements in and out of area 133. To determine if these were to distinct groups or the same group spawning twice, average lengths of the three observed spawning groups (Spring 2001, Fall2001/Winter2002, and Spring 2002) were compared. Results showed that both the spring 2001 and 2002 groups had a significantly larger average size than the winter spawning group, suggesting that these are two different age groups of fish. Genetic analyses of these fish, conducted by Kovach et al. at UNH, indicate that the two spawning groups are genetically different.

For the second tagging project, a total of 59 days, between July 2002 and June 2003, were spent collecting and tagging cod in the WGoMAC and adjacent areas. A total of 6,953 cod were tagged. Of these, 230 (3.3%) were recaptured prior to Dec. 31, 2003. Days at large ranged from 0 (recaptured the same day) to 421. Most (76.8%) were recaptured within 120 days of being tagged and released. Data analyses include

movement, length, and abundance statistics. Results suggest that cod movements in this area are associated with spawning and that the time/area (i.e. rolling) closures, as currently configured, are appropriate for protecting spawning aggregations. Spawning cod moved relatively short distances (most <30 km). A low number of cod were recaptured from the WGoMAC, presumably because commercial fishing is prohibited in the area. However, the data suggests that this is not an area where adult cod are particularly abundant and that it is not an important spawning area. Nevertheless, the WGoMAC may be an important nursery area for cod. If so, then the combination of rolling closures designed to protect spawning cod, and the closure of the WGoMAC that may benefit juveniles, is probably contributing to the recovery of cod in the western Gulf of Maine.

Title:
Development of a hydrodynamic cover for conducting experiments on selectivity of trawl codends onboard fishing vessels

Year Funded:
2001 - $24,570
(PD Award)

Participants:
Pingguo He (University of New Hampshire) and Carl Bouchard (F/V Stormy Weather; Exeter, NH)

Summary:
The project involves the design and development of a codend cover for conducting codend selectivity studies onboard small (45') commercial trawlers in New England. The focus of the development project was to devise a suitable codend cover and to evaluate its application for codend selectivity studies using the covered codend method. The design involved the use of 12 water-borne kites attached to the codend cover to expand the cover when towed through water. Flume tank tests of the full scale prototype were carried out in December 2002 at the Fisheries and Marine Institute in St. John's, Newfoundland. Field tests were conducted in May/June 2003 in the western Gulf of Maine. The codend cover has been proven suitable in terms of its function evaluated by underwater observations and catch assessment. The cover was easy to handle onboard a small inshore commercial trawler. The kite cover has since been used in a project to study the selectivity of the trawl codend of different mesh sizes and mesh shapes funded by the NOAA Fisheries Cooperative Research Partners Initiative during spring/summer 2003 and 2004. The kite cover is recommended for use in other vessels doing codend selectivity research, though the size of cover and the number of kites may differ due to different sizes of codends.

Title:
Development of a (trawl) net to reduce bycatch of cod in the flounder fishery

Year Funded:
2000 - $35,000

Participants:
Allan Michael (ADM Associates) and Bill Lee (F/V Ocean Reporter; Rockport, MA)

Summary:
A standard commercial groundfish trawl net was modified by the addition of a Nordmore style grate and an escape vent. The purpose was to develop a net that would allow flounder to pass through a grate to the codend, but direct cod upwards and out of the net. The gear was tested and videotaped in shallow waters in Ipswich Bay. The original grate design had horizontal openings of decreasing size from an aperture of 10" at the bottom to 2" inches at the top and was inclined towards an escape vent at the top of the net. This design proved unsuccessful, since a significant amount of cod passed through the grate during the first few trials. The design that seemed most successful used a steel grate with horizontal bars spaced 3" apart, producing a 73% reduction in the number of cod caught on the grate or in the codend and a 12% loss of flounder out of the escape vent. A by-product of the project was the development of a video system and methods for documenting trawl net performance and fish behavior.

One challenge the project encountered was clogging of the grate by large monkfish and dogfish. A possible solution would be the use of a ventral escape vent for monkfish. This approach is being evaluated in a much larger, ongoing study that is analyzing a more complicated double-grate system. It received funding by the Northeast Consortium in 2001 and is led by Pingguo He of the University of New Hampshire.

Title:
Feasibility study for knotless codends

Year Funded:
2002 - $10,000 (PD Award)
2002 - $46,180

Participants:
Kelo Pinkham (F/V Jeannie C.; Trevett, ME), Stanley Coffin (F/V Bad Penny; Edgecomb, ME), Bill Lee (F/V Ocean Reporter; Rockport, MA), and Dana Morse (Maine Sea Grant)

Summary:
The selectivity of knotless twine used in the codend of a groundfish trawl was tested relative to a standard codend constructed of knotted twine, in two companion projects. In 2003, 25 tow pair (50 tows) tests were conducted. Analysis of catch per unit effort and length frequency by species detected only a small difference between catches from the knotless and knotted codends. Video footage suggests a general tendency for the knotless twine to remain more fully open during trawling. Escapees from knotless codends may suffer less scale loss and other damage during the escape process. The knotless twine is lighter, easier to handle, and more supple. Future work should focus on the health of escapees, and on continued field trials, including square mesh arrangements. Larger sample sizes and covered codend experiments would help to more fully describe the selectivity of knotless twine in the Northeast groundfish fishery. Evaluations were somewhat hampered by low catches in both control and experimental tows. A research brief is available on the project, which describes some of the positives and negatives of using knotless twine.

Title:
Groundfish trawl nets designed to reduce the bycatch of cod

Year Funded:
2000 - $87,200

Participants:
Michael Pol (Massachusetts Division of Marine Fisheries) and Luis Ribas (F/V Blue Skies; Provincetown, MA)

Summary:
Two trawl nets, the “Ribas net” and a Faroe Island design prototype, were constructed and tested at sea on a commercial vessel, against a conventional two-seam groundfish net, which served as a control. The two experimental nets both modify the top half of a trawl net; the Ribas by using large square mesh and the Faroese by removing much of the twine at the top of the net. The project goal was to reduce cod as bycatch up to 75-90% (and perhaps dogfish (*Squalus acanthias*) bycatch as well). This net was designed to target the following species: yellow tail flounder (*Pleuronectes ferruginea*), winter flounder (*Pleuronectes americanus*), American plaice (*Hippoglossoides platessoides*), windowpane flounder (*Glyptocephalus cynoglossus*), and skate (*Rajidea*).

Seventy pairs of alternate tows with the control net resulted in reductions of cod bycatch of >76% for both nets. Catch rates of sublegal yellowtail flounder were also >74% lower for both nets compared to the control. There were, however, reductions in the legal catch of yellowtail and winter flounders. Underwater video showed cod exiting the nets through the top mesh or gap made by removal of the twine. The results of this project have been presented to the New England Fishery Management Council Multispecies Plan Development Team, which encouraged participants to demonstrate the performance of the Ribas net in off-shore areas. The participants have continued the research with Saltonstall-Kennedy funding. However, modified versions of both nets were included as options in Amendment 13 to the Groundfish Fishery Management Plan.

Title:
Identification of life history parameters for two exploited skate species (Amblyraja radiata and Malacoraja senta) in the Gulf of Maine: Strategies for fisheries management

Year Funded:
2001 - $228,998

Participants:
Paul Tsang (University of New Hampshire), Joe Jurek (F/V Mystique Lady, Andover, MA), and James Sulikowski (University of Florida)

Summary:
The primary objective of the study was to foster a partnership between commercial fishermen and research scientists in order to quantify the life history parameters essential to the development of a fisheries management plan for the thorny skate, *Amblyraja radiata,* and smooth skate, *Malacoraja senta,* in the Gulf of Maine. For the thorny skate, we found that this species grows slowly (k=0.11 for males, and k=0.13 for females), is long lived (16+ years for both males and females), reaches sexual maturity at a late age and size (50% maturity occurs at a total length of 860 mm and near 11 years of age for males and a total length

of 875 mm and around 11 years of age in females) and is reproductively active all year round. While the data for the smooth skate is still being analyzed, our results suggest that like the thorny skate, this species reproduces continuously throughout the year. More research will be needed to ascertain the essential fish habitats and movement patterns for these species.

Title:
Improving the selectivity and utility of demersal hook fishing

Year Funded:
2000 - $96,750

Participants:
H. Arnold Carr (Massachusetts Department of Marine Fisheries), Susan Goldhor (Center for Applied Regional Studies), Mark Leach (F/V Sea Holly; Harwich, MA), Tom Luce (F/V Sea Winn; West Barnstable, MA), Michael Pol (MADMF), and the Cape Cod Commercial Hook Fishermen's Association

Summary:
This project combined at-sea fishing underwater video observation of fish behavior towards baited hooks and aquarium research to expand our knowledge of the behavior of commercially important groundfish (e.g., cod, haddock, yellowtail flounder and other flatfish species) towards a variety of natural and artificial baits. The goal was to analyze fabricated baits for their cod-catching potential. Artificial baits were tested with regard to attractants, size, shape, etc. Successful baits, hook sizes, and gear types were tested in at-sea trials. Results suggest that the methods used for testing and developing artificial baits was successful at narrowing down the selection of bait types for cod and yellowtail, although preferences were difficult to establish. More research is needed to definitively determine which bait type is best at catching cod.

