GULF OF MAINE LOBSTER FOUNDATION
PO Box 523 * Kennebunk, ME 04043 * 207-985-8088 * 207-985-8099fx * gomlf@gwi.net

2010 Final Report to Northeast Consortium

Project Title: Determining Effect of Eastern Maine Bottom Currents On Groundlines
Award Number: 07-090 (NEC development grant)
Period of Performance: 04/05/07 – 11/30/07 (extended to 6/30/10)
Date of Final Report Submission: 30 September 2010

Contact Information of Principal Investigator:

Laura Ludwig, Project Director
Gulf of Maine Lobster Foundation
PO Box 523
Kennebunk ME 04043
Phone: 207-985-8088
laura@gomlf.org

Signature of Principal Investigator

Abstract: Provide a concise statement (250 words maximum) of the project's primary purpose, results, and conclusions.

This project sought to examine the effect of bottom currents on lobster gear 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.

Introduction: Provide sufficient background information to enable the reader to understand the context and importance of the project. Describe the justification or need for the proposed work, particularly in terms of the goals of the Northeast Consortium. *(see attached)*

The design of this bottom current investigation was intended to provide information about how environmental conditions affect a specific component of lobster trawl gear, namely the height of floating rope groundline that links lobster traps together in a multi-trap trawl.

At the time of this project's inception, the impact of proposed federal whale rules on Maine commercial lobstermen in eastern areas of the coast was anticipated to be severe, both operationally and economically. Yet to be published in late 2006, proposed National Marine Fisheries Service (NMFS) federal whale regulations threatened to ban the use of floating rope groundlines on lobster traps, which had been implicated in whale entanglements, and require lobstermen instead to use non-buoyant line between their traps to reduce the threat of whale entanglement -- an unwelcome prospect for lobstermen working in areas of rough, rocky ocean floor.

In areas of extremely rugged substrate and high current action, lobstermen maintained that they need to use floating rope on their groundlines. Requiring the replacement of float rope with sinking groundlines would make it more difficult for a lobsterman to haul his gear due to hang downs in rocky areas, an increased rate of chafing and parting rope and subsequent gear loss. Many lobstermen in these areas believed they could not successfully fish trawls with sinking groundline, and would have to break their gear up into smaller configurations (pairs, triples, or quads), increasing the number of vertical lines in the water and therefore increasing the entanglement risk. Additionally, a requirement to replace floating groundlines with sinking rope would create a huge expense for the individual lobsterman, since sink rope can cost 50% more per pound than float rope and must be replaced more frequently.

In 2003, the Maine Department of Marine Resources (Maine DMR) conducted an underwater video survey, filming floating groundline configurations all along the coast. Those images suggested that in areas of strong currents, the groundline did not rise a great distance off bottom, and may therefore be less likely to entrap a whale. However, there was a lack of precise data regarding the velocity, direction, and duration of currents directly at the ocean floor, and how those currents might affect the profile of floating groundline. Several buoys in the Gulf of Maine Ocean Observing System (GoMOOS) array record ocean currents at the surface and in the water column, but their sensor technology does not allow for measuring the currents closer than about 5m from the sea bottom. This pilot project allowed for a potential correlation between field-gathered data and GoMOOS buoy data to refine the information about currents that affect lobster gear and other gear at the bottom of the water column.

This project, commenced in the spring of 2007, attempted to generate bottom current data which might have mitigated the sinking groundline regulation by demonstrating that floating groundlines do not pose an entanglement risk in certain areas, and to argue the need for some areas to be exempted from the ban on float rope. The intent was to present preliminary results from bottom current tests and data analyses to fishery managers and the Atlantic Large Whale Take Reduction Team (ALWTRT) for consideration in regulating the use of groundlines on lobster gear.

Project objectives and scientific hypotheses: Provide a clear statement of the project's objectives and goals. If appropriate, state the testable scientific hypotheses that were constructed at the outset of the project.

The primary goal of the study was to gather data on the height above bottom of floating groundlines that were considered to be a potential entanglement danger, and to relate these data to the near-bottom currents. The project sought to gather enough data to establish whether there is a geographic line in Maine fishing waters outside of which the bottom current is so strong that it can be presumed to reduce the profile of any floating rope used as groundline. Time series records would show the variations of the rope height above bottom that can be attributed in part to the ebb and flood of tidal currents. The datasets from the GoMOOS buoy array sensors and the gear-deployed sensors in this project would then be used to depict a model of current at the bottom, which could then be extrapolated into other areas where floating groundline is commonly used on lobster trawls.

