Summary of Completed Collaborative Research Projects funded by Northeast Consortium

Volume 2 of 3

Herring • Jonah Crab • Lobster
Ocean Quahog • Red Crab • Scallop
Sea Cucumber • Sea Urchin
Shrimp • Tuna

2000 – present
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 collaborative 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 publication summarizes funded collaborative 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 updated periodically, it will grow 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 collaborative 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 collaborative research in the Northeast region.

Sincerely,

Dr. Chris Glass
Director and UNH Representative
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Definition of Abbreviations
Title:
Atlantic herring stock discreteness and migration: A coded microwire tagging pilot project in the Gulf of Maine

Funding:
2001 - $24,926
(PD Award)
2004 - $212,080

Participants:
Kohl Kanwit (MEDMR), Mark Bichrest (F/V Jennifer and Emily), Danny Fill (F/V Western Venture), Steve Gough (F/V Western Wave), David Libby (MEDMR), Barry Matthews (F/V Ocean Venture), 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 U. S. 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 in the 1960s. The project complemented an existing tagging effort, using coded microwire tags to mark pre-spawning aggregations of herring on Jeffrey’s Ledge in the Gulf of Maine. These tags were selected as the best option for tagging herring, because they are less invasive, result in high retention rates, and allow automated tag detection.

Field methods for obtaining live herring and tagging them with micro-wire proved successful. However, there were difficulties with the tag recovery process. The conclusion reached by MEDMR, Stinsons 2001 Ltd., and various industry members was to abandon the microwire tagging project and initiate a more conventional anchor tagging program for Atlantic herring beginning in the spring of 2003 and incorporated most of the equipment and expertise gathered from the work conducted in 2001-2002. The anchor tagging project began through the sole support of the herring industry. Funding was awarded in 2004 by the Northeast Consortium for an expansion of the project to include tagging on Georges Bank and Southern New England. Project partners continued work in 2006 using residual funds and industry contributions.

Results reveal two major findings: Atlantic herring can be tagged and recovered in meaningful numbers in the context of a modern, mobile gear pelagic fishery pursued offshore, and there is apparent and appreciable intermixing of the western portion of the Nova Scotian herring stock (4X) in both the Gulf of Maine and Southern New England. The first point is noteworthy, because tagging studies on the U. S. coastal complex of Atlantic herring using anything but weir caught fish have only realized limited results mostly related to short-term and short-distance migration patterns. The second point is an important finding, because the U. S. coastal complex and the Nova Scotian complex are currently assessed separately and any intermixing or straying between stocks is considered minimal and insignificant.

Project results for the basis of one article published in scientific literature.
Title:
Commercial vessel acoustic survey of coastal herring spawning units

Funding:
2000 - $168,900
2001 - $130,215
2002 - $205,985
2003 - $198,180
2004 - $168,900
2005 - $192,919

Participants:
John Annala (GMRI), Lendell Alexander (F/V Jennifer & Emily; Harpswell, ME), Brian Bichrest (F/V Safe Haven; Harpswell, ME), Mark Bichrest (F/V Jennifer & Emily), Matthew Cieri (MEDMR), Steve Gough (F/V Western Wave; Prospect Harbor, ME), Andrew Johnston (GMRI), Alden Leeman III (F/V Jennifer & Emily), 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), Daniel Salerno (GMRI), Kevin Scheirer (GMRI), Patrick Sullivan (CU), 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 since 1998. The project has attempted to estimate the biomass of herring spawning in these waters 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 evaluation, 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. Results of the peer evaluation were presented to the NEFMC and the ASMFC in May 2005.

Several project participants have sat on NEFMC PDTs and Advisory Committees for herring over the years and have contributed much empirical knowledge about the distribution and abundance of inshore herring to the management process. Prior to the peer evaluation, data from the acoustic survey had been cited in SAFE reports. Since the peer evaluation concluded that the survey to date could not be considered a consistent time series of stock assessment data, the data has been used more qualitatively. The 2006 TRAC report discussed the use of “commercial acoustic survey biomass estimates” (GMRI acoustic survey data) as one of the three sources of information on relative proportions of the inshore and offshore components:

“The relative proportion of the inshore component of the overall herring stock complex was 18% based on the average proportion from three different data sources (commercial acoustic survey biomass estimates; morphometric studies; and NEFSC autumn survey swept biomass estimates).”

Additional funds were secured from the Northeast Consortium in 2005. The peer evaluation panel’s recommendations were incorporated into the work, with surveys focused on identifying and quantifying “sentinel” spawning grounds. In fall 2006, the survey monitored the location, timing and biomass levels of prespawning and spawning aggregations of Atlantic herring on Jeffreys Ledge and the associated nearshore area. Seven systematic parallel transect surveys were conducted and fish aggregations were sampled with a mid-water trawl net to confirm species identification and to collect biological samples.

Herring were seen in all portions of the study area during most of the survey except on the northern portion of Jeffreys Ledge where no fish were encountered. Total biomass levels remained relatively low (8974 – 33,095 mt) from August through the end of October but increased three fold (99,488 mt) in early November. Prespawning biomass was highest in late August and early September and then dropped to nothing at the end of October. Spawning herring were first encountered in mid-September. Spawning biomass peaked in mid-October and dropped dramatically through early November. This survey was able to capture the complete spawning event. However, the low biomass levels encountered indicate that the area surveyed was not a key area for Atlantic herring spawning in 2006.

The Northeast Consortium has conducted a technical mail evaluation of the FY2005 project, the results of which were submitted to the NEFMC and ASMFC in December 2007.
**Jonah Crab**

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

**Funding:**
2002 - $25,000 (PD Award)

**Participants:**
Carl Wilson (MEDMR), Robert Alley Sr. (F/V Irene Renee I; 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 EFP to be issued to 1000 lobster harvesters in Lobster Management Area 1. The EFP allows participants to develop a targeted Jonah crab trap designed to reduce or eliminate lobster bycatch. The MEDMR 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, ASMFC and NMFS to make informed decisions on the utility of a directed crab trap and/or fishery.

The results of this research formed the basis of a graduate thesis and an article in preparation for publication in scientific literature. The Northeast Consortium has facilitated a technical mail evaluation of this project, the results of which were submitted to the MEDMR in March 2007.

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**Title:**
*Distribution and abundance of Jonah crabs, Cancer borealis, in the near-shore Gulf of Maine*

**Funding:**
2002 - $128,371

**Participants:**
Carl Wilson (MEDMR), Yong Chen (UMO), Larry Knapp (F/V Lady Esther; Boothbay, ME), Oscar Look III (F/V Mary Lou and Kendra; Beals Island, ME), Brian McLain (F/V Silver Bullet; New Harbor, ME), Brent Oliver (F/V Jarsulan III; Stonington, ME), Kathleen Reardon (MEDMR), Rob Russell (MEDMR), Stanley Sargent (F/V Gale Warnings; Milbridge, ME), and Art Vuilleumier (F/V KEEP-AH; South Portland, ME)

**Summary:**
Jonah crab (*Cancer borealis*) has been a traditional and unregulated by-catch of the Maine lobster industry. Little is known about adult *C. borealis* biology and ecology, making the development of assessment and management approaches difficult. Much of the information available on the distribution and abundance of this species was gathered from bottom trawl surveys. Unknown gear selectivity of these survey programs with respect to crabs, and associated gear limitations in complex habitats make interpretation of these results problematic. In the spring of 2004, the MEDMR collaborated with fishermen to complete an experimental video survey in the nearshore Gulf of Maine. Complex bottom habitat, shallow water, eastern survey locations, and season all contributed to the distribution patterns observed. Abundance estimates from the video survey are confounded by the relatively small area sampled at each location. The relative abundance and spatial distribution patterns of this survey did not agree with other surveys conducted in Maine inshore waters, due to the strengths and weaknesses of each survey.