Title:
Maine-New Hampshire inshore trawl survey

Year Funded:
2000 - $38,607
2002 - $299,815

Participants:
Sherman, Sally (Maine Department of Marine Resources), Yong Chen (University of Maine), Jeff Flagg (Portland Trawler Supply; Brownfield, ME), Sam Galli (F/V Tara Lynn; Portland, ME), Doug Grout (New Hampshire Fish and Game), Hannah Smith (MEDMR), Vincent Manfredi (MEDMR), Curt Rice (F/V Robert Michael; Portland, ME), John Sowles (MEDMR), Keri Stepanek (MEDMR), and Bob Tetrault (T/R Fish, Inc.; Portland, ME)

Summary:
This project is a fishery independent multi-species stock assessment along the Maine and New Hampshire inshore waters. The overall goal of the project is to establish a solid foundation for long-term fishery-independent monitoring of the Gulf of Maine inshore waters, filling an information gap on the status and trends of groundfish and other species in this area for which assessment data would otherwise be absent. Funded in part by the Northeast Consortium and in part by the NOAA Fisheries Cooperative Research Partners Program, the survey began in the fall of 2000 and consists of annual, spring and fall stratified random surveys, each covering approximately 115 stations from New Hampshire to Canada. The project is a close partnership with commercial fishermen and the two state agencies charged with managing the inshore state waters. Data is being provided for the management of a number of species including lobster, shrimp, crab, scallop, shad, herring, and groundfish. The project is contributing to stock abundance, structure, and recruitment indices for the area and compliments data from the NOAA Fisheries bottom trawl survey in the Gulf of Maine and the Massachusetts Department of Marine Fisheries inshore trawl survey.

In August 2005, and independent peer review of the project was facilitated by the Northeast Consortium. It was conducted to determine the viability of using the data in regional stock assessments and to improve the project for the future. The project received funding again in 2005 from the Northeast Consortium and the participants are incorporating many of the panel's recommendations in current and future surveys.

Title: *Testing of low-profile low cod bycatch gillnets*

Year Funded: 2000 - $78,810

Participants:
Michael Pol (Massachusetts Division of Marine Fisheries), H. Arnold Carr (MADMF), and Bob Mackinnon (Massachusetts Gillnetters' Association)

Summary:
Two experimental gillnets were tested that are designed to reduce or eliminate the bycatch of cod while targeting flatfish species. Both experimental designs reduce the vertical profile of the nets in the water. One experimental design modifies a foam-core floatline by adding lead every few feet; the other net replaces the gillnet's floatline with another leadline so that the net lies nearly completely on the bottom. Both are 8 meshes deep (MD) and have different floatation and hanging ratios. The nets were quantitatively compared to standard gillnets (25 MD) to determine their effectiveness in reducing cod bycatch. The nets with lower vertical profiles have been shown to reduce the catch of legal cod, but not discarded cod. Catch rates of flatfish could not be compared, due to low catch numbers. Filming with an underwater camera indicated that the orientation of the nets was different than anticipated. Research has continued on these gillnets with additional funding the Northeast Consortium in FY2001.

Title: *Trophic ecology of Atlantic cod: Insights from tri-monthly, localized scales of sampling*

Year Funded: 2001 - $125,475
2002 - $76,250

Participants:
Frank Almeida (NOAA Fisheries Northeast Fisheries Science Center), Theodore Ligenza (F/V Riena Marie; South Chatham, MA), Jason Link (NEFSC), and Brian Smith (NEFSC)

Summary:
The project examined the small scale variation of Atlantic cod feeding based upon tri-monthly stomach sample collections from a nearshore, localized region off Cape Cod, Massachusetts. The first objective was to relate any detectable changes in cod diet and amount of food eaten with changes in temperature, spawning, prey abundance, and major weather events, filling in the information gap between broad scale and in vivo laboratory studies. The second objective was to work cooperatively with the fishing industry to transform anecdotal information into quantitative data. Results suggest that the amount of food eaten by cod is generally stable throughout the year, except when pelagic forage fish migrate through the area. This corresponds to critical periods in the life history of cod. The temporal variation in diet composition remained remarkably consistent each year over the 28-months of the project, suggesting important feeding periods for cod, which correspond to environmental and biological cues. The diet is comprised primarily of several species of forage fish (e.g. Atlantic herring, sand lance, Atlantic mackerel, ophiuroids, Cancer crabs, and other small crustaceans.) Additionally, these results confirm the preference cod exhibit for prey such as herring, sand lance,and crabs. We infer that cod generally eat local forage fish and benthic macro-invertebrates and then supplement their diet by gorge feeding upon migrating pelagic species.

Title: *Utilizing genetic techniques to discriminate Atlantic cod spawning stocks in U.S. waters: A pilot project*

Year Funded: 2004 - $25,000 (PD Award)

Participants:
Heather Deese (Northwest Atlantic Marine Alliance), David Berlinsky (University of New Hampshire), David Goethel (F/V Ellen Diane; Hampton, NH), Adrianne Kovach (UNH), Lorraine Maceda (New York University), Frank Mirarchi (F/V Christopher Andrew; Scituate, MA), and Issac Wirgin (NYU)

Summary:
This pilot project involved commercial fishermen, recreational fishermen, and U.S and Canadian researchers in a partnership to determine the utility of specific genetic techniques for detecting significant differentiation between cod stocks in the region. Microsatellite and single nucleotide polymorphism (SNP) DNA analyses were tested on the specific question of differentiating Atlantic cod from Georges Bank (GB) and the inshore Gulf of Maine (GoM) - are cod in these two regions a single or two genetic stocks? Where possible, we further addressed the question of whether stock subdivisions exist within the GoM and south of GB. Unlike previous efforts, this study focused on actively spawning cod, with spawning state confirmed through analysis of gonad biopsies. Additionally, the focus was on spawning aggregations thought most likely to display genetic differentiation, based on the best available information regarding ecological differences, movements, and expected stock delineations, and within the constraints of collecting new samples during winter 2004/2005.

The sampling strategy focused primarily on comparing winter-early spring spawning cod from GB with both winter and spring spawning cod from inshore, western GoM. Based on experience with genetic cod stock identification in Atlantic Canada, Europe, and recent work within U.S. waters, a total of six informative microsatellite loci and three SNP loci (*Pan I, AHR2, and ARNT2*) were tested for usefulness in distinguishing stock structure in this region. Two of the polymorphic SNP loci (*AHR2* and *ARNT2*) were newly isolated and characterized in this project. The project also focused on collecting, recording and synthesizing information on the location and timing of cod spawning aggregations in the GoM, GB, and south of GB, as a resource for future collaborative research projects, including broader, longer-term project to identify stock structure utilizing genetic techniques. Highly significant stock differences were found among many, but not all, collections made for this study. Cod from GB were significantly different from those collected in Ipswich Bay during the spring months, but not from those collected in the winter. Most interestingly, the spring collection from Ipswich Bay was significantly different from that made at the same location during the winter along with all other collections made in the study. Fish collected from wrecks off Long Island, New York, were significantly different from the GB collection, but not those from Chatham MA or Stellwagen Bank. In summary, for the first time a highly significant genetic difference has been demonstrated between a collection of spawning cod from GB and a collection of spawning cod from the inshore GoM. The genetic results support the morphological observations of stock differences between cod collected during the winter and spring months in Ipswich Bay.

A follow-up, funded by the Northeast Consortium in 2005, is in process to further determine the level of genetic similarity among cod spawning aggregations throughout the GoM and GB. Knowledge of stock structure is critical to effective fishery management. The results from this study and the ongoing follow-up study will be extremely valuable for fisheries scientists, managers, and stakeholders in formulating future management approaches for Gulf of Maine and Georges Bank cod fisheries.

Habitat/Ecosystem/Monitoring

Title:
Comparison of environmental contaminants on Georges Bank and Stellwagen Bank

Year Funded:
2001 - $129,130

Participants:
Emily Monosson (Montague, MA), David Lincoln (Gloucester Fishermen's Wives Association), Angela Sanfilippo (GFWA), and over 14 commercial fishermen

Summary:
This project investigated the potential for contaminant-induced effects on reproduction and development in both nearshore and offshore cod. Heavy metals, polychlorinated biphenyls (PCBs), and oganochlorine pesticides (including DDTs) were measured in cod livers and gonads and sediments from Stellwagen Bank, Georges Bank, and Wilkinson Basin. In general, concentrations of most contaminants were found to be near or below detection limits in cod gonads. Several contaminants were detected in the cod liver including PCBs and DDTs. However, concentrations from Georges Bank were drastically lower than previously published data and below concentrations linked with reproductive or developmental toxicity in fish. Analysis of heavy metals suggests that the concentrations of metals measured in this study are within range of those previously reported in cod except for cadmium. The vast majority of polycyclic aromatic hydrocarbons (PAHs) and metals detected in sediments were below NOAA's Threshold Effects Levels and chlorinated pesticides were below detection limits in the sediments. No one chemical was consistently detected at concentrations suspected of causing adverse effects in cod or their offspring. It would appear that levels of exposure to the chemical contaminants measured are unlikely to have had a considerable impact on the nearshore or offshore cod fishery.