Participants: List all participants in the project with their contact information. For projects involving many participants, identify those who played a key role in project design and implementation.

Laura Ludwig, Project Director and Primary Investigator for the project
Erin Pelletier, Executive Director
Gulf of Maine Lobster Foundation, Lead Institution
PO Box 523
Kennebunk ME 04043
Phone: 207-985-8088
laura@gomlf.org
erin@gomlf.org

Dr. Neal Pettigrew, Director Gulf of Maine Ocean Observing System/Maine Oceanographic Services University of Maine 214 McKay Hall Orono ME 04773 Office: 207-581-4384 nealp@maine.edu	Chris Heinig, Principal MER Assessment Corporation 14 Industrial Parkway Brunswick, Maine 04011 Office: 207-798-7935 Fax: 207-729-4706 Mobile: 207-751-3696 MER@maine.com	Oscar W. "Bill" Look III F/V Time-n-Tide PO Box 11 Flying Place Road Beals Island, ME 04611 Home: 207-497-2834 Boat: 207-263-6435

Methods: Explain the conceptual and technical approaches for the project. Provide a detailed description of the experimental design (including numbers of samples, numbers of replicates, experimental controls, statistical tests used, etc.), project timeline, data analysis, and determination of the results. Describe study areas and why they were chosen for the project. State how this project builds on prior research if any. Were there any limitations in project design and/or methodology? Describe and explain any changes to or deviations from the original statement of work and/or any unexpected difficulties encountered in project planning or implementation.

GOMLF, in consultation with MER and GoMOOS, worked with a commercial lobsterman in Jonesport, Maine, to deploy a variety of measuring devices near or on his lobster gear that would measure bottom current velocity and direction as well as the arc of the floating groundline on the gear. GOMLF designed the project to take place in Downeast Maine because the combined coastal current and tide in that area is known to be strong enough to pull 60" poly-balls under the surface, and because lobstermen in that area suspected that the strong current below the surface lowered their floating groundlines in such a way as to reduce the risk of entanglement. The field work began in June 2007 and was scheduled to run for six months.

Nineteen Star-Oddi pressure sensors (originally purchased by GOMLF with Northeast Consortium right whale funds) were attached to traps and to the mid-points in the groundline on a 20-trap trawl deployed by lobsterman Bill Look and his crew (Figure 1). These sensors measure temperature and depth and were used to measure the height of groundlines above the bottom. The sensors were jacketed with a flotation device so that they were neutrally buoyant (Figure 2), attached to the gear by the Project Director,

remained on the gear for two weeks at a time, and were hauled, downloaded and re-deployed once per month.