There remains a need to accurately document the patterns of distribution and abundance of crabs within the Gulf of Maine. Continued development of a video survey remains a likely candidate, as this methodology allows surveying of complex bottoms at depth. However, problems with area surveys and levels of detection in complex bottom should be resolved first.

The results of this research formed the basis of a graduate thesis and an article in preparation for publication in scientific literature. The Northeast Consortium facilitated a technical mail evaluation of this project, the results of which were submitted to the MEDMR in March 2007.
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

Funding: 2001 - $111,972

Participants:
Jonathan Grabowski (GMRI), 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 (UNE), and Carl Wilson (MEDMR)

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 and 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.

The Northeast Consortium has facilitated a technical mail evaluation of this project, the results of which were submitted to the ASMFC in December 2006. Data has formed the basis of two articles published in scientific literature.

Title: Depth-related settlement patterns of the American lobster in the Gulf of Maine and Southern New England

Funding: 2004 - $25,000 (PD Award)
2006 - $264,735

Participants:
Rick Wahle (UMO), Charlene Bergeron (UMO), Rich Crowley (Bigelow), Norbert Lemieux (F/V Christina-Marie; Cutler, ME), John O’Leary (F/V Captain Bligh; Wakefield, RI), Matt Parkhurst (F/V Sea Spray; Boothbay Harbor, ME), and Carl Wilson (MEDMR)

Summary:
For more than two decades, the American Lobster Settlement Index has been a useful indicator of year class strength in New England, and in the last year has been elevated to the status of a Reference Point for the health of the lobster fishery. To date, monitoring has been limited to diver-based sampling in shallow waters. Passive postlarval collectors permit the expansion of sampling capabilities into areas beyond the limits of diving, thereby enhancing its ability to inform lobster stock assessment and recruitment models. This project’s primary objective, therefore, was to use passive postlarval collectors developed earlier with NEC seed support (FY2004) to evaluate the depth-wise distribution of recently settled, young-of-year (YoY) and older juvenile lobsters in three oceanographically contrasting regions of the Gulf of Maine (GOM) and southern New England shelf (SNE). In 2007 and 2008, 300 cobble-filled collectors were deployed at three depths (10-20, 30-50, and 70-80 m) in eastern and midcoast Maine, and Rhode Island. Water column thermal structure was described at all three regions. The project extended into a third year with the first exploratory deployment of 120 collectors on Georges Bank. In all, the pattern of depth-wise settlement was strongly linked to the degree of thermal stratification: in stratified regions, such as the western GOM and SNE, larval settlement was concentrated within the shallowest strata. In well mixed regions such as the eastern GOM, in contrast, larval settlement spread uniformly over the depths, and was generally lower overall. No settlement was detected in pilot deployments on Georges and Platts Banks. Settlement in collectors compared favorably with suction sample-based samples collected at the same depth and location. Because the collectors proved effective at sampling a number of other invertebrates and fish species, there may be potential application in biodiversity studies.

The unique feature of this project is the widened collaboration it inspired with other scientists and harvesters in New England, Atlantic Canada, and Europe. The collective effort more than quadrupled the number of collectors deployed, and achieved an unprecedented spatial coverage from Newfoundland to Rhode Island. As the largest synoptic survey of its kind to date, the project dramatically expanded the limits of our knowledge of lobster recruitment processes, and further demonstrated the synergies realized through collaborative research. Project results have formed the basis of one article published in scientific literature.
Title: Designing and testing a sublegal lobster sampling trap

Funding: 2005 - $24,739 (PD award)

Participants:
Robert Bayer (UMO), Joseph Chalmers (Southwest Harbor, ME), William Gongleton (UMO), William Fike (UMO) and John Riley (UMO)

Summary:
While there are many different methods for collecting data concerning the lobster fishery, the quantity of data is inadequate and contains gaps with respect to the lobster life cycle. Sampling smaller younger lobster gives additional time to respond to any changes observed in the lobster population. Because of the lack of data for juvenile lobsters, new means are necessary to collect information. A sublegal lobster sampling trap was designed, created and tested to assist in the collection of data. This trap allows sublegal sized lobster to enter without allowing legal sized lobster to enter. Several entry sizes were tested on various substrates. The results were compared with those from a ventless trap and showed that the sampling trap caught lobsters that were smaller on average than those caught by the ventless trap. It is believed that the presence of large lobsters inhibits the smaller lobsters from entering the traps. Therefore, the smaller lobsters are not adequately sampled by ventless traps containing large lobster. A different sampling trap from the ventless trap can fill a gap in data being collected at an earlier stage in the lobster life cycle.

Title: Determining the effect of eastern Maine bottom currents on groundlines

Funding: 2006 - $25,000 (PD award)

Participants:
Laura Ludwig (GMLF), Sara Ellis (GMLF), Chris Heining (MERAC), Oscar Look III (F/V Time-n-Tide; Beals Island, ME), and Neal Pettigrew (UMO)

Summary:
The effect of bottom currents on lobster gear were examined in nearshore eastern Maine waters, to establish whether bottom currents there are strong enough to significantly reduce the profile of floating rope used as groundline between traps, thus reducing the risk of whale entanglements in lobster gear. Datasets from three measuring devices were collected during five months of field-work. Depth and groundline height data was extrapolated from Star-Oddi pressure sensors deployed on a 20-trap trawl each month; current velocity and directional data was recorded by a Sensor Data 6000 current meter deployed near the lobster trawl; and three months' worth of data from acoustic Doppler current profilers (ADCP), rigged in a customized 3' lobster trap directly into the trawl, gave more detailed information about the velocity and direction of current acting on the groundline. Assessment of the current meter data indicates that the current off Jonesport, Maine – where all the equipment was deployed -- measured at the bottom of the ocean on level with the traps (1-2m off bottom), is often over 30 cm/sec and has little to no “slack” period between tides. Analysis of the sensor data showed the floating groundlines at or below 2m (one fathom) of arc height over a 20 fathom length, and overall the measurements suggest that the flow of current is significantly stronger near the ocean bottom than anticipated, which would tend to depress the floating line more than would be estimated assuming much lower flows.

Title: Development of an alternative bait for the American lobster industry

Funding: 2003 - $132,997

Participants:
Robert Bayer (UMO), Herbert Hodgkins (Lobster Products, Inc.), Manildra Group (Australia), Patricia Pinto (Saltwater Marketing, LLD; Portland, ME), and Ron Rompala (Blue Seal Feed, Inc.; Londonderry, NH), and several commercial fishermen

Summary:
This project developed an effective formula for a soy-based lobster bait. Initial studies using polymer carriers for the bait revealed that this carrier was too costly and cumbersome to be market-friendly. The bait was then converted from its mealy paste-like consistency to a pellet form, striving to achieve the appropriate leaching and longevity characteristics needed for successful lobster bait. Lobstermen were recruited to boat-test these pellet prototypes to observe their efficacy under commercial fishing conditions. The efficacy of the bait in its paste-like form was not reproducible. An appropriate binder-attractant combination was sought. Work continued with funding from a Maine Technology Institute grant received by Saltwater. Blue Seal Feeds were partners. Fishermen were recruited from Beals Island to Kittery to test the product as it evolved. As a result of this project, a commercial bait product, Clawdia’s Secret, was launched in October 2007 and is currently being sold by Blue Seal Feeds. The bait extender lasts 12-14 days and is used in combination with fresh bait.
Title: Implementation of an automated, comprehensive monitoring program for the Atlantic offshore lobster fishery

Participants:
Win Watson (UNH), 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 (AOLA)

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 Georges 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.

Project data has formed the basis of four articles in scientific literature (two published and two under review).

