Environmental Monitors on Lobster Traps
Phase VI: Bottom Currents
Final Report 2009

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Abstract:
Motivated by an issue of potential whale entanglements in lobster gear and the uncertainty of whether sinking groundline is actually needed in some regions, we developed a low-cost method of monitoring the bottom currents from lobster gear. We designed a low-cost current meter based on the drag of a tethered buoyant cylinder equipped with $75 ONSET accelerometers and data loggers. The instrument was calibrated in the field against acoustic current meters. Its working range is found from 3 to 75 cm/s. Ten instruments were distributed among volunteer lobstermen for a 1 month trial deployment which provided near bottom current measurements from the lobster traps throughout the Gulf o Maine.

September 30, 2009

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Introduction:
Given the recent issue associated with potential whale entanglements in lobster gear and the uncertainty of whether sinking groundline is actually needed in some regions, we proposed to develop a low-cost method of monitoring the bottom currents from lobster gear. As many lobstermen have suggested, the existing groundlines often lay down on the seafloor given strong currents in certain areas. While some work is currently underway to examine the degree to which groundline is dragged down, little is known about the spatial and temporal variability of bottom currents in these areas. Since conventional means of monitoring bottom currents with commercially available instrumentation is cost prohibitive, we proposed to design and evaluate a simple concept of inferring bottom currents using locally-made $75 ONSET accelerometers tethered above the ocean bottom. We tested and validated the proposed method using additional sensors such as pitch, roll, and heading sensors, pressure sensors, and two traditional current meters that we already have in stock. If the concept works, we would subsequently propose to secure these accelerometers to dozens of lobster gear end-lines throughout the Gulf of Maine.

Project objectives and scientific hypotheses:
The objective of this research is to provide lobstermen with low cost means for monitoring near bottom currents as an alternative to prohibitively expensive commercial current meters. The solution is based on the use of a tethered buoyant cylinder equipped with $75 ONSET accelerometers and data loggers. Our hypothesis is that this will give a simple, robust, elegant, and reliable way for estimating near bottom currents. If the concept works, we will subsequently propose to secure these accelerometers to dozens of lobster traps throughout the Gulf of Maine.

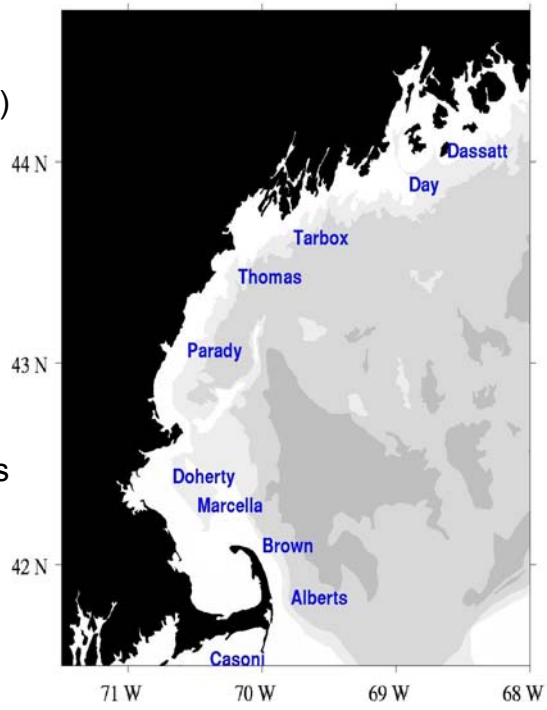
Methods and work plan:
We tested these new bottom-current-indicators in a series of steps. We conducted deployments alongside the traditional acoustic current meters: Sontek Argonaut-MD, Nortek vector in order to obtain calibration curves for conversion between the tilt angle and current magnitude. Then we designed, manufactured from PVC pipe and tested an instrument that could be mounted on a lobster trap. Ten instruments then were mailed to volunteer lobstermen to try on their lobster traps for a period of one month. Results from these deployments were analyzed and further improvements have been implemented.

Work completed:
During this project we conducted calibration deployments of a new instrument alongside with acoustic current meters (made by Sontek, Nortek, FSI) at several sites with substantial tidal currents (the Woods Hole Oceanographic Institution dock, the Little River Boat Yard in Waquoit Bay, Bournes Pond Inlet in Falmouth). These deployments allowed us to obtain calibration curves for conversion between the tilt angle and the current magnitude. We also obtained experience in deploying the instruments in different environments and by different means: by diver on Stellwagen Bank, from a small boat in Waquoit Bay.

We designed a prototype tilt current meter that could be used on a lobster trap. We chose to make it from 1inch PVC pipe 25cm long. We compromised between the accuracy, sensitivity of the instrument and its length. The instrument should not interfere with the fishing activity.

