CINAR

Cooperative Institute for the North Atlantic Region

Annual Progress Report

April 1, 2011 - March 31, 2012

Donald M. Anderson, Director

Submitted to:
National Oceanic and Atmospheric Administration
Ocean and Atmosphere Research (OAR)
April 2012

Gulf of Maine Research Institute

RUTGERS THE STATE UNIVERSITY OF NEW JERSEY

University of Maryland CENTER FOR ENVIRONMENTAL SCIENCE

1865 THE UNIVERSITY OF MAINE

WOODS HOLE OCEANOGRAPHIC INSTITUTION 1930

CINAR

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Reporting Period: April 01, 2011- March 31, 2012

Submitted by:

Donald M. Anderson, Director

Submitted to NOAA on 04/30/2012

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EXECUTIVE SUMMARY

CINAR began operation on July 1, 2009. WHOI is the lead institution in partnership with the University of Maryland Center for Environmental Science, Rutgers University, University of Maine and the Gulf of Maine Research Institute.

The geographic domain of CINAR is the U.S. northeast continental shelf from Cape Hatteras to Nova Scotia. Because of the importance of large-scale climate and biological connectivity in the North Atlantic, CINAR's geographic scope also includes basin and global-scale processes that affect the shelf ecosystem. The overall goal of CINAR is to engage NOAA and academic scientists in cutting-edge research that enables NOAA to make informed decisions about sustainable and beneficial management of the U.S. northeast continental shelf ecosystem.

Funding:

In its first year of operation, CINAR supported 11 projects for 9 investigators, totaling $3.6 million in funds. Year one funds were mainly through the NMFS line office ($3.5 million). In year two, funding increased significantly to a total of $11.4 million with $3.3 million from NMFS, $7.7 million from OAR, and $0.3 million from NOS. In year three, funding was nearly $10.4 million with $5.7 million from OAR, $3 million from NMFS, and $1.7 million from NOS.

Database Development

Through an agreement motivated and coordinated by CINAR, the NSF-funded Biological and Chemical Oceanography Data Management (BCO-DMO) Office has agreed to make available the New England Fisheries Science Center (NEFSC) EcoMon data on the hydrography and biology of Gulf of Maine. In addition, BCO-DMO has worked on Bottle and Underway data from Dennis McGillicuddy and Don Anderson's project, "Investigations of *Alexandrium fundyense* dynamics in the Gulf of Maine". As other CINAR projects and programs generate data for the region, we will work with BCO-DMO to provide free and easy access.

Postdoctoral Support

Currently, WHOI supports one 18-month CINAR Postdoctoral Scholar per year as part of its cost-sharing commitment. Given the funding source, these postdoctoral scholars are located at WHOI. We are pleased to include progress reports from Postdoctoral Scholar Joel Llopiz and Robert Todd as part of this year's CINAR progress report. In an effort to strengthen the program, we worked with partners at the Northeast Fisheries Science Center to prepare a joint proposal to the PACE (Postdocs Applying Climate Expertise) Fellowship Program at UCAR. Ultimately that proposal was not submitted due to unexpected budget cuts at the NEFSC, which would need to cover half the cost of each postdoctoral investigator. We will explore submitting to this program once again later this year.

Program Development

During year two, CINAR Theme Leaders, working with the CINAR Council of Fellows and Executive Board, devoted a good deal of time to developing a series of workshops for CINAR investigators and NOAA program managers and scientists. These workshops, organized around CINAR themes, are designed to outline NOAA's needs in a particular area, as well as their plans for future programs. This is an opportunity for new approaches and technologies to be highlighted in a common effort to identify gaps or impediments as well as potential solutions. We believe this format will enhance the ability of CINAR investigators to develop relationships with NOAA programs and mangers, potentially leading to future funding opportunities. During the three workshops last year, a total of 52 CINAR investigators and 27 NOAA managers and scientists were brought together to discuss NOAA's needs and CINAR's capabilities. Though it is too soon to fully realize the outcome of these workshops, we are pleased with the results so far. A report has been prepared for each workshop and made available online (www.cinar.org) presenting the major issues that were discussed, as well as recommendations for future actions. In several cases, informal groups of CINAR investigators and NEFSC personnel are discussing programmatic ideas that were raised during the workshops, with a strong likelihood of future interactions and funding. This is consistent with one of the major goals of the workshops – to facilitate the formation of relationships that lead to future projects and programs.

Another outcome has been the funding of a follow-on workshop on EBFM (*Integrated Approaches to Ecosystem Based Fisheries Management Combing Social and Ecological Perspectives through Pilot Fishery Ecosystem Plans*.) A meeting with our Council of Fellows will be held soon to discuss the outcomes of these workshops and to prioritize future topics. A major activity already planned for next year will be a workshop on *Innovative Sensors and Technologies to Transform Stock Assessments*, focusing on new instruments and approaches developed by CINAR investigators that can transform the way the NEFSC obtains and analyzes data on the fisheries stocks that it manages.