Title:
eMOLT: Environmental monitors on lobster traps phases 1 – 3 of 4: temperature, salinity, and data management

Year Funded:
2000 - $82,000
2001 - $116,000
2002 - $79,775

Participants:
James Manning (NOAA Fisheries Northeast Fisheries Science Center), Bill Adler and David Casoni (Massachusetts Lobstemen's Association), Jeremy Cates (Downeast Lobstermen's Association), Charles Gregory (Southern Maine Community College), Clare Grindal (DLA), Tom Long (SMCC), David and Patrice McCarron (Maine Lobstermen's Association), Erin Pelletier (Gulf of Maine Lobster Foundation), David Sleeper (Spruce Head Fishermen's Cooperative), Bonnie Spinazzola (Atlantic Offshore Lobstermen's Association), Pat White (MeLA), 100+ commercial fishermen, and 15+ SMCC students

Summary:
The eMOLT project is a non-profit collaboration of industry, science, and academics devoted to monitoring of the physical environment of the Gulf of Maine and the Southern New England shelf. Low-cost strategies to measure bottom temperature and salinity and, most recently, surface current velocity have been developed with the help of nearly 100 lobstermen dispersed along the entire New England coast. The objective is to extend multi-year time series (as well as monitoring capabilities), continue integration with the Gulf of Maine Ocean Observing System (GoMOOS), and contribute to whatever operational systems are developed for our region in the future.

Having created this network of participating fishermen, the primary goal is to supply these individuals with the latest in low-cost instrumentation sufficient for maintaining continuous time series of physical variables at fixed locations and depths. As of January 2006, the database consist of 1.8 million hourly records of temperature, 80 thousand hourly records of salinity, and 50 thousand satellite drifter fixes. The mission is primarily motivated by lobster science and the need to document background conditions, but the database is accessible to the general public in the form of web served products and raw data (http://www.emolt.org).

The distribution of temperature and salinity probes in phases 1 and 2 is complete. In Phase 3, the eMOLT project set up a regional database network, so that project participants can enter, download, document, and view their data. In a quest to minimize instrumentation cost, eMOLT has partnered with both the Marine Science Department at the Southern Maine Community College and local engineers in the private sector. With funding in 2003 from the Northeast Consortium (Phase 4), gulf-wide surface current observations are made, documenting the degree of transport between basins, and demonstrating the dynamic exchange of water masses. Devices have consequently been developed of interest to the oceanographic community in general. The first is a GPS drifter at nearly a third the cost of conventional units that implements the SENS technology with the GLOBALSTAR low-orbiting satellite system. These units have already logged more than 50 thousand kilometers of ocean. Another is a real-time bottom temperature sensor (attached to lobster traps) that wirelessly transmits data to a shipboard system as it is hauled on deck. The drifters are now fully operational and being used by several other research groups but the wireless temperature sensor is still under development.

It is expected that the primary users of eMOLT data, aside from the lobstermen themselves, will be local ocean circulation modelers. The need for data in initialization, assimilation, and validation of their numerical simulations is becoming more and more obvious. The complex time-varying nature of the Gulf of Maine system calls for incorporating as much data as possible in order to generate realistic flow fields. The objective is to supplement the data supplied by GoMOOS by providing modelers with a extensive array of bottom observations as well as Lagrangian drifter tracks. The hope is that these numerical models will someday help in our understanding of particulate matter transport, such as lobster larvae drift and Harmful Algal Blooms, the mechanisms that govern both the short-term and long-term variability of the GoM ecosystem, and if realistic, time-varying, 3-d simulations of these changes can be generated. The eMOLT philosophy is that local fishermen already spend their days at sea, have the biggest stake in preserving our coastal marine resources, and are the most knowledgeable of the local waters. Their interest, curiosity, and enthusiasm are sincere. They should play an important part in our nation's Integrated Ocean Observing Systems.

Title:
Intensive study of the Western Gulf of Maine Closure Area

Year Funded:
2002 - $204,340

Participants:
Raymond Grizzle (University of New Hampshire), Jason Driscoll (F/V Karen Lynn; Exeter, NH), Mark Dowell (UNH), Peter Kendall (F/V Miss Alicia; Rye, NH), Michael Lesser (UNH), Greg Mavrikis (F/V Marion Mae; Eliot, ME), Larry Mayer (UNH), Rob Robertson (UNH), Andy Rosenberg (UNH), and Larry Ward (UNH)

Summary:
This project was an interdisciplinary investigation of ecological and social issues related to the Western Gulf of Maine (WGOM) closure area. It represented the initial stages of a longer-term program to determine various ecosystem-level impacts of the closure, and included gathering new and existing data from satellite imagery available on the web, multibeam sonar, direct sampling of the seabed, and public surveys. New maps are in production based on individual and combined datasets focused on a 400 km^2 (150 mi^2) study area located along the western boundary of the closure area. At the time of this report all data had not been analyzed, but four major conclusions were drawn. (1) Habitat types ranged from mud bottom in deep water (>100 m) dominated by deposit-feeding infauna to hard bottom (gravel and boulders) in water <80 m dominated by epifaunal organisms. (2) Some bottom characteristics and benthic community characteristics correlated strongly with water depth, suggesting that the new multibeam bathymetry map can be used to construct high-resolution maps of bottom habitat types. (3) Maps of some benthic community characteristics had patterns indicating substantial differences when comparing sites within to similar sites outside the WGOM closure area. (4) Preliminary statistical analyses indicated significant differences for some infaunal and epifaunal benthic community characteristics for sites within the WGOM closure compared to similar sites outside. Conclusions 3 and 4 suggest that there has been dramatic recovery of some habitat types in the 8 years since establishment of the WGOM closure. Additional funds for the project were obtained from the NOAA/UNH Cooperative Institute for New England Marine Fisheries and Aquaculture. Funds to continue the research was received from the Northeast Consortium in 2003.

Herring

Title:
Atlantic herring stock discreteness and migration: A coded microwire tagging pilot project in the Gulf of Maine

Year Funded:
2001 - $24,926
(PD Award)

Participants:
Kohl Kanwit (Maine Department of Marine Resources), David Libby (MEDMR), David Reingardt (F/V Thunder Bay; Wakefield, RI), and Alton West (Stinson 2000 Inc.)

Summary:
The project need was based on the lack of migration and spawning site data available for Atlantic herring in the inshore Gulf of Maine. The last tagging effort in US waters occurred during the late 1970s and early 1980s. Since then, mobile gear fishing pressure on the inshore stock component increased, herring moved further from coastal waters and the Georges Bank stock component recovered from its collapse of the 1960s. The pilot project funded by the Northeast Consortium was designed to complement an existing tagging effort by using coded microwire tags to mark pre-spawning aggregations of herring on Jeffrey's Ledge in the Gulf of Maine. Microwire tags were selected as the best option for tagging herring, because they are less invasive, result in high retention rates and automated tag detection is possible.

Field methods for obtaining live herring and tagging them with micro-wire proved successful. However, DMR began a review of the project after experiencing major difficulties with the tag recovery process. The conclusion reached by DMR, Stinsons 2001 Ltd., and various industry members after a full evaluation of the program was to abandon the microwire tagging project and initiate a more conventional anchor tagging program for Atlantic herring. The anchor tagging project began in the spring of 2003, through support of the Northeast Consortium funds and incorporated most of the equipment and expertise gathered from the work conducted in 2001-2002.

Title:
Commercial vessel acoustic survey of coastal herring spawning units

Year Funded:
2000 - $168,900
2001 - $130,215
2002 - $205,985
2003 - $198,180
2004 - $168,900

Participants:
John Annala (Gulf of Maine Research Institute), Brian Bichrest (F/V Safe Haven; Harpswell, ME), Mark Bichrest (F/V Jennifer and Emily; Harpswell, ME), Matthew Cieri (Maine Department of Marine Resources), Steve Gough (F/V Western Wave; Prospect Harbor, ME), Andrew Johnston (GMRI), Cameron McLellan (F/V Adventurer; Newcastle, ME), Paul Morse (F/V Western Hunter; New Bedford, MA), David Reingardt (F/V Thunder Bay; Wakefield, RI), Shale Rosen (GMRI), Kevin Scheirer (GMRI), Joel Wezowicz (GMRI), and Philip Yund (GMRI)

Summary:
The temporal and special characteristics of spawning herring aggregations in coastal Gulf of Maine waters have been studied during the fall since 1998. The program has attempted to estimate the biomass of herring spawning in these waters during the fall months to establish an index of spawning stock biomass. Surveys have been conducted from Cape Ann, Massachusetts to Cutler, Maine. Each year, techniques have been refined for implementing acoustic surveys and collecting representative biological samples on fishing vessels.

In March 2005, the Northeast Consortium funded and facilitated an independent peer review, which concluded that acoustic surveys are an appropriate way to survey herring in this area and recommended continuation of the project. It also recommended that future surveys focus on estimating biomass using a broad-scale systematic survey approach, as well as developing an annual "sentinel" acoustic survey of the important spawning grounds. This project continues with additional funds from the Northeast Consortium granted in 2005. The panel's recommendations are being incorporated into the work, and will focus surveys in 2006 on identifying and quantifying "sentinel" spawning grounds.