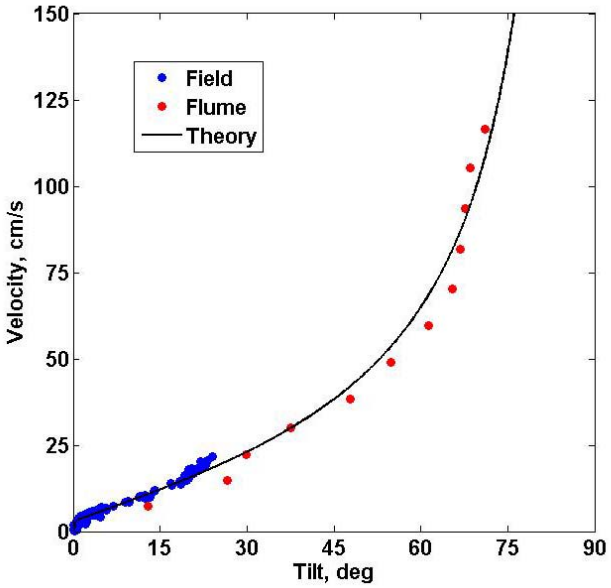
Lobstermen w/a SeaHorse Current Meter

Ten instruments (shown in the photo above) along with an instructions letter then were mailed to volunteer lobstermen (shown in map below) to try on their lobster traps throughout the Gulf of Maine for a period of one month. They were deployed at depths from 5 to 25m. Most of the deployments went fine. Only in one case a lobsterman did not read the instructions carefully and missed the preprogrammed deployment window. Results from these deployments as well as the feedback from the lobstermen were analyzed and further improvements to the design have been implemented.

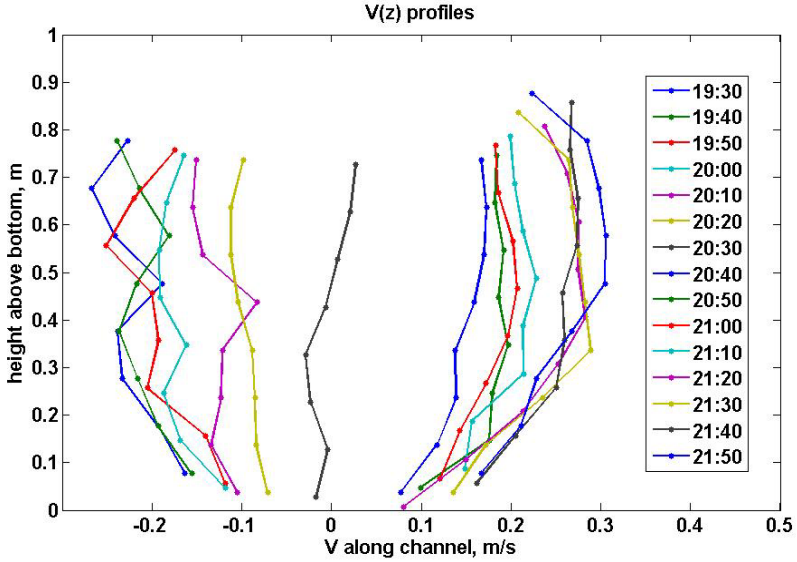


Results to date:
The main result of the work is a confirmation that this simple and inexpensive method works well. It offers accuracy in velocity estimation about 2.5 cm/s and about 5 degrees in direction. Shown below is the calibration curve used for converting the tilt angle of the instrument to the magnitude of the ambient current. The data obtained from the field experiments are shown by blue dots,

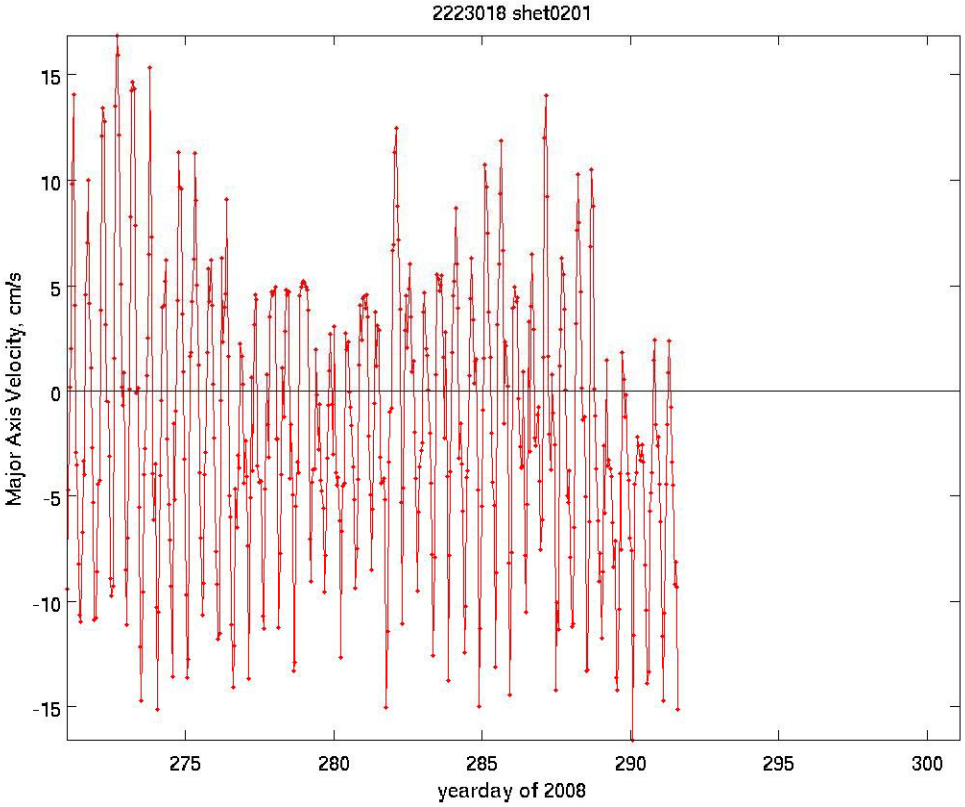
they span velocity range up to 25 cm/s. The extended range up to 125 c/m was studied in the flume at the Woods Hole Oceanographic Institution, Coastal Research Center (data shown by red dots). The theoretical curve that we adopted for conversion is shown in black.