In a related effort, the CINAR Director has been working closely with NEFSC leadership on development of an *Innovation and Transformation Program* that would initially focus on the "low hanging fruit" of advanced technologies that lack only the resources for demonstration and evaluation in an operational setting. These technologies would be selected through an open solicitation of ideas to the NEFSC staff and investigators at the five CINAR partner institutions. Another element of such a program would be the provision of funds for projects that are in earlier stages of development (higher risk), but that show considerable promise for transforming current approaches. To facilitate this process, several CINAR- and NEFSC-sponsored workshops would be supported (including the one mentioned above on innovative sensors and technologies) that bring CINAR investigators and NEFSC staff together to identify impediments and solutions to NOAA's management activities. Follow-up workshops could help to guide and flesh out aspects and priorities of the proposed program. At this point, funding for such a program is not secured, but we will continue to work with senior staff at the NEFSC to develop such a program. For the coming year, one project will be funded under this umbrella – "*Manual and Automated Analysis of Stereo Images and Transition of HabCam Technology to NOAA Operations*". We will provide an update on this project in next year's report.

Education and Outreach

We are pleased to report that plans are underway to initiate a series of Teacher Workshops organized around CINAR themes. Initially, these workshops will be held at WHOI but eventually will be expanded to involve scientists from all CINAR partners in conjunction with their university or state education and outreach programs (e.g., Sea Grant). One example from the recent past is a workshop on HabCam technology held for middle and high school teachers. HabCam is a towed camera system that takes sequential images of the seafloor along a horizontal track as it is towed by a boat, creating a "continuous image ribbon." This demonstration of the video images and the software needed to process those images was highly popular with teachers, and thus there are plans for a follow up workshop in the future. These activities are being pursued in cooperation with the Sea Grant Program at WHOI. Meetings have been held to explore and develop ideas of this type where projects that have been funded by CINAR and Sea Grant can be highlighted in various forms for outreach and education purposes.

The CINAR Program Office has been working closely with the NEFSC to develop a research and education program to enhance teaching and advising activities and to develop and implement of new technologies that can improve and enhance assessment and management capabilities in the region. One activity in this program is the distribution of a curriculum in fisheries science that was developed by the NMFS among CINAR partners. The curriculum is of courses that are needed for future NOAA staff involved in fisheries management. Our hope is that by adding certain courses to the academic programs of our partner institutions, we can provided targeted training in priority topic areas to students who will someday become members of the NOAA workforce.

In a related activity, a partnership is being established between WHOI, the University of Massachusetts School for Marine Science and Technology (SMAST), and the NEFSC to address issues related to Massachusetts and regional fishing communities. Two components are included: 1) a series of rotating, competitive Fellow awards for WHOI scientists working in areas relevant to the central theme of quantitative fisheries science; and 2) faculty support at SMAST to conduct research and educational activities related to stock assessment and quantitative fisheries science. The primary goal of this program is to provide both the research tools and the trained personnel that are needed to help address the challenge NOAA and the Northeast Fisheries Science Center face in moving toward Integrated Ecosystem Assessments and Ecosystem Approaches to Management. With a purposefully strong local focus, this program demonstrates the willingness of the NEFSC to develop programs that support fishing communities like those in New Bedford and Gloucester. We look forward to reporting on this program in next year's progress report.

CINAR ANNUAL RESEARCH HIGHLIGHTS

Donald Anderson – Woods Hole Oceanographic Institution
US National Office for Harmful Algal Blooms

The National Office serves as a focal point for US HAB research and information by organizing and providing for scientific community access to the latest research developments, workshop reports, research strategies, and related data and information. The Office facilitates an open exchange of scientific information to advance the state of knowledge and research efforts.

- PI Anderson provided testimony at the Subcommittee on Energy and Environment Hearing, "The Harmful Algal Blooms and Hypoxia Research and Control Amendments Act of 2011", Washington, DC, June 1, 2011.
- A major contribution on HABs was published in the Annual Reviews in Marine Science - *Anderson, D.M., A.D. Cembella, and G.M. Hallegraeff. 2012. Progress in understanding harmful algal blooms: Paradigm shifts and new technologies for research, monitoring and management. Annu. Rev. Mar. Sci. 4: 143-76.*

Mark Baumgartner - Woods Hole Oceanographic Institution
Autonomous Gliders for Real-Time Passive Acoustic Remote Sensing

The overarching goal for this project is to explore the capability for autonomous gliders to provide real time locations of marine mammals as part of the NOAA Northeast Fisheries Science Center's ongoing efforts to monitor and assess marine mammal stocks.

- Three ocean gliders were successfully deployed in the southwestern Gulf of Maine for four weeks; the gliders recorded a variety of baleen whale calls, including those from humpback, fin, sei, and North Atlantic right whales.
- A manuscript on a generalized baleen whale call detection and classification system was completed and now published (Journal of the Acoustical Society of America).
- Implemented the generalized low-frequency call detection and classification system on the DMON acoustic instrument, and integrated the system with both the glider and profiling float controller software.