Jonah Crab

Title:
A cooperative investigation towards an exempted trap to exclusively target Cancer borealis in Lobster Management Area 1

Year Funded:
2002 - $25,000
(PD Award)

Participants:
Carl Wilson (Maine Department of Marine Resources), Robert Alley Sr. (F/V Irene Renee II; Beals Island, ME), Brad Billings (F/V Bumps and Bruises; Stonington, ME), Thomas Lawson (F/V Katherine Louise; Southwest Harbor, ME), and Brent Oliver (F/V Jarsulan III; Stonington, ME)

Summary:
This project was designed to facilitate and monitor the performance of an Experimental Fisheries Permit (EFP) to be issued to 1000 lobster harvesters in Lobster Management Area 1. The EFP allows participants to develop a targeted Jonah crab trap deigned to reduce or eliminate lobster bycatch. The Maine Department of Marine Resources believes it is important to increase our understanding of Jonah crabs, *Cancer borealis*, and assess the potential for a targeted trap. The project has demonstrated the development of a Jonah crab specific trap, monitored EFP activity in Lobster Management Area 1, collected detailed biological information on Jonah crabs and positioned the State of Maine, Atlantic States Marine Fisheries commission and NOAA Fisheries to make informed decisions on the utility of a directed crab trap and/or fishery.

Lobster

Title:
Are we using herring to farm lobsters? The effect of herring bait on lobster growth and the fate of discarded bait on bottom habitat

Year Funded:
2001 - $111,972

Participants:
Jonathan Grabowski (Gulf of Maine Research Institute), Erika Clesceri (GMRI), Sherman Kinghorne (Grand Manan Fishermen's Association; New Brunswick, Canada), Mike Myrick (F/V Shannon Rose, Cushing, ME), Phil Poland (F/V Charlene Gail; Cushing, ME), Laura Taylor-Singer (GMRI), Matthew Weber (F/V Griffin; Monhegan Island, ME), Phil Yund (University of New England), and Carl Wilson (Maine Department of Marine Resources)

Summary:
In order to assess the effects of herring bait on lobster population dynamics, diet composition (stomach content analyses), tissue production (nitrogen stable isotope ratio analyses), and growth (mark-recapture experiments) of large (66-83 mm CL) and small (45-65 mm CL) sublegal lobsters, lobsters were sampled in seasonally closed sites around Monhegan Island fished sites around Georges Islands in mid-coast Maine during the summer and fall of 2002 and 2003. Collectively, the results support the notion that herring bait may be very important for lobster population dynamics in the Gulf of Maine, and therefore, the contribution of herring bait should be considered when developing management policies that affect fishing effort.

Title:
Implementation of an automated, comprehensive monitoring program for the Atlantic offshore lobster fishery

Year Funded:
2001 - $111,104
2002 - $129,939

Participants:
Win Watson (University of New Hampshire), Paul Bennett (F/V Hedy Brenna; Newport, RI), Denny Colbert (F/V Virginia Marie; Sandwich, MA); Bro Cote (F/V William Bowe; Hyannis MA), Nick Jenkins (F/V Eulia McGrath; Newington, NH), Marc Palombo (F/V Terri-Ann; Sandwich, MA), David Spencer (F/V Nathaniel Lee; Newport, RI), and Bonnie Spinazzola (Atlantic Offshore Lobstermen's Association)

Summary:
The overall goal of this project is to develop a monitoring program for the offshore lobster fishery, which encompasses an area extending from waters off the Gulf of Maine to Hudson Canyon. Specifically, the project is designed to: 1.) determine the size frequency distribution of lobsters caught in offshore lobster traps; 2.) map the distribution and abundance of berried females captured offshore; 3.) map the temporal and spatial patterns of shell disease in lobsters captured offshore; 4.) measure the size at maturity of female lobsters captured offshore and determine if there is a spatial pattern that is correlated with water temperature; and 5.) make management recommendations, at the end of the study, based upon the data obtained.

Results indicate that there are large differences in the size frequency distributions of lobsters captured throughout Area 3. There is a higher abundance of berried females with new eggs in the fall, both in the middle and the northern areas. However, the abundance is much greater in the north. While lobsters with late stage eggs are observed throughout the year in the middle canyons, they are rarely observed in the northern basins. This suggests that they may migrate up onto George's Bank to incubate and release their larvae during certain times of the year. The prevalence of shell disease has been extremely low in the study areas to date. Size at maturity data clearly showed that female lobsters in the northern portion of the fishery do not reach sexual maturity until ~ 93 mm carapace length.

This project continues with additional funding in 2003 from the Northeast Consortium.

Title: *Inshore/offshore patterns of lobster larvae and postlarvae spatial relationships*

Year Funded: 2001 - $142,453

Participants:
Lew Incze (University of Southern Maine/Gulf of Maine Research Institute), Mathew Thomson (F/V Shearwater; Monhegan Island, ME), and Proctor Wells (F/V Tenacious; Phippsburg, ME)

Summary:
This project involved two field sampling efforts. The first was a two-year (2001-2002) study of the distribution, stage composition and abundance of lobster larvae and postlarvae and hydrography from the central coast of Maine to the Canadian border. Eight survey transects, conducted over a 2+ week period in the middle of the larva/postlarval season, went across-shelf from near shore to approximately the 150 m (82 fIn) isobath, crossing three hydrographic and current regimes: the inner shelf or near-shore; the Eastern Maine Coastal Current (EMCC); and the stratified offshore. The objective was to understand the contribution that each area might make to lobster recruitment, both temporally and spatially. For example, the EMCC seems to move early life stages down to the central coast: how many, and where do these end up settling? How important is this compared to other processes driving postlarval abundance in that region? How many move offshore? A series of hypotheses dealing with the three regimes can be partially addressed by the survey design. The second sampling effort was directed at larval and postlarval production estimates along the central coast of Maine, immediately west of the surveys described above. This one-year effort involved a season-long study of all stages that complemented a preliminary study done in 2000. The study found that the settled abundance of Young-of-Year lobsters is determined to a significant degree by the abundance and delivery of postlarvae to appropriate settlement habitats. Settlement densities and the productivity of the lobster fishery in Maine are distinctly different east and west of Penobscot Bay. The research is helping understand the mechanisms behind those differences. More specific research has continued on egg production, circulation modeling, settlement, growth, and fisheries production. It is funded by NOAA Fisheries Coastal Ocean Program to L. Incze and ten co-PI's.

Title: *Mapping spawning and hatching grounds of the American lobster*

Year Funded: 2002 - $260,000
2004 - $105,175

Participants:
Diane Cowan (The Lobster Conservancy), Andrew Solow (Woods Hole Oceanographic Institution), Win Watson (University of New Hampshire), and 15+ commercial lobstermen from Friendship and Monhegan Island, ME

Summary:
The purpose of this study was to investigate the relationship between temperature, movements, and body size for ovigerous (egg-bearing) lobsters tagged recently after spawning and tracked throughout the 9-13 month brooding period. We made predictions about where and under what temperature conditions small (< size at 50% maturity) versus large (≥ size at 50% maturity) lobsters would brood. It was found that although small female lobsters were abundant in Muscongus Bay, most were not ovigerous. Small ovigerous lobsters tended to spawn and remain inside the bay where they brooded at lower winter, but higher spring and summer temperatures than large ovigerous lobsters. In contrast, large ovigerous lobsters (≥size at 50% maturity) were relatively rare, but most were ovigerous. They tended to spawn at greater distances from shore and while many stayed near where they spawned, others achieved a maximum displacement of up to 240 km. Large ovigerous lobsters were at more moderate temperatures throughout the year regardless of how far they traveled. Both small and large ovigerous lobsters experienced (1) sufficiently low winter temperatures for successful ovarian maturation, and (2) approximately the same number of degree days for egg development. These findings suggest that known thermal requirements of optimal cold temperature for successful ovarian maturation are balanced with sufficient numbers of degree-days for egg development via two distinct behaviors. Small ovigerous lobsters remain in shallow water where they experience colder winter but warmer spring and summer temperatures than large ovigerous lobsters that move to deeper water with warmer winter but colder spring and summer temperatures.

Title:
The relationship between traps, effort, and fishing mortality in the Maine lobster fishery: Manipulative experiments in the Monhegan Lobster Conservation Area

Year Funded:
2003 - $25,000
(PD Award)

Participants:
Carl Wilson (Maine Department of Marine Resources), Robert Bracy (F/V Pandora; Monhegan, ME), Mathew Thomson (F/V Shearwater II; Monhegan, ME), and Matthew Weber (F/V Griffin; Monhegan, ME)

Summary:
Four experimental trapping areas were established within the Monhegan Lobster Conservation Area (MLCA) to determine how the number and spatial arrangement of traps affects catch rates and fishing impacts. The number of traps and size of the experimental areas were designed to determine the joint effects of trap density and the aerial extent of fishing on lobster catch rates, population depletion, and mortality. High trap density areas significantly lowered the catch rates as compared to low density areas. The cumulative catch was higher in high trap density areas than low density areas over the course of the experiment, yet gross economic gains were largely offset when expenses were factored in. Methodologies were successfully developed that allowed accurate and high resolution quantification of the impacts of removals by lobster traps in discrete experimental sampling areas. Recaptured lobsters were easily identified by daily batch tags, and provided reliable estimates of recapture through the course of the experiment. This project development grant lead to the application of the methodologies to a larger experiment within the MLCA, funded by the Northeast Consortium in FY04, that involved seven fishermen and 1,500 traps placed at different densities in eight 1 km^2 experimental areas. This work will benefit lobster management in the future as we begin to understand how trap increases or reductions could impact the lobster population and associated fishery.