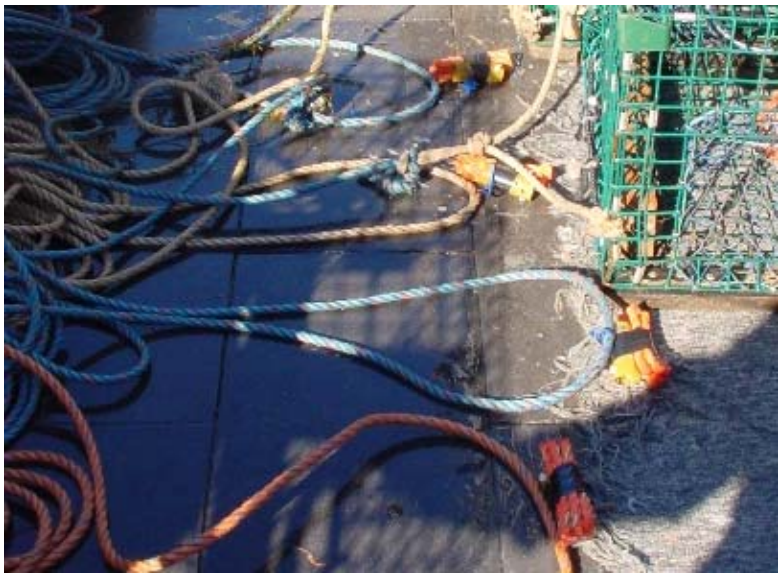

Figure 1 – pressure sensors attached to floating groundline on the boat's deck

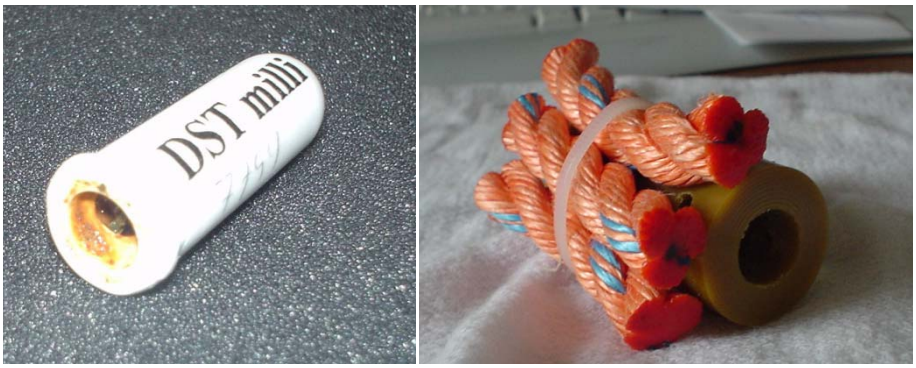

Figure 2 – a Star-Oddi pressure sensor (l) and its housing and float-rope PFD (r).

Concurrently, a Sensor Data 6000 current meter (Figure 3) was deployed for the same two weeks each month, adjacent to the trawl rigged with the pressure sensors. The current meter was retrieved at the end of each deployment and transported to Brunswick, Maine, where the data was downloaded by MER and the sensor was reset for deployment the next month. The current meter recorded velocity and direction of the current at approximately one meter off the bottom.

Figure 3 – Sensor Data 6000 flow meter being rigged on the boat's deck

During the two-week period, the trawl was hauled once or twice (in its normal harvesting rotation, but with extra care) by Look, and observations about the current meter and pressure sensors were noted in a logbook. The logbook was comprised of a diagram of the trawl showing the position and ID number of the pressure sensors; and a logsheet where deployment and hauling dates and locations were notated. (See attached "Look Logbook".)

One major and auspicious change to the design of the project was the incorporation of donated acoustic Doppler current profilers (ADCP) in the first, second and last months of the project, which contributed greatly to the dataset of current direction and velocity (see Figure 4). During June and July, the first two months of deployment, an ADCP was donated to the project by the National Marine Fisheries Service Northeast Regional Office (NMFS-NERO) in a dual-purpose contribution: NMFS-NERO was eager to have the unit tested and ground-truthed for data collection; and the Lead Scientist was eager to add another layer of corroborating data for eventual inclusion in the modeling work. For the last month of field work, the Lead Scientist on this project contributed a second ADCP unit to the project, with the idea that the data will benefit not only this examination and modeling of bottom currents and their effect on lobster gear, but as a test of the GoMOOS mission to reflect real-time current information as well.

Figure 4 – the Aquadopp acoustic Doppler current profilers from NMFS (l) and GoMOOS (r)

The ADCP was secured in a customized lobster-style trap which replaced one trap in the trawl for three deployments (Figure 4). The PI retrieved the data from each deployment and submitted it to the Lead Scientist for processing.

The readings from the Star-Oddi pressure sensors presented some difficulties and much time was spent smoothing out the data. There were two extreme cases where the data was incomplete or inaccurate, involving traps at different depths and the height of the groundline arc during very strong current flows. Many of the pressure sensors indicated a below-bottom height. Close scrutiny of the data provided information about the height of the line during very strong flows, where the drag overwhelms the buoyancy. This information was used to determine the minimum height above bottom for maximum flood and ebb tides. While this should have helped remove readings that showed negative heights above bottom, data that indicates less than very strong flows may have resulted in an under-estimation of the rope's height above bottom.

It became clear through intense data scrutiny that the pressure sensors are not very accurate, and may have offsets that are themselves pressure-dependent. Much of the data analysis effort expended was to compensate for the fact that the Star-Oddi sensors are not of sufficient quality to provide precise readings on this gear-type in tidal current conditions.

Other components of the experimental design of the project were flexible enough to make some advantageous adjustments in the methodology as needed. For example, early on it was determined that the project would not require the services of a professional diver to check the mooring system for the Sensor Data current meter as was budgeted for, because Bill Look (the participating lobsterman) was able to check on the gear's successful deployment by hauling it up, verifying the lack of rope snarls in the line, and re-setting it. The budget for the diver was instead used to purchase additional mooring anchors for the equipment.

Also, a hand-held GPS unit was not needed after all, as the boat's electronics included a plotter that could be read in degrees latitude and longitude. Like most Maine lobstermen, Look typically uses Loran-C on his plotter, but switched the GPS signal to Lat-Long in order to record locations of the equipment.