In order for the instrument to work and give measurement representative of the near bottom currents it has to be placed outside of the bottom boundary layer. Shown below are velocity profiles obtained with the Nortek acoustic current meter at one of our test sites in the Little River as the tidal current changes from ebb to flood near the slack water (at 20:35). The plot demonstrates that the thickness of the boundary layer is about 20-30 cm. Thus our instrument when mounted on a lobster trap will be outside the boundary layer and in the region of relatively uniform currents.



From the test deployments by 10 volunteer lobstermen on their lobster traps the typical velocities near bottom were found to be around 10-15 cm/s at most sites. One of the records from Thomas Elliot in Casco Bay is shown below. The semidiurnal oscillations are clearly visible.



All other records, including deployment coordinates and times, can be found on a website http://www.nefsc.noaa.gov/epd/ocean/MainPage/tilt/shtcm.html.

One of the byproducts of our deployments is the realization of the fact that many lobster traps do land on the bottom upside down or on their side which prevents normal fishing. We also found that such landings may cause damages to the current meters.

We also tested possibility of using a compass logger manufactured by Star-Oddi with our instrument. Apart from the relatively high cost $1300 per unit, the Star-Oddi sensor was found not suited for our purposes because it could not be mounted along the axis of our instrument. Thus it failed to provide accurate measurements.

Future work: We plan to further look for a suitable compass data logger and when such electronics package becomes available we will incorporate it in our instrument.

Impacts and applications:
The most impact of this work is on aquaculture and fishing applications. Knowledge of the near bottom currents is important for planning and monitoring ecological systems. These instruments may also be used in sediment resuspension studies. Plans are underway to deploy units later this year in a tidal power assessment of Cape Cod Canal. Finally, our goal is to provide numerical ocean circulation modelers data for validating their simulations of current.

Partnerships:
The instruments were deployed by 10 volunteer lobstermen . Jim Manning maintains active contacts with a network of fishermen belonging to the various lobstermen associations around New England. Erin Pelletier, executive director of Gulf of Maine Lobster Foundation helped in identifying the volunteers for the project. The lobstermen deployed and recovered the instruments as well as provided the notes on the conditions during the experiment. In turn the data were made available to them via a website. We also communicated the data to scientists at the University of New Hampshire, University of Rhode Island, University of Massachusetts at Dartmouth, and Woods Hole Oceanographic Institution. One of the units deployed in Massachusetts Bay provided data for the Mass Division of Marine Fisheries researchers who were designing fish traps and were interested in the current speeds at a certain location.

Presentations:

1. Sheremet V. and J. Manning. Locally-developed instrumentation for validating ocean models. *7th Informal Workshop on Coastal Circulation Modeling Around New England* 29 May 2008 ~9:30am-4pm at Stephen Clark Conference room in NMFS Aquarium building in Woods Hole.
2. Manning J. and V. Sheremet. Building a Low-Cost Observing System with Help from Lobstermen. *MABPOM 2008 Meeting.* September 22-23 - *5th Floor Clark Laboratory, Quissett Campus WHOI.*
3. Sheremet, V. Tidal Observations in Waquoit Bay with Low Cost SeaHorse Tilt Current Meters. *MABPOM 2008 Meeting.* September 22-23 - *5th Floor Clark Laboratory, Quissett Campus WHOI.*
4. Manning J. and V. Sheremet, Low-cost bottom-current meter: results from prototype deployments. *Coastal Environmental Sensor Network Conference* 23-24 July 2009. UMASS Boston.
5. The results will be presented at the Ocean Sciences Meeting in Portland, Oregon, Feb 2010.

Published reports and papers:
The up to date information about the project is available online at
http://www.nefsc.noaa.gov/epd/ocean/MainPage/tilt/shtcm.html
including the data from the deployments and interpretations.
Peer reviewed publications in the scientific journals are in preparation.

Data:
The data are available online at
http://www.nefsc.noaa.gov/epd/ocean/MainPage/tilt/shtcm.html
Upon completion of analysis the data will be submitted to Northeast Consortium Fisheries & Ocean Database.