Title:
Ventless Trap Survey (VenTS)

Year Funded:
2003 - $13,513
(PD Award)

Participants:
Patrice McCarron (Gulf of Maine Lobster Foundation), Erin Pelletier (GoMLF), and 47 lobstermen from Maine and Massachusetts

Summary:
The Ventless Trap Survey (VenTS) was established in Canada and the United States in 2000, to develop a low cost fishery independent index of juvenile lobster abundance that could be used as a predictive tool to help manage the lobster fishery and that directly involves the industry in data collection. Specifically, it is a trap based sampling program conducted by volunteer lobstermen year-round in the Gulf of Maine and Atlantic Canada. The Gulf of Maine Lobster Foundation (GoMLF) manages the U.S. portion of the project. The purpose of this NEC Development Project was to standardize the U.S. portion of VenTS with Canada, to expand our outreach and to recruit additional U.S. participants. The standardization was successful and the international relationship with Canadian scientists and fishermen is continuing. The level of participation in the U.S. has increased and more participants are recruited each season. The data collected through the VenTS has been used to derive fishing exploitation rates in Canada and in the most recent Canadian stock assessment. Results indicate that ventless traps are an excellent tool for monitoring juvenile abundance. The U.S. portion of VenTS has produced a 5-year time series of data that shows the overall trend in sublegal lobsters has decreased from 2000 to 2004. A comparison of the juvenile component of the catch from the VenTS project (fishery-dependent) with juvenile abundance indicators from the Maine-New Hampshire Inshore Trawl Survey (fishery-independent) indicated that VenTS and trawl survey data are highly correlated. This positive association affirms the significance of the VenTS results and the need to continue with this cost effective and low-impact study of the juvenile lobster population.

Ocean Quahog

Title:
Gulf of Maine ocean quahog (Arctica islandica) assessment

Year Funded:
2001 - $23,326

Participants:
Dan Schick (Maine Department of Marine Resources), Scott Feindel (MEDMR), and Kristan Porter (F/V Whitney and Ashley; Cutler, ME)

Summary:
In the spring of 2002, an industry-collaborative pilot survey was conducted of Maine's quahog resource. Base-line information was collected to begin to establish a biological basis for quota allocation. Objectives were to map the species' distribution to the 50-fathom depth contour and to obtain population structure, length-weigh, relative abundance data and bycatch information. Work included a stratified random survey of the three management zones where fishing is currently allowed (225 stations), a systematic survey of the main known beds between Cross Island and Petit Mann Island (46 stations), and a descriptive survey of an historically fished area in Passamaquoddy Bay (23 stations). Six permanent stations were also established to track temporal trends. Few small patches of quahogs were discovered at random stations beyond known historically fished areas, but juvenile animals (<20 mm) found at some previously fished sites indicated at least some recent recruitment. The Gulf of Maine population was characterized by younger and potentially slower growing clams compared to populations found in commercially fished beds off southern Massachusetts and the Mid-Atlantic. Preliminary estimates of stock abundance were made. Parameter estimates and the distribution map obtained from this research will allow future surveys to be optimized. A dredge-efficiency study would be needed before an absolute biomass for the resources can be calculated.

Red Crab

Title:
Developing stock assessment methods and evaluating beam-trawls in stock assessment surveys of the New England deep sea red crab fishery

Year Funded:
2001 - $113,000
2002 - $24,928
(PD Award)

Participants:
Richard Wahle (Bigelow Laboratory for Ocean Sciences), Yong Chen (University of Maine), and Jon Williams (Benthic Fishing Corp.; Westport Island, ME)

Summary:
The goal of this project is to gather necessary demographic information on New England deep-sea red crab toward the development of a stock assessment program that involves harvester vessels and their expertise. A major challenge of the project is to repeat the only camera and trawl surveys conducted for red crab in 1974 by NOAA Fisheries with the *R/V Albatross*, but with smaller industry vessels and updated technology. Additional objectives are to conduct tagging studies to obtain sorely needed information on growth, to conduct at-sea sampling of the commercial catch, and to develop stock assessment models based on the demographic information collected. This project has successfully adapted a benthic sled system for camera surveys, generating the first population density estimates of red crab in 30 years. As part of a supplemental NEC development grant, both otter and beam trawl were tested as means of collecting data on crab size, sex, and reproductive status. Otter trawl, as in the earlier survey, seems to be the more efficient sampler. Together, the camera and net trawl data are providing demographic data very consistent with the earlier survey. Changes in the size structure sex composition of the population reflect the impact of targeting large male crabs. To date about 5000 crabs have been tagged and returns are still awaited to detect growth. With funding obtained in 2003 from the Northeast Consortium and the industry, the project was able to continue surveys for the years 2003-2005. These data will contribute to a full stock assessment for the red crab fishery the spring of 2006, the first to be conducted for this species with updated information.

Scallop

Title:
A new role for the commercial fishing fleet in monitoring, predicting, and managing sea scallop resources

Year Funded:
2000 - $135,000

Participants:
Scott Gallager (Woods Hole Oceanographic Institution), Cabell Davis (WHOI), Arnie DeMello (F/V Kathy Marie; New Bedford, MA), John Doran (F/V Amy Philbrick; Newington, MA), Alan Kuzirian (Marine Biological Laboratory), Grant Moore (F/V Direction; New Bedford, MA), John Quinlan (NOAA Fisheries Northeast Fisheries Science Center), Paul Rosonina, and Richard Taylor.

Summary:
The primary goal of this project was to integrate real-time data collection and transmission technologies into the commercial scallop fishing fleet for the purpose of identifying scallop larvae in the plankton and in oceanographic features where larvae aggregate in high numbers. The Larval Identification and Hydrographic DAta Telemetry package (LIHDAT) was constructed and installed aboard commercial fishing vessel Kathy Marie of New Bedford, MA. Data was collected from the vessel intake water during the course of fishing trips, with hourly averages transmitted to shore via the vessel's satellite VMS system and plotted on a project website. Novel approaches to optically identifying bivalve larvae were developed using polarized light comparing the birefringence of shell patterns of various shellfish species, with positive identification in the 90% range, significantly better than results obtained from a trained human observer. A gonadal/somatic index was developed through field sampling over the course of the project, critical for identification of exact scallop spawning time. Finally, spat collectors were deployed in three locations on Georges Bank to begin study of larval concentration and disbursement. Scallop juveniles in retrieved bags averaged 3,500 per bag at 8mm after 6 months. Molecular techniques were applied to determine utility in identification of sub-populations. This project has received further funding from several sources. The instrument has received several upgrades to both hardware and software and is now fully portable and in regular use aboard R/V Tioga.

Title:
Development of an off-bottom scallop drag

Year Funded:
2002 - $12,200
(PD Award)

Participants:
David Autio (Commercial fisherman; Medomak, ME), Phil Averill (Ocean Adventure, Inc.!; Bristol, ME), Scott Feindel (Maine Department of Marine Resources), Frank Genthner (Commercial fisherman; New Harbor, ME), Nate Hannah (Round Pond, ME), Larry Holmes (Bristol, ME), Robert Russell (MEDMR), and Kevin Varney (Sheepscott, ME)

Summary:
This project aimed to develop a scallop drag which catches scallops, but reduces the impact of the gear on the bottom. It used a new concept involving a hydrodynamic wing that causes a turbulent lifting force behind it as it is towed over the bottom. The catch is lifted into a solid cage rather than a ring bag. The whole rig rides on skis, which are the only part that touches the bottom. Everything else is at least 3" off the bottom. Eighteen tows were made with the gear over two days in shallow (8-10 fathom) water on a known scallop bed. Diver and video observations were made of drag performance. Some scallops were caught, but comparative tows later showed the wing drag to be much less efficient in harvesting scallops than was expected. One offshore test showed that significantly more weight would need to be added to the rig to keep it on the seafloor. Modifications were made after underwater video and diver observations, but did little to improve scallop harvest. Participants hope that more research on hydrodynamic scallop gear will occur in the future.

Title: *Field trials of 4" rings in the inshore scallop fishery of the Gulf of Maine*

Year Funded: 2003 - $92,932

Participants:
Dana Morse (Maine Sea Grant), Robert Holland (F/V Double J; Jonesboro, ME), and Steve Patryn (F/V Northern Eagle; Jonesboro, ME)

Summary:
In November of 2003, a project in eastern Maine coastal waters evaluated the selectivity of 4² (101.6 mm) diameter rings used in a scallop drag, as compared to a drag rigged with the regulation-sized 3.5² (88.9 mm) rings. The objective was to examine the utility of larger rings with respect to a recent state regulation that increased the minimum landing size from 3.75² to 4.0², shell height (SH) The fieldwork used side-by-side tows by two fishing vessels and a paired tow analysis. Experimental and control drags were switched between vessels each day. Data collection included catch volume of scallops and other species, scallop shell heights, location, and bottom type. After ten fishing days, a significant loss of scallops was observed with the larger rings. A lesser difference also existed for urchin catch volumes. No differences were detected for lobster, sea cucumber or rubble. Loss of legal scallops, when judged at the regulated SH of 4.00² was 3%. Sub-legal scallop catches were reduced by 25.5%. Tests in deeper waters need to occur to understand selectivity patterns more fully. Results have been distributed to industry members, Maine DMR, NEC and others; video clips, photos and the final report are available from the Maine Sea Grant web site: http://www.seagrant.umaine.edu/extension/fisheries/scalring.htm

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Title: *Maine scallop fishery: Monitoring and enhancement*