Another change to the experimental design involved the length of time the data loggers and current meters were in the water. Originally planned to be deployed over three weeks each of the six months, it was discovered prior to the first deployment, during pre-meetings with all participants, that a sufficient if not ample amount of data could be collected on a two-week set of the equipment. Two weeks allowed for the measuring of a full lunar tide, and allowed the requisite time for GOMLF to retrieve the equipment, download the data, re-program all the equipment, and return to Jonesport for the next deployment. During the month of October, the mid-water and purse seine herring fleet descended upon the area, causing a great loss of fixed lobster gear in the process. In order to avoid the risk of losing expensive scientific equipment, GOMLF opted to wait until the herring fishery closed (on October 25th) before setting the measuring equipment out again. Thus only five months of data were collected.

Data: Describe what data have been collected. Include, in table or figure format, all data that support the conclusions of the project. All data from Northeast Consortium-funded projects should be submitted to the Northeast Consortium Fisheries & Ocean Database (http://www.northeastconsortium.org/). State whether or not the data have been submitted to the Northeast Consortium database, and if not, indicate when the data will be submitted. If the data are internet-accessible in another format, provide the internet address (URL).

All data were processed by staff from the three organizations (GOMLF, MER, and Maine Oceanographic Services) with expertise in the standard preparation and data processing procedures recommended by the instrumentation manufacturers and by established practice. Complete datasets from the Star-Oddi pressure sensors and the Sensor Data 6000 current meter have been included here; the ADCP data is housed at the GoMOOS database and will be submitted as soon as possible.

See attached Datasets from Star-Oddi pressure sensors and Sensor Data 6000 flow meter. Preliminary analysis by the Lead Scientist of these two datasets required strenuous assessment of the pressure sensors' accuracy, and resulted in a detailed report on the first two months' worth of data (attached, NP Draft3 Report_for NEC). Unfortunately, the data from the ADCP were never included in any analysis received by GOMLF.

Results and conclusions: Describe the scientific and/or technical results of the project and explain their significance in terms of the project objectives and the Northeast Consortium goals. Can the project

results be generalized (e.g., relative to fishing practices or fisheries management implications)? Are there any limitations for the interpretation or use of project results?

The three datasets were to be collated by the Lead Scientist with the intent of producing a model of the effect of current on groundline in eastern nearshore Maine waters. Unfortunately, data analysis efforts were prolonged over the duration of this project, in part due to issues with the pressure sensors, but also due to time constraints on behalf of the Lead Scientist, who ultimately sustained a brain injury and was unable to draw a final conclusion about the data. There were several well-intentioned attempts to revisit the data by the Lead Scientist's staff, but no final conclusions were drafted to submit with this final report to the Northeast Consortium.

The latest report submitted to GOMLF by the Lead Scientist (January 2010) has been attached as part of this report, as it details the extensive amount of effort applied to data analysis. Two months of data are presented in table or figure format in that report.

Partnerships: Describe the quality and extent of the fisherman-scientist partnership(s). Explain the extent to which this research topic has been of mutual interest to fishermen and scientists, whether members of both communities have been key participants throughout the course of the project, and whether the project allowed and fostered broad participation among fishermen and scientists.

Bill Look, collaborating lobsterman, was eager to take part of this project from the get-go. His considerable experience as a fisherman, his prior classroom teaching, and his thoughtful approach to solutions made him an ideal participant in this effort. He is also an excellent partner in lobster research because of his natural leadership role among his peers. He communicates well with fishermen and scientists alike, and has the respect of the fleet in Jonesport. As a result there was a great deal of interest in the project by other lobstermen in the area. His pivotal role in the project kept the Jonesport-Beals lobstering community involved on the periphery. Look's early suggestions regarding rigging, mooring and deployment of the current meter and ADCP were instrumental in their safe retrieval each month. His and his crew's care in tending the gear were critical elements in the success of data collection throughout the project. His maintenance of the logbook was consistent and provided the necessary information about each month's deployment.

Chris Heinig, MER, played a lead role in developing the protocols of this project, and was instrumental in fine-tuning the methodology during the pre-field work meetings and at-sea deployment of the gear. He worked closely with the lobstermen to design the best mooring and flotation system for the current meter (Figure 5). He appreciated the careful approach taken by Look and crew when using the expensive scientific equipment, and worked closely with the lobstermen in developing the best methods for deploying the gear.

Figure 5 – MER scientists Steve Karpiak and Chris Heinig (kneeling) discuss the gear with lobsterman Bill Look (center) aboard *F/V Time-N-Tide*.