Title: Influence of water temperature on the distribution of berried females and duration of egg development in American lobsters

Participants:
Win Watson (UNH), Diane Cowan (TLC), Jason Goldstein (UNH), Bonnie Spinazzola (AOLA), Michael Tlusty (NEA), nine graduate and undergraduate students (UNH), and 24 commercial lobstermen from Maine to Rhode Island

Summary:
The continued success of the North American lobster fishery is largely attributed to a high degree of brood stock conservation through the preservation of berried (egg-bearing) females. The goal of this study is to test the hypothesis that berried lobsters undertake seasonal migrations, moving offshore during colder months and inshore during warmer months, in order to expose their eggs to a thermal regime that optimizes egg development and maximizes the survival of larvae. Berried lobsters were tagged, released, and monitored for both their movements and thermal history. All field studies were carried out in cooperation with commercial lobstermen who fished in NH, Maine and offshore waters.

Initial results of large-scale tracking from two seasons combined indicates a trend by some inshore lobsters in maximizing degree days by moving short distances (5-10 km) offshore where eggs are subject to minimal degree days below 4°C, a physiologically restraining temperature for positive egg development. In contrast, a select number of large female lobsters (>100 mm CL) appear to be moving larger distances (>15 km) from inshore to offshore locations in an overall south-southwest direction. These initial results confirm that lobster movements do influence the temperatures experienced by developing eggs. Ongoing data analyses coupled with current ultrasonic tracking laboratory studies should help determine the extent to which large movements actually enhance egg development and larval survival.

The Northeast Consortium conducted a technical mail evaluation of this project, the results of which were submitted to the ASMFC in February 2008.
Title: Inshore/offshore patterns of lobster larvae and postlarvae spatial relationships
Funding: 2001 - $142,453

Participants:
Lew Incze (USM/GMRI), 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 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.

Project data has contributed to five articles published in scientific literature. More specific research has continued on egg production, circulation modeling, settlement, growth, and fisheries production. It is conducted by L. Incze and ten co-PI’s and is funded by NMFS Coastal Ocean Program. The Northeast Consortium completed a technical evaluation of this project in September 2010.

Title: Mapping spawning and hatching grounds of the American lobster
Funding: 2002 - $260,000
2004 - $105,175

Participants:
Diane Cowan (TLC), Andrew Solow (WHOI), Win Watson (UNH), 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.

The Northeast Consortium facilitated a technical mail evaluation of this project, the results of which were submitted to the ASMFC in January 2007. Project data has formed the basis of one article and one book chapter published in scientific literature.
**Title:**
Random stratified ventless trap survey design for pilot study in Massachusetts Bay

**Participants:**
Robert Glenn (MADM), John Barrett (F/V Susan T; Norwell, MA), John Carver (South Shore Lobstermen’s Association), David Casoni (MALA), Susan and Jay Michaud (F/V International Harvester; Marblehead, MA), Fred and Wes Penney (F/V Curmudgeon; North Billerica, MA), Derek Perry (MADM), Tracy Pugh (MADM), Skip Ryan (F/V Finest Kind; North Quincy, MA), David Scarpitti (MADM), Stefanie Stielow (MADM), Steven Voss (MADM), and Steven Wilcox (MADM)

**Summary:**
This survey was designed to generate robust estimates of lobster relative abundance. Two additional components, sediment verification and tagging calibration, were incorporated to ensure data quality and appropriate interpretation of ventless catch data. The Massachusetts Bay study area was stratified by depth and bottom substrate; 80 stations were randomly selected. Each of these stations was sampled with a six trap trawl composed of vented and non-vented traps, which were hauled twice monthly from May through November in 2005 and again in 2006. Biological data were collected for every lobster observed. Sediment verification was conducted at each of the 80 stations, using an underwater camera. Multiple photos were taken at each station and analyzed based on percent cover of sediments present. The tagging calibration study took place at a subset of the ventless trap sampling stations. Cinch-up tags were applied to lobsters at 41 stations in June, August, and October of 2006, as well as October of 2005 (pilot effort). Recapture data were analyzed for short term movement information and recaptures in the survey gear for calibration of ventless abundance estimates.

Results of the sediment verification project led to re-classification of the ventless sampling stations, based on newly defined strata (three depth ranges and two substrate types). Tagging results suggested that recaptures were too low (1.4%) to warrant calibration of the ventless abundance estimates. Ventless trap survey data analyses were based on 42,911 lobsters in 2005 and 58,561 lobsters in 2006. Non-vented traps had higher catch rates than vented traps; most of the catch in non-vented traps was composed of sublegal (< 83 mm CL) lobsters. The size distribution of lobsters generally shifted towards larger lobsters in deeper strata, but showed no trends with respect to bottom type. Patterns observed in the sex ratio of lobsters appeared to be related to demographics; male dominated areas occurred inshore and especially inside Boston Harbor, while females tended to dominate at stations further offshore. The percentage of females bearing eggs generally increased with depth, and the pattern of v-notched females was similar. Catch rates of both sublegal and legal lobsters varied significantly by strata (depth and substrate) both years. The most obvious trends were that sublegal catch tended to decrease with increasing depth, while legal catch increased with increasing depth. Catch rates of both size ranges of lobsters also appeared to be dependent on both strata and season, and there was a significant interaction. More detailed patterns in catch are difficult to discern with only two years of data.

The success of this project has led the Lobster Technical Committee of the ASMFC to adopt the survey methodology for use in a coast-wide effort to enhance the way lobsters are monitored. The Northeast Consortium facilitated a technical evaluation of this project, the results of which were submitted to the ASMFC December 2010.

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

**Participants:**
Carl Wilson (MEDMR), Michael Bell (Lowestoft Laboratory, United Kingdom), David Boegel (F/V Kathleen; Monhegan, ME), Robert Bracy (F/V Pandora; Monhegan, ME), Yong Chen (UMO), Lucas Chioffi (F/V Fenris; Monhegan, ME), Ross Claytor (Bedford University, Nova Scotia), Dan Murdock (F/V Sylvia Anne; Monhegan, ME), Sherman Stanley (F/V Legacy; Monhegan, ME), Mathew Thomson (F/V Shearwater II; Monhegan, ME), Rick Wahle (Bigelow), Matthew Weber (F/V Griffin; Monhegan, ME), and Tom Weber (UNH)

**Summary:**
Four experimental trapping areas were established within the Monhegan Island Lobster Conservation Area (MILCA) 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 relative 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. Methods were successfully developed to allow 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, providing reliable estimates of recapture through the course of the experiment.

This project development award lead to the application of the methodologies to a larger experiment within the MLCA, funded in 2004. This involves seven fishermen and 1,500 traps placed at different densities in eight 1 km² experimental areas. Two manipulative trapping experiments were conducted within the MLCA during September - October 2005 and August - September 2007. In addition, the MILCA fishery was evaluated with respect to annual catch, trap hauls, maximum trap limits and season length through daily harvester logbooks. The objectives of the trapping studies were to test the impact of trap density on catch rates and the cumulative catch, and to determine the relationship between soak time and catch rates. In 2005, catch rates for medium (167 km-2) and low (50 km-2) trap density areas always exceeded those of high (500 km-2) trap density areas. Catch rates for all areas paralleled an increase in lobster abundance, determined by independent video monitoring, over the course of the study. The cumulative catch found in high trap density areas was 16 and 68% higher than medium and low density areas respectively. However, soak times in medium trap density areas could have been decreased to compensate for losses in total catch. Migration within the MILCA, as measured by recapture rates in trapping areas, suggest that in excess of 90% of lobsters moved out of the areas within eight days after initial capture. In 2007, the impact of soak time on catch was non-linear and indicates that a maximum catch for traps with reduced competition from other traps is 4.2 times higher than is observed in the surrounding Maine lobster fishery. The extension of the MILCA season by two months and reduction of the maximum trap limit from 600 to 300 traps following the 2006/2007 season resulted in a median 72 and 67% increase in landings for MILCA participants in the two seasons following the change. These studies suggest the current Maine lobster fishery could reduce traps with little impact on total catch, but the level and spatial extent of any reduction would need to be matched to the annual movements of the lobster resource and fishery.

The work is benefitting lobster management, increasing knowledge of how trap numbers impact the lobster population and associated fishery. Several communities are interested in conducting similar studies. The Northeast Consortium facilitated a technical evaluation of this project, the results of which were sent to the ASMFC June 2011.