Year Funded: 2001 - $207,411

Participants:
Dan Schick (Maine Department of Marine Resources), Marsden Brewer (Commercial fisherman; Stonington, ME), Wallace Gray (F/V Foxy Lady; Stonington, ME), Scott Fiendel (MEDMR), Dana Morse (Maine Sea Grant), and Craig Pendleton (Northwest Atlantic Marine Alliance)

Summary:
The concern over the steady decline of scallop landings in Maine since the early 1990 and the uncertainty of other fisheries pointed to a need for a dedicated assessment program for inshore scallops in the Gulf of Maine. There has also been an interest in restoration and industry efforts to adapt stock enhancement technology for this public resource called for participation and support from the Maine Department of Marine Resources. The positive focal point of enhancement further set the stage for this industry/science collaborative project, which sought to design and implement a suite of monitoring programs including port and sea sampling and a fishery-independent survey. Methodology for these monitoring efforts were honed and evaluated. Baseline data were collected to better document the current fleet and fishing practices and to characterize the resource in terms of spatial patterns in size structure, meat yield, relative abundance, catch per unit effort, recruitment, habitat, and associated fauna. These data are especially pertinent in light of newly enacted regulations in the scallop fishery. This work culminated in an ongoing research program supported by a dedicated scallop fund and guided by an industry-chaired scallop advisory group. We initiated a Geographic Information Systems database of suitable spat collection areas and provided scientific support foe enhancement activities including evaluation of reseeding in the form of diver surveys, tagging and outreach. A scallop enhancement conference was held at the end of the project to summarize past work and consider avenues for the future.

Title: *Non-invasive, real time assessment of sea scallop abundance and habitat*

Year Funded: 2001 - $220,000

Participants:
John Howland (Woods Hole Oceanographic Institution), Arnie DeMello (F/V Kathy Marie; New Bedford, MA), Scott Gallager (WHOI), Harlyn Halvorson (University of Massachusetts, Boston), Paul Rago (NOAA Fisheries Northeast Fisheries Science Center), Paul Rosonina, Hanumant Singh (WHOI), Ron Smolowitz (Fisheries Survival Fund), Richard Taylor, and Page Valentine (United States Geological Survey).

Summary:
This project was designed to develop new optical imaging technologies to collect data on the abundance and distribution of scallop populations, and scallop habitat structure. A prototype imaging sled was built and tested to photograph benthic fauna and flora and their habitat with sufficient spatial resolution to identify species, substrate composition, and distribution. Image and other data outputs from the towed vehicle were networked to the vessel wheelhouse via the fibreoptic tow cable, allowing for both realtime processing and

adaptive sampling. One of the key issues addressed by this new imaging technology is the examination of appropriate sampling scale(s) for scallop populations in order to improve the precision of population estimates. It is especially useful to identify the pattern of variance associated with "quadrats" of varying size along the continuous ribbon-like mosaic. This has important implications for the estimation of precision for the NOAA Fisheries scallop survey. With contiguous blocks of samples, we can determine if the variance of density from quadrat samples was relevant to the estimation to the total and what the cost (i.e. number of samples and vessel time for survey) is to estimate the true density and variance. This also has important implications for the interpretation of catch data from commercial vessels. The funding from the Northeast Consortium was to develop the hardware necessary to acquire high resolution images of the sea floor deployed from a commercial fishing vessel. The next phase is to assemble proposals to a variety of agencies to develop the software tools for target identification, mosaicing, and automated classification of substrate.

This project has received additional funding from several sources, including the Scallop Research Set Aside (NEFMC/NMFS/Industry) for both hardware and software development. An advanced version is currently (Jan 2006) in use aboard F/V Kathy Marie along the US Atlantic coast producing ~1 terabyte of imagery each day of operation. See http://www.seascallop.com/HabCam.html Another instrument is being built for use in the Alaska scallop fishery.

Title: *Saco Bay scallop stock assessment*

Year Funded: 2002 - $25,000 (PD Award)

Participants:
Craig Pendleton (Northwest Atlantic Marine Alliance), Heather Deese (NAMA), Scott Feindel (Maine Department of Marine Resources, Dana Morse (University of Maine Sea Grant), Dan Schick (MEDMR), Steve Zeeman (University of New England), and over twenty commercial fishermen

Summary:
Sea scallop (*Placopecten magellanicus*) occurred in more places and in greater numbers in Saco Bay in recent decades than they do now, and supported a substantial fishery. In an attempt to rebuild a productive fishery, Saco Bay fishermen teamed with state agencies, Sea Grant and university scientists, and Northwest Atlantic Marine Alliance staff in 2000 to undertake wild scallop stock enhancement efforts in the Bay. Fishermen and scientists working together proved that they could collect wild scallop juveniles ("spat") in large numbers (>10^6) in netron-stuffed bags set from fall through spring in the Bay. The 6-9 month old scallops were seeded in currently or previously productive scallop beds. The Northeast Consortium-funded project began in March 2002 and built on two years of spat collection and reseeding focusing on learning about survival of seeded spat. Methods included environmental monitoring, observation of seeded spat in a variety of locations and conditions, and an intensive field study investigating the influence of migration and predation on spat survival immediately after reseeding. Results indicate surprisingly high spat mobility, surprisingly low interaction with predators within enclosures (starfish), and the importance of habitat type. Beyond technical results, the project was highly successful in bringing more fishermen into research and management processes and building meaningful partnerships and knowledge exchange between fishermen and local researchers.

Sea Cucumber

Title: *A preliminary study of the Maine Sea Cucumber (Cucumaria frondosa) fishery*

Year Funded: 2002 - $25,000 (PD Award)

Participants:
Yong Chen (University of Maine), Peter Collin (Coastwide Bio Resources, Stonington, ME), Scott Feindel (Maine Department of Marine Resources), Elena Gudimova (Murmansk State University, Russia), Sheril Kirshenbaum (UMaine), David Leach (F/V; Steuben, ME), Russell Leach (F/V; Steuben, ME), Drusilla Ray (Cherry Point Products; Milbridge, ME), and Lawrence Ray (F/V Eugenia II; Milbridge, ME)

Summary:
This project fills a much needed information gap on the sea cucumber, which is an emerging fishery in the state of Maine. The fishery began in 1988, but started expanding in 1994 when Asian markets opened up. There was little knowledge about the key life history processes that determine the population dynamics of the sea cucumber and limited data on the fishery and population. Sea cucumbers are unique in morphology,

behavior and biology relative to other commercially harvested species. A standardized procedure was therefore needed for collecting data and measuring biological characteristics. The project developed, tested, and identified a standardized procedure for biological sampling and surveying of the Maine sea cucumber. Through theoretical, lab, and field work, an optimal monitoring program was identified for collecting sea cucumber fishery data and a cost-effective survey program to collect information about the Maine sea cucumber population. The effectiveness was tested of some tagging techniques for the study of cucumber growth, mortality, and movement. A protocol for biological measurement of sea cucumber along the coast of Maine was developed and tested. The results derived from this study were used in the development and implementation of a full project, which was funded by the Northeast Consortium in 2003, and is still in progress. This project sets up the standard for future research related to the sea cucumber along the coast of Maine.

Sea Urchin

Title:
A simulation framework for developing optimal sampling strategies for the Maine sea urchin stock

Year Funded:
2001 - $23,920
(PD Award)

Participants:
Yong Chen (University of Maine), Robert Grabowski (UMaine), Margaret Hunter (Maine Department of Marine Resources), and Robert Russell (MEDMR)

Summary:
A pilot study for the annual fishery-independent survey program for the green sea urchin fishery was initialized in Maine in the summer of 2001. The high degree of spatial variability in sea urchin abundance, however, prevented using standard optimization techniques, such as traditional statistics or even geostatistics. Northeast Consortium funding was then sought to conduct kernel estimation and computer simulations to characterize the large-scale spatial density structure of the sea urchin population and investigate how different sampling strategies effected realizations of density structure. Since realizations of the large-scale density structure are vital components of the sea urchin stock assessment, any changes in this structure would dramatically alter the outcome of the assessment. Therefore, an optimal sampling strategy was defined that produces realizations of the large-scale spatial structure that are similar to the original population while using less sampling intensity than the original sampling strategy. Considering that the sea urchin data will be analyzed by traditional and spatial statistics, reducing the original stratified random sampling design to 10 locations per strata is the most sensible optimization for the Maine green sea urchin fishery-independent survey at this time.

Shrimp

Title:
Comparison of catch and bycatch with beam and otter trawls in the Northeast shrimp fishery

Year Funded:
2003 - $24,950
(PD Award)

Participants:
Bill Lee (F/V Ocean Reporter; Rockport, MA), Robert Cotrino (F/V Gretchen Marie), Melissa Ferraro (Royalston, MA), Bob Fisher (F/V Marina Rose), John Hogan (F/V Odie Colonie), Jack Ketchopulos (F/V Special K), Tim Macdonald (F/V Dory I), Allan Michael (ADM Associates; Magnolia, MA), Dennis O'Connell (F/V Lady Elaine), Jason Pollison (F/V Rumboogie), Paul Theriault (F/V Terminator), and Jay VanDerpool (F/V Rover)

Summary:
A 17' beam trawl was built and tested for the possible application of this gear in the northeast shrimp fishery. The 1.75" mesh net was fitted with a Nordmore grate and towed from the fishing vessel during the months of January through March, 2004. Seven additional vessels reported their catch and bycatch while towing for shrimp using standard otter trawls during the same time period and in the same general area as the vessel using the beam trawl. The beam trawl had a significantly lower catch rate for shrimp than the vessels using standard otter trawls. This was, in part, due to the relative size of the gear since the opening of the beam trawl was 17' and that for the otter trawls ranged from 28 – 34'. Percent bycatch (by weight) for the beam trawl was 13%, whereas that for the otter trawl fleet was 10.7%. There was a wide variation in the bycatch

rate among the seven vessels using the otter trawl (0.4 – 16.5%). Composition of the bycatch differed with a higher percentage of groundfish in the beam trawl and a higher percentage of pelagic fish in the otter trawl(s). Fuel consumption was greatly reduced with the use of the beam trawl. The gear is inexpensive to make and can be used with a single warp and from small vessels with lower horsepower. Further modifications might make this gear useful under specific conditions, near hard bottom, or where fixed gear is deployed. Additional research that could be done would be an evaluation of the relative impact of the lightweight beam trawl versus the standard otter trawl on the benthic environment.