Neal Pettigrew, Lead Scientist from the GoMOOS program at UMaine and principal at Maine Oceanographic Services, was very interested in participating in the project, despite his many obligations. He posited that although near-surface and water column currents have been measured at several locations as part of the GoMOOS buoy array, those measurements do not extend to closer than about 5 m from the sea bottom, and direct measurements within the bottom boundary layer have generally been lacking in the Gulf of Maine region. He was interested in capturing data regarding the bottom layer of current, and much of the preliminary data analysis he conducted gave surprising results about the strength of current at the ocean floor and may ultimately yield even more information about the oceanographic processes in eastern Maine.

While the Principal Investigator has nothing but the highest regard for the Lead Scientist on this project, the lengthiness of the data processing effort was frustrating for GOMLF, given that the field work was completed by December 2007. The Final Whale Rule, implemented in April 2009 and mandating the use of sinking groundlines in the very area this project was conducted (and most of the rest of the Maine coast as well), now

renders the impact of this resultant data ineffectual. The lesson learned for all parties involved in the protracted data work is that highly-qualified individuals often have tremendous demands on their time from other priorities, particularly when the impetus for summarizing the data and presenting a model for possible use in the regulatory process has been removed.

Impacts and applications: Describe any beneficial impacts of all project outcomes and deliverables for end-users, focusing especially on fishermen, scientists, and/or fisheries, coastal, or ocean managers. Describe current and potential impacts on fishing practices; fisheries, coastal, and ocean management; and socio-economic conditions. Identify who would best benefit by knowing about the project. State the name, professional title, and occupation and provide contact information for these key end users.

GOMLF was hopeful that the work conducted during this pilot project would be informative for the regulatory process issuing the Final Whale Rule; however, it came too late to factor into that process -- the federal rule regulating the use of floating groundline in the lobster industry was finalized during the timeframe of this project (issued in the Federal Register in October 2007, implemented in April 2009).

Without any hard and fast conclusions about the collated datasets, the information generated by this project will only be marginally useful for future research applications regarding bottom current impacts on gear and/or federal whale regulations. Future oceanographic studies would benefit from the lessons learned regarding choice of measuring instrumentation, insofar as the data from the pressure sensors was skewed and required considerable massaging. That said, current data from the bottom of the ocean has been unavailable until now and this methodology may be resurrected for future projects involving the impacts of current/tide on fixed gear.

Downeast lobstermen are interested in seeing this scientific examination of the bottom currents in their area, as they know from experience that their gear is subject to rigorous action by tide, current, and rough ocean bottom. Lobster fishing in most Maine state waters and all federal waters is now mandated to use sinking groundline between traps. Therefore, while the timing of the results of this project may not be of immediate use to the fishing industry, managers or regulators, it may be useful in future management or regulatory applications. Regardless, it will be of great interest to the lobstermen who have been fishing in these waters for generations.

Related projects: If this project was done in association with, or leveraged by, other research, outreach, or education projects, explain the nature of the collaboration and identify the source(s) of funding.
n/a

Presentations: Provide information for all presentations related to this project, including: name of presenter(s), title, meeting, date, and location.

Apart from a brief reference at a talk in 2007 by Chris Heinig and a fixed display of the preliminary data by GOMLF at the Maine Fishermen's Forums in 2008 and 2009, no presentations or papers involving this data have been made.

Student participation: Name all students who have been associated with this project, listing high school, college/university, and graduate students separately and including the name of their institution.
n/a

Published reports and papers: List reports and papers that have resulted from this project, either published or submitted, including newsletter and web-based materials. Provide citations or internet addresses for all items. One copy of each publication should be submitted with the final report.

The preliminary data analysis is represented on the GOMLF website:
http://gomlf.org/bottomcurrents.htm
The data is otherwise unpublished.

Images: Digital photographs, electronic diagrams, and other graphical materials markedly enhance the readability and appeal of project final reports. Please provide images in JPG or TIFF formats if possible.

See attached for a deployement diagram of Sensor Data 6000 flow meter, a photo of lobsterman Bill Look and scientist Chris Heinig, and a PDF copy of Look's field logbook.

Future research: Provide recommendations for future directions of research.

What remains to be done is the comparison of the theoretical solutions with the data set to see if the fit is sufficiently good to allow confidence in the calculations. Once data analysis is complete, the findings can be generalized and discussed within the context of oceanographic conditions of the eastern waters of nearshore Maine, and might show where oceanographic processes and features may result in similar effects on floating groundline. It is not out of the question that the Lead Scientist and his team may yet produce the conclusions from their data analysis, which would be retroactively submitted to the Northeast Consortium.