**Title:** Ventless Trap Survey (VenTS)  
**Funding:** 2003 - $13,513 (PD Award)

**Participants:** Patrice McCarron (GMLF), Erin Pelletier (GMLF), and 47 lobstermen from Maine and Massachusetts

**Summary:** The Ventless Trap Survey (VenTS) was established in Canada and the US 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 GMLF manages the U.S. portion of the project. The purpose of this Northeast Consortium 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 catch data 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.
**Title:** Workshop to plan the evaluation of community hatchery-based lobster enhancement  
**Funding:** 2005 - $23,294 (PD Award)

**Participants:**
Ted Ames (PERC), Robin Alden (PERC), Kevin Atherton (UMO), Brian Beal (UMM), Kathleen Billings (Stonington Fisheries Alliance), Glen and Joel Billings (commercial lobstermen), Kenneth Bovee (University of Pennsylvania), Foy Brown (commercial lobsterman), Dick Bridges (Deer Isle Lobster Co-op), Butch and Lance Ciomei (commercial lobstermen), Stan Cobb (URI), Joseph Crivello (UCT), Louise Gendron (DFO), Frank Gotwals (Stonington Lobster Co-op), Jeff Eaton (commercial lobsterman), Irv Kornfield (UMO), Dick Larrabee (commercial lobsterman), Steve Robbins III (commercial lobsterman), Steve Rosen (commercial lobsterman), David Tarr (commercial lobsterman), David Towle (MDIBL), Paul Venno (commercial lobsterman), Rick Wahle (Bigelow), Nora Warren (commercial lobsterman), Carl Wilson (MEDMR), and Kristen Wilson (UMO)

**Summary:**
This project funded the two-day Collaborative Lobster Enhancement Evaluation Workshop in April 2006 to develop a strategy to measure the success of the Zone C Lobster Hatchery, which was created in early 2006. What resulted was a consensus recommendation that a Before-After-Control-Impact (BACI) design would address short-term goals of survival, and that a combination of late-stage tagging and genetic marking would address long-term goals of the hatchery's impact on lobster populations. The workshop also recommended a limited scale experiment comparing survival rates of Stage IV and Stage V or older lobsters. All recommendations were outlined so that they could later be developed into full research proposals.

The workshop was a significant step in developing plans for research. Participants felt that the meeting was successful, because it was collaborative. It has evolved into an annual meeting, drawing all who are interested in the hatchery and its work.

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**Title:** Gulf of Maine ocean quahog (Arctica islandica) assessment  
**Funding:** 2001 - $23,326

**Participants:**
Dan Schick (MEDMR), 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. Baseline 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. It was determined that a dredge-efficiency study was needed before an absolute biomass for the resources could be calculated.

The research has continued with funding from a tax dealers pay on each bushel of quahogs that they purchase. This includes additional surveys of the stock of quahogs and research on dredge efficiency, data from which is being used in conjunction with NMFS data in a current collaborative assessment of the status of the stock of ocean quahogs. This has given Maine an active role in the management of this stock. The Northeast Consortium facilitated a technical mail evaluation of this project, the results of which were submitted to the MAFMC in September 2006. The data has provided the scientific justification for fishing quota levels in Maine.
Red Crab

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

Funding:
2001 - $113,000
2002 - $24,928
2003 - $274,132

Participants:
Richard Wahle (Bigelow), Yong Chen (UMO), and Jon Williams (Benthic Fishing Corp.; Westport Island, ME)

Summary:
The four main objectives of this project were to: (1) Employ camera-based and net-trawl sampling methodology established by an earlier NMFS red crab surveys (Wigley et al. 1975) to determine whether abundance, size structure, and sex composition of the population has changed significantly at the same sites sampled in 1974, (2) Conduct sea sampling to better characterize the commercial catch, (3) Conduct tagging to obtain much needed information on red crab growth rates and movement, and (4) Develop three stock assessment modeling approaches of different complexities (size-structured yield-per-recruit model, production model, and size-structured simulation model) to evaluate the dynamics of the red crab stock, estimate current status of the fishery, and evaluate alternative management strategies. Supplemental project development support was used to compare the efficacy of otter-trawl to beam trawls in this application.

The camera and otter trawl collections generated the first population density estimates and demographic data of red crab in 30 years. The supplemental comparison of the two net trawl methods confirmed that otter trawls were the most efficient approach in these surveys. Results of the main project indicated that the abundance of the largest crabs (males >114 mm, 4.5 inches) targeted by the fishery is down by approximately 42% since 1974. Based on at-sea sampling by the commercial fishing crew, the fishery now harvests smaller male crabs, and our camera/net surveys estimate that the standing biomass of crabs of this size is on a par with 1974 levels. The abundance of even smaller males and females is estimated to be substantially higher than in 1974. Some 9600 crabs were tagged over the course of the study, and of about 300 returns there was little evidence of growth, which is consistent with prior evidence of slow growth for this species. However, the limited growth data curtailed application of the stock assessment models. The full parameterization of these models awaits additional growth data. Models are implemented as Excel spread sheets that and are available from the PI, and will be easy for the user to update as data become available.

These results were a key component of the NMFS red crab stock assessment conducted in 2006, the first full assessment for this species since 1977. The project director led the writing of stock assessment report with the assistance of NMFS and NEFMC staff. Project results also form the basis of one article published in scientific literature.

Red Fish

Title:
Evaluating the practicality and economic viability of a pilot Acadian redfish (Sebastes fasciatus) jig fishery

Funding:
2009 - $29,454

Participants:
Steve Eayrs (GMRI), Adam Baukus (GMRI), Kristen Garabedian (GMRI), Jayson Joyce (F/V Andanamra; Swan’s Island, ME)

Summary:
The goal of this project was to explore the potential revival and development of a redfish fishery in downeast Maine using automatic jigging machines. Redfish are currently an abundant and under-utilized species. The redfish allocation for 2010 was 6,848 tons, but only 1,587 tons were harvested as of April. Redfish could offer fishermen an alternative target when quota of other species is running low, or is at a low market price. The goal of this project was to determine if a profitable commercial fishery for redfish could be established using electronic jigging machines. The project was broken down into two areas, a field research component, and a
market research component. The objectives of the field research component were to: demonstrate potential daily catch rates of redfish; determine optimal hook size and shape for catching legal size redfish; and assess levels of bycatch using jiggling machines. The objectives of the market research component were to: investigate the level of interest and obstacles in serving redfish in local restaurants; and identify factors that are most important in determining the popularity and the price for redfish.

There are still many uncertainties involving the redfish fishery and its recovery. Current knowledge of redfish distribution is limited, with historical ranges potentially contracted, or highly seasonal. Knowledge of size and age class structure is often biased by sampling method and gear type. The resiliency of redfish stocks to fishing pressure is also unclear. NAFO reports show that regulating mesh size isn’t always the answer, as smaller mesh leads to increased catch, but not necessarily of smaller size classes. This suggests significant amounts of legal sized fish are escaping, and likely lost to barotrauma mortality. Underwater tagging techniques for mark and recapture studies may be a good tool to help us learn about distributions and migrations, age structures etc., without killing fish. It is agreed that redfish are currently an abundant resource, but without increased ex-vessel prices and expanded market potential a successful fishery is questionable. Further research is needed to help estimate what fishing practices are sustainable, and how to make progress on the marketing front.