Title:
Exploring the addition of an acoustic survey to the summer Gulf of Maine shrimp survey

Year Funded:
2003 - $24,703 (PD Award)

Participants:
Dan Schick (Maine Department of Marine Resources), Shale Rosen (Gulf of Maine Research Institute), and Proctor Wells (F/V Tenacious; Phippsburg, ME)

Summary:
This project attempted to test whether an acoustic component could be successfully added to the annual summer survey for Northern Shrimp, *Pandalus borealis*. The summer shrimp survey consists of 15-minute bottom trawl tows conducted in a stratified, random design with station density per stratum weighted by the historical presence of shrimp. Relying on a trawl survey means only a small portion of the total bottom is surveyed, due to time constraints and limited areas where a net can be towed. Additionally, it is impossible to know whether a high-catch tow represents a tow that passed through the center of a medium sized school, or one that passed through the edge of a much larger school. Acoustic survey techniques are generally not hampered by rough, untowable bottom and have the potential to cover areas more rapidly and completely than an equal amount of effort spent conducting trawl surveys. The participants hoped to demonstrate whether acoustics could be used to inform the results of the tow samples and to conduct surveys in areas that cannot be assessed using a bottom trawl. Despite carrying out operations in areas where shrimp were know to be present and using frequencies other groups have used successfully to detect *Pandalus borealis*, shrimp schools were never recorded by the 40, 75 or 120 kHz equipment used in this project. While other equipment and techniques (different frequencies and multibeam systems for example) might be effective in detecting and discriminating shrimp, results from this project indicate the tools and techniques tested in this study were not suited to assessing shrimp in the Gulf of Maine.

Title:
Reducing seabed contact of trawling: Design and model test of a semi-pelagic shrimp trawl for the pink shrimp fishery

Year Funded:
2001 - $81,004

Participants:
Pingguo He (University of New Hampshire), George Littlefield (F/V Lady Regina, Kingston, NH), and Bart McNeel (F/V Aaron and Melissa II; Portland, ME)

Summary:
This project involved gear design and model tests of a semi-pelagic shrimp trawl, one that has its doors off the bottom while leaving the trawl on the bottom. Tank tests have resulted in a new three-bridle trawl with longer bridles. Tests showed that the semi-pelagic trawl was able to stay in contact with the seabed when trawl doors were as much as 30 feet off the seafloor. A follow-up project, funded by the Northeast Consortium in 2002, testing the new semi-pelagic shrimp trawl at sea in the Gulf of Maine pink shrimp fishery is being completed. The results of that project showed similar catch rates of shrimps while the new gear operated in a semi-pelagic mode. However, changing water depth and turning during towing resulted in less desired trawl positions relative to the seabed, and could have resulted in the loss of catch. Fine adjustment of warp lengths was not possible due to inability of separate control of winches in small inshore vessels in Gulf of Maine. More details of field tests of the semi-pelagic trawling will be available in that report which will be available in 2006.

Social Science/Outreach/Education

Title: *Institutionalizing social science data collection*

Year Funded: 2001 - $113,700

Participants:

David Bergeron (Massachusetts Fishermen's Partnership), Jennifer Brewer (Clark University), Nancy Colbeth (Beals Island, ME), Madeline Hall-Arber (Massachusetts Institute of Technology Sea Grant College Program), Bonnie McCay (Rutgers University), Jay Michaud (F/V International Harvester; Marblehead, MA), Sarah Robinson (Harvard University), and Lahny Silva (Boston University)

Summary:

This project explored the potential for community-based data collection and analysis to help address the scarcity of social science data on the fishing industry and fishing communities. Community Panels were established for Jonesport/Beals Island, ME and Gloucester and the South Shore, Massachusetts. Each panel was comprised of 10 to 12 individuals, a cross section of harvesters, processors, shore-side businesses, and other members of the fishing communities. The groups identified issues of concern to their ports, and with the help of coordinators and the PIs, gathered data through interviews and focus group meetings, and drafted and reviewed reports.

A major goal was to provide management agencies with information about the potential impacts of regulatory changes on fishing communities so that adverse impacts could be mitigated. Consequently, each of the Panels reported on the potential impacts of Amendment 13 to the Multispecies (groundfish) Fisheries Management Plan and the Panels in Massachusetts reported on the economic needs of both their fleets and shoreside businesses to a Governor's Seafood Task Force. Another goal was to establish a community-based, participatory and on-going research platform in each of the communities, and the Panels can be and have been reconvened for special topics, such as the environmental justice focus group of the Beals Island Panel.

One of the issues of major concern raised in each of the panels was the status of the fishing industry infrastructure. Elements that each panel considered essential for the sustainability of their industry were considered. The panels also documented some of the benefits of the industry to their communities, as well as the threats or constraints on their continued viability. The understanding of infrastructure and its continued importance to both the fishing fleets and the communities, now and in the future when fishing stocks have rebuilt, has influenced harbor planning in Gloucester, and helped preserve infrastructure and access in Plymouth, Cohasset and Swampscott.

Other results that have already been used to support "fishing-industry friendly" decisions in various communities are:

- Information provided in the Gloucester Harbor Planning process formed the basis for the preservation of fishing industry infrastructure and access in the working harbor.
- The only lobster pound and docking access for 30 lobster vessels in Cohasset, MA was retained.
- Commercial vehicle parking access for 150+ fishermen in Plymouth, MA was retained.
- Retained waterfront access to a net hanging facility for 12 gillnet fishermen in Swampscott, MA.
- Provided a report and recommendations to the Governor's Seafood Task Force on the distribution of $5.5 million in federal disaster assistance funding in 2002.

Among the initiatives emerging from the Community Panels Project are:

- A project to promote safety through training and incentives, funded by the NOAA Cooperative Research Partners Research Initiative, results expected in 2007.
- MFP is utilizing project data in strategic planning to develop appropriate responses to needs such as: fishing industry characterization; data on the infrastructure in 52 Massachusetts fishing ports for municipal, state, and coastal zone planning; improving the market for locally harvested seafood through labeling; utilizing best safety practices to lower insurance and labor time costs; and expansion of health insurance for fishing families in other states.

In 2003, the Saltonstall-Kennedy program funded a companion project that formed three Community Panels in Portland, ME; New Bedford, MA; and Pt. Judith, RI. Reports for this completed project is accessible on the web at www.mass-fish.org.

Title: *Marine Resources Education Project (MREP)*

Year Funded: 2001 - $84,000

Participants:
Mimi Larsen-Becker (University of New Hampshire), John Coon (UNH), David Goethel (F/V Ellen Diane; Hampton, NH), Andy Rosenberg (UNH), Mary Beth Tooley (East Coast Pelagics' Association), and John Williamson (Industry representative; Kennebunk, ME)

Summary:
The purpose of the Marine Resource Education Project (MREP) is to take effective steps toward bridging the gap between fishermen, scientists and managers by providing a series of six highly-focused week-long training workshops for participation by all involved. Presentations made by assessment scientists and managers describing the population assessment process and the ways in which data is translated into regulation increase capacity within the fishing community. Fishermen provide knowledge gained from their working familiarity of the marine system. Negotiation and collaboration techniques are taught with case studies and discussed in breakout sessions. Ways in which the participants can better work together are explored. The goal of this project is ultimately to break down the historical barriers to cooperation and to develop leaders in the fishing industry able to promote trust in the management process and to forge new areas of involvement of fishermen in the regulatory process. The workshops have continued with additional project funding from the Northeast Consortium in 2003, 2003, 2004, and 2005.