### Scallop

**Title:**
*A collaborative effort to examine new strategies for managing closed bottom habitats for sea scallops*

**Funding:**
2006 - $143,625

**Participants:**
Brian Beal (UMaine Machias), Colon Alley (Jonesport, ME), Jeff Alley (Jonesport, ME), Maurice Alley (F/V First Edition; Beals, ME), Preston Alley (Beals, ME), Raymond Alley (Jonesport, ME), Robert Alley, Jr. (Jonesport, ME), Chris Bartlett (ME Sea Grant), Ernest Kelly, Jr. (Jonesport, ME) and Terry Stockwell (MEDMR)

**Summary:**
Commercial populations of sea scallops, *Placopecten magellanicus*, are at or near record low catch levels in eastern Maine. Three independent field trials were conducted in the Jonesport-Beals region from May 2007 to May 2009 that focused on providing information for fishermen and fisheries managers about the efficacy of using closed bottom areas to enhance commercial populations of these bivalves. The first trial was short-term, and conducted from May to June 2007. Two approximately 1 km² bottom areas were closed to all dragging and diving activities. Bottom plots (15 m x 15 m; n = 8) within each area were seeded at a density of 2.5 individuals/m² using legal and sub-legal size scallops dragged from an area in Englishman Bay, in Jonesport. One-half of the plots in each area received scallops that had been stored for ~7 hours in commercial fish totes (black, plastic units measuring 70 cm x 40 cm x 28 cm deep with holes in the bottom) on board two commercial draggers, while the other half of the plots received scallops that had been held in flow-through containers (modified Xactic box) for the same period of time. The fate of these scallops was followed for thirty days by SCUBA divers. Scallop recovery and survival in all plots in both areas was excellent and independent of handling treatment. In one of the two areas, mean number of scallops recovered on Day 30 from both handling treatments was not significantly different from the initial seeding density. Final recovery was lower at the other area where faster tidal currents occurred that tended to push scallops out of the marked bottom plots.

The second (2007-2008) and third (2008-2009) field trials involved collecting wild scallop spat (juveniles < 20 mm in shell height) using fine-mesh bags similar to those used successfully to collect small scallops of the same species in nearby Passamaquoddy Bay during the 1990’s, and in the Northumberland Strait and surrounding areas of the Canadian Maritimes in the past decade. In addition, materials and methods of deploying spat bags were similar to those used successfully in Japan, Chile, and Northern Europe. The reason for attempting to collect wild spat was for the purposes of enhancing the bottom plots in both closed areas. A total of 1200 bags were deployed in late summer 2007 and 2008, and these were retrieved in the spring of 2008 and 2009, respectively. Each year, one half of the bags were placed on the eastern and western side of Great Wass Island, in the town of Beals. On each side of the island, one-half of the bags were deployed in shallow (< 20 m) and deep (>30 m) water. Less than 40% of the gear was retrieved in both years. In May 2008, number of spat per bag averaged 2.8 ± 0.43 individuals (n = 460 bags). Recruitment was approximately
6.5x higher in May 2009 (18.6 ± 2.04 individuals per bag; n = 383 bags). In May 2008, scallop density per bag was significantly higher and scallop size was significantly greater on the western vs. eastern side of Great Wass Island. In May 2009, no significant difference in scallop density was observed between sides of the island, but scallop size remained higher on the western vs. eastern side. In both years, more scallops settled into bags deployed in deep vs. shallow water. These results are in stark comparison to the work of others in the Canadian Maritimes where > 3,000 spat have been collected in similar size bags. These results suggest that enhancement of bottom plots is feasible using legal and sub-legal individuals; however, it remains to be seen whether dragging animals from open areas to seed into closed bottom areas is a sustainable activity. The discouraging results from spat collection trials suggest that commercial scallop populations are recruitment-limited and that, at least in the Jonesport-Beals area, other methods to collect wild spat or produce culture spat should be explored.

The Northeast Consortium is facilitating a technical evaluation of this project.

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**Title:**

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

**Funding:**

2000 - $135,000

**Participants:**

Scott Gallager (WHOI), 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 (NMFS NEFSC), Paul Rosonina (Captain, F/V Kathy Marie; New Bedford, MA), and Richard Taylor (Commercial fisherman; Gloucester, MA)

**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 8 mm after six 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.

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**Title:**

*Design and preliminary testing of an innovative scallop dredge*

**Funding:**

2004 - $25,000 (PD Award)

**Participants:**

Cliff Goudey (MIT), Dave Bergeron (MFP), Michael Pol (MADMF), Paul Tasha (Commercial diver; Provincetown, MA), and Louis Williams (F/V Pretty Girl; Swampscott, MA)

**Summary:**

This project aimed to develop a habitat-friendly scallop dredge. Laboratory studies were conducted to better understand the way in which hydrodynamic flows generated by various shapes, when passed over a scallop, can lift the scallop and render it vulnerable to capture. Tests were done in the MIT Ocean Engineering tow tank and promising results were implemented in a prototype dredge design. Preliminary fishing trials, followed by in-situ video observations, confirmed the tow tank results and revealed the promise of a more habitat-friendly approach to harvesting scallops.
Title: Development of an off-bottom scallop drag

Participants:
David Autio (Commercial fisherman; Medomak, ME), Phil Averill (Ocean Adventure, Inc.; Bristol, ME), Scott Feindel (MEDMR), Frank Gentner (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

Participants:
Dana Morse (MESG), 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 4" (101.6 mm) diameter rings used in a scallop drag, as compared to a drag rigged with the regulation-sized 3.5" (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 3.75" to 4.00" 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 4.00” 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, the Northeast Consortium and others. Video clips, photos and the final report are available from the MESG web site: http://www.seagrant.umaine.edu/extension/fisheries/scalring.htm.

The Northeast Consortium has facilitated a technical mail evaluation of this project, the results of which were submitted to the NEFMC in May 2007.

Title: Maine scallop fishery: Monitoring and enhancement

Participants:
Dan Schick (MEDMR), Marsden Brewer (Commercial fisherman; Stonington, ME), Wallace Gray (F/V Foxy Lady; Stonington, ME), Scott Fiendel (MEDMR), Dana Morse (MESG), Craig Pendleton (NAMA), and several other scientist and commercial fishermen

Summary:
The concern over the steady decline of scallop landings in Maine since the early 1990’s 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 MEDMR. 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 the Maine Scallop Research Fund (supported through annual licensed fees) and an industry-led advisory council to oversee the fund. A GIS database has been initiated of suitable spat collection areas. Scientific support for enhancement activities is being provided, including evaluation of reseeding in the form of diver surveys, tagging, and outreach. The scallop survey has continued, with enhancement efforts and port and sea sampling activities. The fund sponsored an international scallop enhancement workshop in February 2005 held in Ellsworth, ME to lay the foundation for next steps in scallop enhancement along the Maine coast.

The Northeast Consortium facilitated a technical evaluation of this project, the results of which were submitted to the NEFMC in August 2006. Project data has formed the basis of an abstract published in scientific literature.

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<th>Title</th>
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<tr>
<td>Non-invasive, real time assessment of sea scallop abundance and habitat</td>
<td>2001 - $220,000</td>
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<th>Participants:</th>
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<td>John Howland (WHOI), Arnie DeMello (F/V Kathy Marie; New Bedford, MA), Scott Gallager (WHOI), Harlyn Halvorson (University of Massachusetts, Boston), Paul Rago (NMFS NEFSC), Paul Rosonina (Captain, F/V Kathy Marie; New Bedford, MA), Hanumant Singh (WHOI), Ron Smolowitz (Fisheries Survival Fund), Richard Taylor (Commercial fisherman; Gloucester, MA), and Page Valentine (USGS)</td>
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<td>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 NMFS scallop survey. With contiguous blocks of samples, we can determine if the variance of density from quadrant 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 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.</td>
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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 U.S. 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.

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<tr>
<td>Saco Bay scallop stock assessment</td>
<td>2002 - $25,000</td>
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<th>Participants:</th>
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<tr>
<td>Craig Pendleton (NAMA), Heather Deese (NAMA), Scott Feindel (MEDMR), Dana Morse (MESG), Dan Schick (MEDMR), Steve Zeeman (UNE), and 20+ commercial fishermen</td>
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<td>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, university scientists, and NAMA 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 (&gt;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, building on two years</td>
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of spat collection and reseeding focused 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 scientists.

The Northeast Consortium facilitated a technical evaluation of this project, the results of which were submitted to the NEFMC December 2010.

### Sea Cucumber

<table>
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<th>Title:</th>
<th>Funding:</th>
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| An evaluation of the Maine sea cucumber (Cucumaria frondosa) resources and impacts of exploitation | 2002 - $25,000 (PD Award)  
2003 - $165,645 |

| Participants: |  
Yong Chen (UMO), Peter Collin (Coastwide Bio Resources; Stonington, ME), Scott Feindel (MEDMR), Elena Gudimova (Murmansk State University, Russia), Sheril Kirshenbaum (UMO), David Leach (Commercial fisherman; Steuben, ME), Russell Leach (Commercial fisherman; 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 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. |

Using the approaches developed during the project development award, collaborative research was conducted to (1) survey the sea cucumber resources in major sea cucumber fishing grounds along the coast of Maine; (2) collect biological information of the Maine sea cucumber population; (3) evaluate the impacts of exploitation on the sea cucumber population by conducting a before- and after-fishing comparative study. Through collaborative research, both fishermen and scientists participated in a large-scale survey of the population from 2005 to 2007 in Frenchman and Narraguagus Bays, which yielded more than 90% sea cucumber landings in Maine.

The survey suggests that rock bottom appeared to be the most favorable habitat for the sea cucumber in the survey area and that exploitable stock biomass varied with depth, with sea cucumber more abundant in the shallow waters (< 20 meters). Stock biomass decreased substantially from 2005 to 2006, but was stable from 2006 to 2007. No clear pattern was observed between the experimental plot and control plot for the soft substrates. For the hard substrates, the number of sea cucumber in the experimental plot tended to increase with the time after the dredging depletion in the BACI experiment, suggesting the recovery of sea cucumber density after dredging. This study suggests that the major spawning event of sea cucumber occurs from January to March, but minor spawning events may also occur in other months. Differences in water temperature among different depths and seasons may account for differences in gonad development at different depths.

This project is the first one in this area that systematically studies the sea cucumber biology and fishery. The MEDMR is developing management plan for the fishery using project information. This project has already had real and significant impacts and will have significant long-term impacts on the management of the sea cucumber fishery in Maine.

A graduate thesis and three articles for scientific literature (one published, two in preparation) have been produced from this project.
Sea Urchin

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

**Funding:**
2001 - $23,920 (PD Award)

**Participants:**
Yong Chen (UMO), Robert Grabowski (UMO), Margaret Hunter (MEDMR), 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 density 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.

The model has been tested by a UMO graduate student for use in the sea urchin fishery and found that it could be a tool used for management. An article has been published in scientific literature based on this project.

**Title:**
*Examining fishing practices of divers in the Maine sea urchin fishery*

**Funding:**
2007 - $31,509

**Participants:**
Margaret Hunter (MEDMR), Greg Brown (diver; Steuben, ME), Marcus Jones (F/V Lora Lee Too; Steuben, ME), Kerry Lyons (MEDMR), Pearly MacLean (tender; Steuben, ME), Andrew Preston (culler; Steuben, ME), Rob Russell (MEDMR), and Dale Wright (culler; Steuben, ME)

**Summary:**
Maine’s valuable sea urchin fishery is conducted primarily by divers, who use both size-selective and non-size-selective (“straight raking”) harvesting techniques. Straight raking generally results in high bycatch of small, sub-legal urchins, which are later culled from the catch. Whether the culled urchins survive is unknown. In a collaborative controlled experiment we compared harvest culling rates for the two fishing methods, and tested whether straight-raking negatively impacted the abundance of small, sub-legal-sized urchins, over the short and long terms, as compared with size-selective fishing. Reductions in urchin abundance can also result in an increase in the algae upon which they feed, which in turn can harbor urchin predators and negatively affect urchin recruitment. The project tested whether straight-raking impacts algal cover, as compared with size-selective fishing. Although the results were mixed, size-selective harvesting resulted in fewer short- and long-term negative impacts. The illegal-sized urchins that were harvested during this experiment were replanted on a nearby site and monitored for survival. They survived well for over four months, but abundance had declined by 75% a year later, and the surviving urchins were still not big enough to be harvested legally.

**Title:**
*Testing the effectiveness of various escape panel configurations on urchin drags*

**Funding:**
2004 - $31,509

**Participants:**
Margaret Hunter (MEDMR), Andrew Gowen (independent consultant; New Castle, ME), Steve Patryn (F/V Northern Eagle; Jonesboro, ME), and Everett Roberts (gear builder; Lubec, ME)

**Summary:**
Escape panels have been required on sea urchin drags in Maine since 2003, at the urging of industry, but there has never been any quantitative testing of their effectiveness in releasing small (sublegal) sea urchins. This project tested six different configurations of escape panels, and compared their performance with a control net with no escape panel. Although panel effects varied greatly from place to place, two panel treatments consistently improved the mean size of urchins being retained, when used where urchins were generally small. However, the degree of improvement was variable, and relatively small. Further industry input is needed to determine whether the panels would be cost effective. For draggers who fish on small urchins, escape panels in the bottom or entire back of the drag will provide a modest reduction in the number of smalls in the catch. A formal presentation of these results was made to the Maine Sea Urchin Zone Council in the fall of 2007.
Shrimp

Title: A contemporary assessment of the bycatch of regulated species and the Nordmore grate in the northern shrimp fishery

Funding: 2007 - $84,832

Participants:
Steve Eayrs (GMRI), Adam Backus (GMRI), Vincent Balzano (F/V North Star; Saco, ME), Curt Brown (GMRI), Randy Cushman (F/V Ella Christine; Port Clyde, ME), Andy Lang (F/V Lady Dee; New Castle, NH), Stephen Lee (F/V Kristen Lee; Portsmouth, NH), Kelo Pinkham (F/V Jeanne C.; Trevett, ME), Maggie Raymond (AFM), Dan Salerno (GMRI), Nicole Stephens (GMRI), Joe Wodjenski (GMRI)

Summary:
A data collection program was established to monitor and document the bycatch of regulated groundfish and non-regulated species during the 2008-2009 shrimp season. The catch was sampled from 137 hauls (tows) over a period of 39 days (fishing trips). Initially, four boats were used to collect data, one operating in the waters of northern Massachusetts, one near Boon Is., one in Saco Bay, and another in midcoast Maine. NOAA observers sampled the catch from 106 hauls over 25 fishing trips. The location of each fishing trip sampled by these observers was unknown. GMRI and NOAA data indicated that the shrimp catch comprised almost 96% and 92% of total catch weight respectively. The proportion of regulated bycatch from both data sources was less than 2% of the total catch weight. In 51% of all fishing trips sampled by GMRI, regulated species bycatch averaged less than 1% of total catch weight, including all trips from midcoast Maine. In an additional 33% of fishing trips, regulated bycatch averaged between 1 – 2% of total catch weight. The bycatch of regulated species exceeded 5% of total catch weight in only 5% of hauls, and weighed no more than 55 lbs in any haul. All but one fishing trip sampled by GMRI staff had an average regulated species bycatch of less than 5% per haul. The boat operating in midcoast Maine consistently recorded the lowest proportion of regulated bycatch per haul, while the highest proportions were consistently recorded at Boon Is, particularly in January. Juvenile American plaice comprised almost 50% of regulated species bycatch sampled by GMRI staff. The effect of grate orientation was tested on one boat, but did not appear to alter grate performance. The bycatch of regulated species did not exceed 5% of total catch weight in any haul sampled by NOAA observers. American plaice similarly dominated the bycatch of regulated species, but only represented 27% of the total catch of this bycatch. Grate orientation had little impact on the proportion or composition of shrimp and regulated bycatch in the total catch.