Title: *Workshop on trawl selectivity and conservation*

Year Funded: 2001 - $84,000
2002 - $41,691

Participants:
Pingguo He (University of New Hampshire)

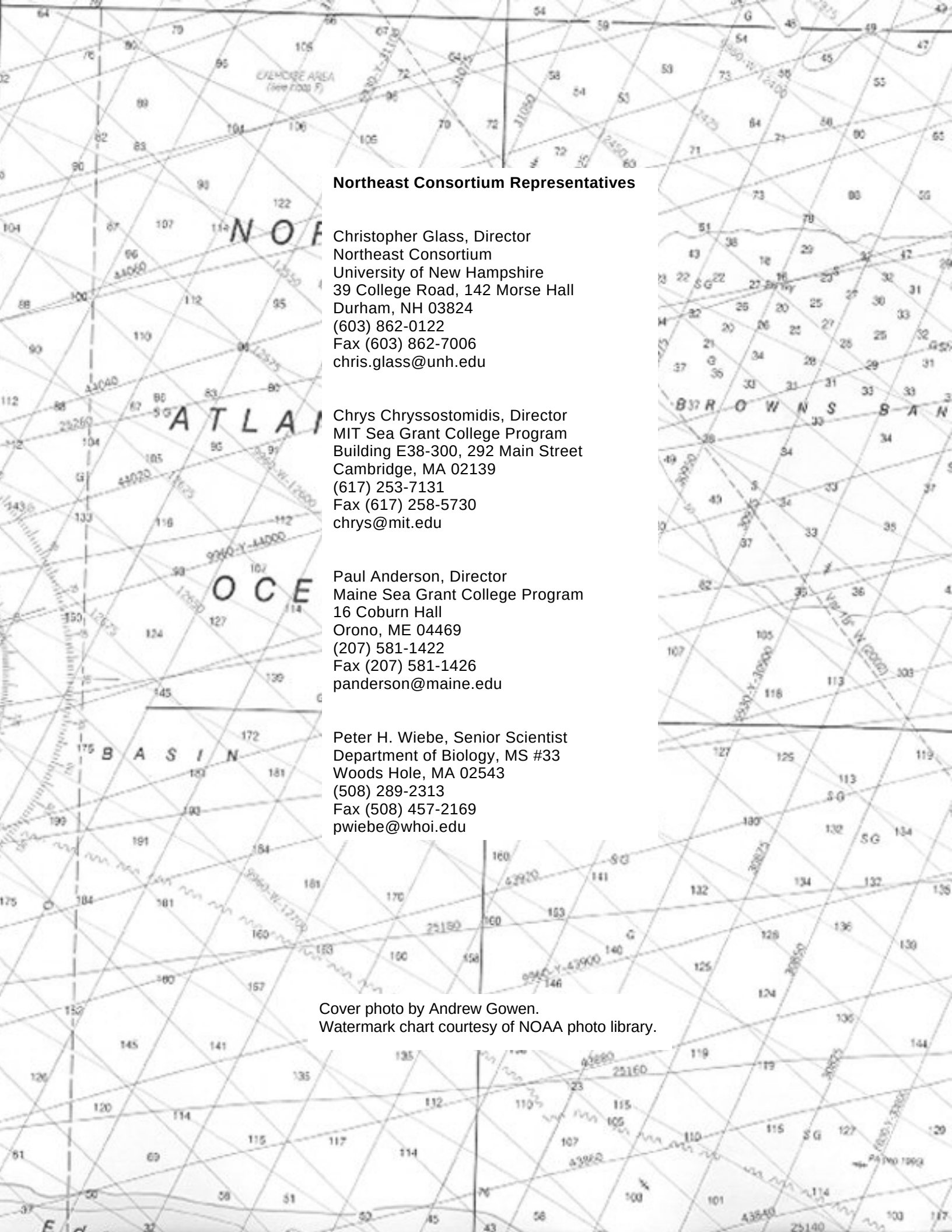
Summary:
These two projects funded five-day custom-designed trawl gear workshops at the Center for Sustainable Aquatic Resources of Memorial University of Newfoundland. Groups of eleven to thirteen people from the commercial fishing industry, Sea Grant, and state and federal agencies from the three states around Gulf of Maine participated in the workshops. The workshops centered around the world's largest fisheries flume tank, where various trawl gears and components are demonstrated and examined. Demonstrations focused on gear performance and conservation, such as selectivity grids and seabed-friendly trawls. The workshops enhanced participants' knowledge of trawl gear and stimulated interest in engaging in cooperative research related to trawl gear selectivity in the Gulf of Maine. The workshops have been well received by the participants and have resulted in cooperative project proposals. The project received funding in 2003 from the Northeast Consortium to continue holding workshops.

Title: *Adopt-a-Boat: Commercial fishing vessels in K-12 education*

Year Funded: 2001 - $193,000

Participants:
Cliff Goudey (Massachusetts Institute of Technology Sea Grant), Phil Averill (Ocean Adventure!, Inc.; Bristol, MA), Kenneth Ekstrom (MIT Sea Grant), Dean Goodwin (Kimball Union Academy; Meriden, NH), Robert Groman (Woods Hole Oceanographic Institution), Robert Kohl (F/V Glenna and Jacob; Marston's Mills, MA), Grace Lee (MITSG), Cameron McLellan (F/V Adventurer; Portland, ME), Brandy Moran (MIT Sea Grant), and Craig Pendleton (Northwest Atlantic Marine Alliance)

Summary:
The Adopt-a-Boat program is a collaboration between the MIT Sea Grant College Program, the fishing industry, and several individuals and organizations involved in education and outreach. The goal is to use commercial fishing boats as a vehicle for teaching the complexities of marine resource utilization, marine ecology, and life as a fisherman to K-12 students. By offering this program, authentic learning opportunities are provided to students. A balanced picture of commercial fishing is presented, helping to build an enlightened citizenry regarding marine resource utilization and its importance to coastal communities. During year one of Adopt-a-Boat, ten classroom/vessel partnerships were built and their collaborative activities were supported with state-of-the-art technologies. A variety of approaches were used to inquiry-based learning and curricula and lesson plans were developed that follow national and state educational frameworks. The project received continued funding from the Northeast Consortium in 2002, which expanded the Adopt-a-Boat program significantly and evaluated the curricula developed in year one. Since its initiation, Adopt-a-Boat has grown into a region-wide program involving approximately 50 fisherman/classroom partnerships in four New England states. Based on its success, new Adopt-a-Boat programs have been formed or are being developed in three other locations across the country. To date, over 2,000 school children have benefited from the program.



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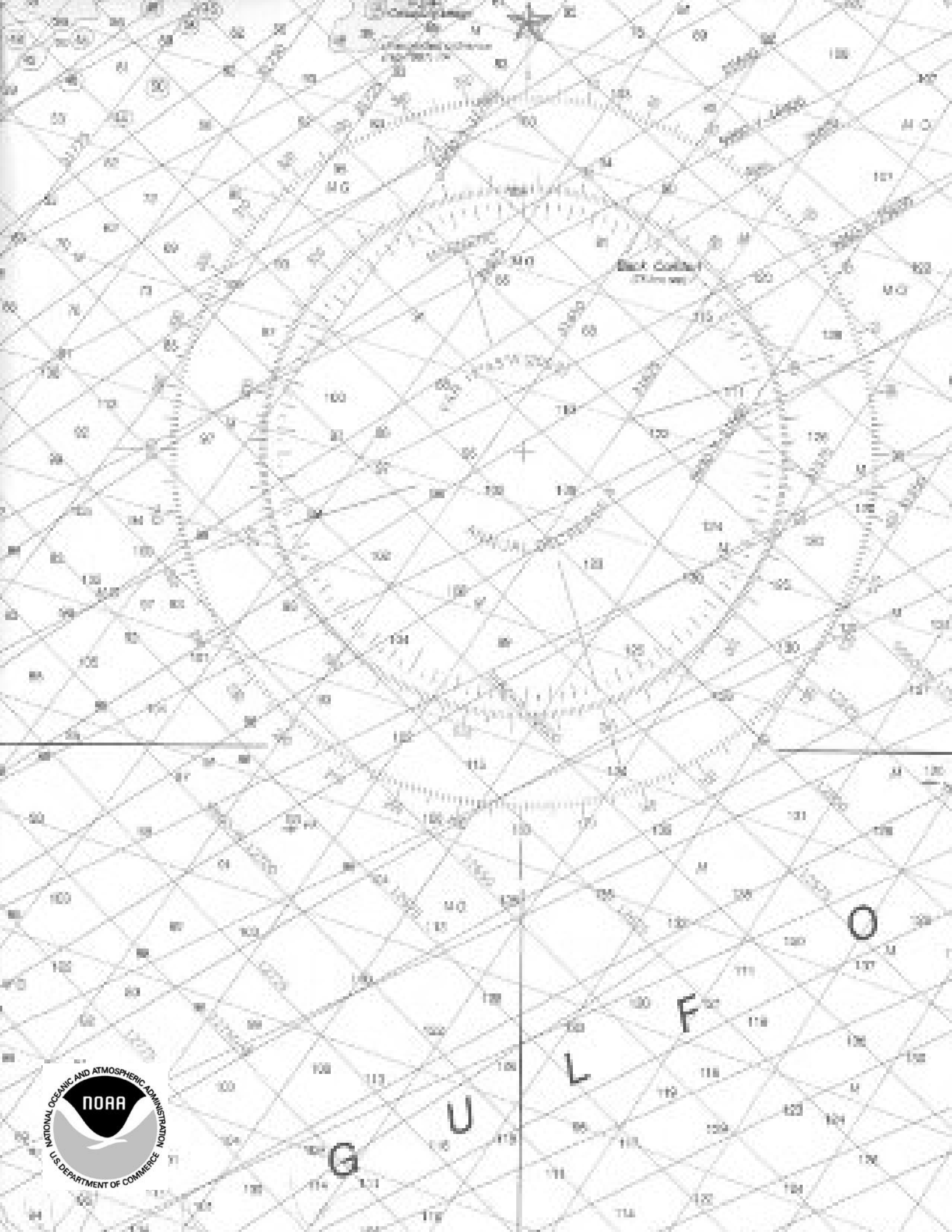
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