Title: Abundance, migration, and recruitment of northern shrimp in the Gulf of Maine: An industry-initiated verification survey and environmental monitoring pilot project

Funding: 2002 - $319,999
2003 - $250,721

Participants:
Dan Schick (MEDMR), Vincent Balzano (F/V North Star; Saco, ME), Togue Brown (GMRI), Yong Chen (UMO), Stanley Coffin (F/V Bad Penny; Edgecomb, ME), Margaret Hunter (MEDMR); Lew Incze (Bigelow), Dale Page (F/V Aaron & Sarah; Boothbay Harbor, ME), Craig Pendleton (F/V Susan & Caitlyn; Saco, ME), Kelo Pinkham (F/V Jeanne C.; Trevett, ME), Laura Taylor Singer (GMRI), David Townsend (UMO), and Lessie White (MEDMR)

Summary:
Two essential information needs were addressed by this project. The first was an evaluation of the effectiveness of the existing annual Gulf of Maine northern shrimp summer survey. The second was an understanding of what drives the inshore-offshore migration of female shrimp and the related timing and location of egg hatching and the ultimate chances for survival of the larvae. To address the first need, an industry-based survey was conducted at the same time as the summer state-federal research survey, using a stratified random design like the research survey, but with a higher sampling intensity. The R/V Gloria Michelle cruise successfully sampled 54 stations and the two industry cruises each successfully sampled 57 stations, for a total of 168 tows. The two industry cruise results were not significantly different from each other and may be combined to form a single survey. However, the state-federal research survey produced significantly higher biomass and abundance indices than did the industry survey.
Environmental and biological data were collected for two years to evaluate the timing of shrimp migration inshore; the different distributions and movements of ovigerous and post-hatch females and males; and the timing of hatching in relation to water temperature to address the second need. A total of 626 shrimp trawls were conducted using a combination of six fixed transect stations extending across the coastal shelf from nearshore to approximately the 160 m isobath and fishermen-selected stations. Hatching began earlier in 2002, probably because of the warmer water temperatures encountered on the shelf in fall and early winter. Interestingly, the hatching curve for 2002 progressively caught up with the curve for 2003, so while the curves differed by >30 d at 1% hatch, they differed by only 11 days at 50% hatch and only a few days at 90 and 99% hatch. In both areas and years, hatching was virtually completed by March 26. Although hatching began earlier in 2002, it did not begin while shrimp were farther offshore: the ovigerous females were already inshore when hatching commenced. Conversely, the earlier arrival of shrimp in 2003 did not result in earlier hatching, which may have been delayed by the colder water temperatures. Thus, despite different migration times and different hatching times, larvae were in both years released into the water at a similar distance offshore.

The Northeast Consortium facilitated a technical mail evaluation of this project, the results of which were submitted to the NEFMC and ASMFC August 2007.

Title:
Bycatch reduction in the northeast shrimp fishery

Funding:
2003 - $22,800 (PD Award)

Participants:
Bill Lee (F/V Ocean Reporter; Rockport, MA), Melissa Ferraro (Royalston, MA), Bob Fisher (F/V Marina Rose), David Goethel (F/V Ellen Diane; Hampton, NH), Jack Ketchopoulos (F/V Special K), George Littlefield (F/V Lady Regina; Kensington, NH), Allan Michael (ADM Associates; Magnolia, MA), Dennis O'Connell (F/V Lady Elaine), Domenic Pike (F/V Muktuk), Jason Pollison (F/V Rhumboogie), and Paul Sargent (F/V Joyce Marie)

Summary:
Small escape holes made from cut pieces of 6-inch PVC pipe were sewn into the net in front of the Nordmore grate in a standard shrimp net used in the northeast fishery. Preliminary tests had provided video of fish escaping through these holes during active trawling. A series of tows, with and without these holes in the nets were, made with two vessels. Seven other participating boats towed standard gear at the same time and in the same general area. Catch and bycatch were weighed and identified to provide a direct quantitative comparison of the percentage bycatch with and without the escape holes. Mean catch rate for vessels using nets without rings was 235.5 lbs shrimp/hr with a bycatch rate of 16.7 lbs/hr or 6.6%. For the two vessels with escape rings installed in the nets, the catch rate was 228.6 lbs shrimp/hr with a bycatch of 27.5 lbs/hr or 10.7%. The data was confounded by the large variation in bycatch rates among vessels and the limited number of tows. The experimental vessels encountered schools of pelagics (whiting or herring) on some days which heavily influenced results. One vessel appeared to show a significant reduction in bycatch rate from 19.4% without the rings to 9.4% with the escape rings installed. The other vessel had a bycatch rate of 7.5% without rings and 11.3% with the rings. A high catch of pelagics on several days during the tests with rings influenced results from this vessel. A complication to the study was a discrepancy in bycatch rates between vessels operating out of Hampton, New Hampshire and those out of Rockport, Massachusetts. The New Hampshire vessels had lower overall bycatch rates, which could be due to the area trawled, or performance of the gear. A similar study in the previous year had documented a lower catch of pelagics by the New Hampshire vessels. Future studies should involve a larger number of tows from one or two vessels.

The Northeast Consortium facilitated a mail evaluation of this project, the results of which were submitted to the ASMFC and the NEFMC in May 2007.
Title: Comparison of catch and bycatch with beam and otter trawls in the Northeast shrimp fishery

Funding: 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 were 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.

The Northeast Consortium facilitated a technical evaluation of this project, the results of which were submitted to the NEFMC in October 2006. This gear has since been used in three ecosystem studies of Stellwagen Bank.

Title: Development of a juvenile shrimp trap for use in establishing a juvenile abundance index for the Gulf of Maine northern shrimp, Pandalus borealis

Funding: 2004 - $24,997 (PD Award)

Participants:
Rebecca Jones (UNH), Bradford Parady (F/V Angela & Ashley; Kittery Point, ME), and Kelo Pinkham (F/V Jeanne C.; Trevett, ME)

Summary:
This project aimed to develop a standard trap design that can be used in the development of trap-based surveys of juvenile Northern shrimp (Pandalus borealis), ≤ 1 ½ years old, in the western Gulf of Maine for both management and research purposes. The ASMFC annual summer shrimp survey sampling gear has a 50% capture rate of small shrimp. Previous research and ancillary information from fishermen supported the idea that juvenile behavior is similar to adults in that they are attracted to traps. We modified conventional lobster traps by lining the interior with 1 x 1 ½ cm mesh and fitted the tops of the traps with 3 types of shrimp “V-trough” style entry vents: a conventional 1” wide vent (Control), a ¼” narrow vent (Narrow) and a trap-wire-covered conventional vent (Wire). The wire type vent sampled significantly smaller sized shrimp species and was most effective at reducing bycatch. Beam trawls were very efficient in locating juvenile Pandalus borealis within the coastal environment. Overall, the trap failed to consistently attract juvenile Northern shrimp, however the net used to determine where the juvenile were located provided important spatial/temporal information on juveniles.
**Title:**

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

**Funding:**

2003 - $24,703 (PD Award)

**Participants:**

Dan Schick (MEDMR), Shale Rosen (GMRI), 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 known 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.

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**Title:**

*Improving the size selectivity for northern shrimp through use of a modified Nordmore grate and square mesh codend*

**Funding:**

2002 - $107,994

2003 - $76,250

**Participants:**

Kelo Pinkham (F/V Jeannie C.; Trevett, ME), Dan Schick (MEDMR), and Les White (MEDMR)

**Summary:**

Comparative tows with a trouser trawl were conducted to test improved release of small shrimp and fish and retention of large shrimp using various configurations of a compound Nordmore grate and diamond or square mesh in the lengthening piece and cod end. The forward (upper) grate section had small bar spacing (7/16") sized to allow small shrimp to flow between the bars and into the cod end mounted behind this section. Two sizes of small bar space section, ½ and ¼ of the total length were tested. The ½ length sections released more small shrimp, but also retained less large shrimp than the ¼ length section compared to a standard Nordmore grate/cod end. The large shrimp were flowing out the escape hole at the bottom of the compound grate. The aft section was lengthened for better retention of large shrimp and the small bar space section was tilted (bent) another 10° to improve small shrimp release. A small bar space section with tapered openings was added to the test series as was square mesh in the lengthener and/or cod end. The two modified compound grates with the four mesh combinations produced eight test series where each gear type was judged for finfish release, shrimp weight retained, small shrimp release, and large shrimp retention. The best combination was the 7/16“ bar space bent grate with diamond lengthener and square mesh cod end.

The Northeast Consortium facilitated a technical mail evaluation of this project, the results of which were submitted to the ASMFC and NEFMC July 2007.
Title:
Modifying the Nordmore grid rigging to reduce fish discards in shrimp trawls in the Gulf of Maine

Funding:
2004 - $24,239
(PD Award)
2005 - $175,504

Participants:
Pingguo He (UNH), Vincent Balzano (F/V North Star; Portland, ME), Tim Eddy (F/V Persistence; Portland, ME), Ben foster (UNH), and Dan Schick (MEDMR)

Summary:
Since the implementation of the Nordmøre Grid in the Gulf of Maine pink shrimp trawl fishery in the early 1990s, fish bycatch has been drastically reduced. However, the Nordmøre Grid does not improve shrimp size selection and a large amount of small shrimps is landed when present on the fishing grounds. This paper reports two designs of a new size-sorting grid system, one with a funnel and one without a funnel. The main feature of the system is that the size-sorting grid is installed in front of the main Nordmøre grid. The design was tested at the flume tank and at sea to evaluate its potential of reducing juvenile shrimps in the pink shrimp (Pandalus borealis) fishery in the Gulf of Maine. Both parallel tows involving two vessels and alternating tows using one vessel were made to compare the size-sorting grid system with a trawl fitted with a conventional Nordmøre grid. Both size sorting designs significantly reduced small shrimps in the catch. This was indicated by a reduction of shrimp count (number per kg) by 38 and 45, respectively. There was a reduction of shrimp catch rates, presumably due to the release of small shrimps. There were no significant differences in the number or amount of major bycatch species between the commercial grid and the two experimental grid designs. The designs were practical to operate and easy to install. Their application may have wider implications in reducing small shrimps in the pink shrimp fishery in the Gulf of Maine and other areas.

The project formed the basis of one article published in scientific literature. Several commercial fishermen have incorporated this technology into their fishing practices.

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

Funding:
2001 - $50,000
2002 - $81,004

Participants:
Pingguo He (UNH), George Littlefield (F/V Lady Regina; Kingston, NH), Bart McNeel (F/V Aaron & Melissa II; Portland, ME), and Richard Syphers (F/V Janice Marie; Hampton, NH)

Summary:
Bottom trawling, including shrimp trawling, alters the physical and biological structure of the seabed. While the effect of alteration on benthic ecosystems and fish/shellfish populations may vary with seabed type, bottom complexity, benthic community structure, and oceanographic conditions of the fishing grounds, reducing alteration to the seabed by fishing activities would be viewed positively by all concerned with the marine environment and fishery. This two-phase project involved gear design and model tests of a semi-pelagic shrimp trawl in a flume tank, followed by sea trials of a new semi-pelagic shrimp trawling system on board commercial shrimp trawlers in the western Gulf of Maine. In 2003, catch of shrimp from the experimental trawl was compared with the average of the vessels fishing in the same general area. In 2004, a commercial trawler was contracted to fish side-by-side the trawler fishing with the experimental semi-pelagic trawl. While catch results were variable, the semi-pelagic trawling system with trawl doors off bottom had potential to catch a similar amount of shrimp. However, the system is very sensitive to depth change, tidal current and turning. Similar catch rates can be realized with carefully controlled rigging and monitoring. However, with the existing deck machinery and fishing conditions in the Gulf of Maine, application of the semi-pelagic fishing method is not recommended in this fishery. It has potential for application in other pink shrimp fisheries where more sophisticated deck equipment is available, fishing areas are larger and sea bottom is flatter.

This work formed the basis of two publications in scientific literature. The Northeast Consortium facilitated a technical mail evaluation of this project, the results of which were submitted to the NEFMC and the ASMFC in April 2007. Follow-on research is being conducted by Canadian colleagues off of northeast Newfoundland.
Title: Use of kites in shrimp codends to reduce small shrimp and bycatch species

Funding: 2003 - $162,553

Participants:
Pingguo He (UNH), Vincent Balzano (F/V North Star; Portland, ME), Dan Schick (MEDMR), and Proctor Wells (F/V Tenacious; Phippsburg, ME)

Summary:
A full scale kite-assisted shrimp codend was tested at the Memorial University flume tank to determine kite size, number of kites, and their position on the codend. The resulting full scale codend was tested at sea for the pink shrimps in Gulf of Maine through comparative fishing using the two vessel parallel tow method. Seventy-seven pairs of tows were completed on two rigging designs. The results did not support the assumption that codends expanded by water-borne kites, reducing finfish and small shrimp catch in the fishery. Catch and bycatch data collected throughout sea trials showed that a significant amount of fin fish bycatch still exists in the fishery even with the use of the Nordmore Grid. This is especially true for whiting, for which a large amount of catch was discarded late in the season. This result indicates a need for continued effort in research and development for a better shrimp trawl to minimize bycatch in the pink shrimp fishery.

The Northeast Consortium facilitated a technical evaluation of this project, the results of which were submitted to the NEFMC and ASMFC November 2010.

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### Tuna

Title: Acoustic assessment of juvenile bluefin tuna aggregations: A feasibility study

Funding: 2007 - $74,247

Participants:
Molly Lutcavage (UNH), Marc Brochu (Lily Custom Fishing and Eco Charters), Ben Galuardi (UNH), Sam Greenaway (UNH/NOAA Corps.), Michelle Heller (UNH), Larry Mayer (UNH), Bill Muniz (F/V Lily; Gloucester, MA), Joseph Powers (LSU), George Purmont (Pura Vida, Inc.), and Tom Weber (UNH)

Summary:
This project was a feasibility study using multibeam sonar to examine the efficacy of direct assessment methods to determine school biomass of Atlantic bluefin tuna. The long term objective is to develop reliable indices of abundance and to improve stock assessments. This was done using high frequency (400 kHz) multibeam sonar mounted on a commercial tuna/lobster boat in Cape Cod Bay, Massachusetts. Tuna purse seine spotter pilots located schools and estimated fish size and school biomass. Aerial imagery of the tuna schools was collected simultaneously with the multibeam data. Together, the sonar and aerial imagery data demonstrate that it is viable to enumerate school size and fish packing density within the school.

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Title: New methods to chill giant bluefin tuna

Funding: 2003 - $25,000 (PD Award)

Participants:
Robert Campbell (Yankee Fishermen’s Cooperative), Walter Golet (UNH), Joe Jurek (F/V Mystique Lady; Andover, MA), David Linney (Cape Neddick, ME), Molly Lutcavage (UNH), and Scott McGuire (CBL)

Summary:
The Atlantic bluefin tuna is the most sought after fish in the world’s oceans. Ex-vessel prices during the early and mid 1990's were typically $15.00 to $20.00 per pound. Unstable overseas markets combined with increased processing cost and reductions in fish quality have reduced prices to $4.00 to $8.00 per pound. High internal temperatures of bluefin tuna delay shipping time and often increase the incidence and effect of tuna burn, further reducing the commercial value of these fish. We designed and implemented a novel new chilling method for reducing the internal temperatures of bluefin tuna. This simple and cost effective design is suitable for vessels of all sizes, thus it can be widely distributed throughout the fishery. Initial results suggest that internal temperatures of bluefin tuna cooled four times faster when perfused with this system compared with control fish. Chilling bluefin tuna quicker will reduce the effects of tuna burn and decrease the time between capture and shipment to market potentially leading to higher ex-vessel prices.
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<td>Associated Fisheries of Maine</td>
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<td>MERAC</td>
<td>Maine Environmental Resource Assessment Corporation</td>
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<td>MESG</td>
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<td>MLCA</td>
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<td>WHOI</td>
<td>Woods Hole Oceanographic Institution</td>
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