Cabell Davis – Woods Hole Oceanographic Institution
High Resolution 3D Mapping using the VPR

The primary objective of this project was to conduct a broad-scale Video Plankton Recorder (VPRII) survey of the Gulf of Mexico during March/April 2011 aboard the R/V *Oceanus.* The cruise objective was to collect high-resolution data on plankton and marine snow together with environmental variables using the VPRII.

- The VPRII was towyoed for a record 3,048 nautical miles, from St. Petersburg to Galveston.
- The VPRII collected over 10 million plankton images together with environmental data on over 3,500 vertical profiles (the equivalent of over 3,500 CTD casts and plankton tows). This sampling is the most intensive large-scale plankton survey ever done (it is 500 miles longer than our previous transatlantic VPRII towyo).

- The survey encompassed such diverse areas as the loop current waters, Apalachicola and Mobile coastal waters, the near-field of the DWH wellhead, the Mississippi outflow, and the Flower Gardens. The environmental data supplementing the video images included, temperature, salinity, depth, chlorophyll fluorescence, turbidity, photosynthetically active radiation (PAR), and acoustic backscatter (ABS) from four high-frequency transducers (0.5, 1, 2, 4 MHz).
- All data were archived and distributed through a chain of custody to NOAA and BP/Entrix.

Steve Eayrs – Gulf of Maine Research Institute
Facilitating the Submission of Electronic Vessel Trip Reports by Northeast Fisherman

The overall objectives of this project are to test the efficacy of three different computer software options across a range of commercial fishing vessels to transmit electronic vessel trip reports (eVTRs) and identify issues pertaining to electronic data transmission and software operation. These options were tested on a range of 30 vessels over the course of 2010 (the eVTR Pilot phase, during which time fishermen were required to transmit using both electronic and handwritten options). The goals of the project this year were to expand upon that testing and begin outfitting additional boats with eVTR hardware and software.

- Thirteen fishermen were trained over the past twelve months in the use and operation of electronic logbook software to transmit logbook data electronically and to outfit their vessels with appropriate hardware and software
- GMRI has been established as the point of contact with fishermen/sector managers/NMFS managers regarding eVTR issues and operation
- A variety of technical issues were resolved and the spread of accurate information on eVTR transmission options, data requirements, timeliness of data flow, and use to industry was facilitated.

Josh Kohut – Rutgers University
Evaluation of Broad and Fine Scale Models of Butterfish BIOMASS to by-Catch Reduction in the Longfin Inshore Squid Fishery in the Mid-Atlantic Bight

The goal of this project is to evaluate existing auto-correlative and environmentally based models of butterfish biomass with an at sea trial and demonstrate the feasibility of employing real-time temperature data delivered automatically from industry boats.

- The at-sea evaluation of the butterfish model identified the scales over which the model can be applied. Over the Mid-Atlantic Bight Scale, the model did a good job at identifying the preferred offshore butterfish habitats.
- The evaluation identified a role the model could play in guiding an industry based survey focused on small pelagic fish like butterfish, extending the coverage of the fishery-independent survey and sampling habitat regions not currently sufficiently sampled.
- The results of the experimental operational habitat model were shown to fishermen in Cape May to see if a hindcast of the model matched what the fishermen were observing. These parties were interviewed about the qualitative accuracy of the model via email. Fishers stated that the model appeared to be accurate at a broad scale and over time.

William Lange – Woods Hole Oceanographic Institution
A Third Dimension: Applying Imaging and Visualization Technology to Battle of the Atlantic Shipwrecks

The *Monitor* National Marine Sanctuary is in the process of considering expanding the current sanctuary to include additional maritime heritage resources off the coast. Expansion requires the identification and characterization of significant vessels, to aid in determining sanctuary boundaries and appropriate management practices. The goal of this project was to catalog site significance and integrity, and identify degrading impacts from both environmental and cultural factors.

- The Advanced Imaging and Visualization Laboratory (AIVL), in conjunction with MNMS, imaged and surveyed a series of wrecks near Cape Hatteras, NC. The targets were a combination of wrecks that had been discovered and surveyed over the years by the local dive community and a collection of new targets that were discovered during a NOAA sponsored survey cruise earlier in the summer. The wrecks were imaged by a series of 2D and 3D WHOI- AIVL camera systems that have been developed over the past decade and have been optimized for underwater survey and cinematography work. Both divers and ROV's were used to capture images.
- NOAA and WHOI have presented the results of this project at the Society Historical archeology Conference in January 2012. Further outreach is being planned for the sanctuaries visitor center as well as educational television work with the National Geographic Society.

Robert A. Weller and Albert J. Plueddemann - Woods Hole Oceanographic Institution
Ocean Climate Observations and Analyses (2011-2012)

The Ocean Reference Station project is carried out to provide critical, sustained observations of a key region of the ocean, the trade wind region, that plays an important role in weather and climate. They are also where the ocean provides CO_2 to the atmosphere in contrast to the higher latitudes where the ocean gains CO_2 from the atmosphere. An improved and accurate understanding of the exchange of heat, freshwater, momentum, and compounds such as CO_2, across the trade wind region is required to improve our ability to understand the way in which the atmosphere and ocean interact and how that interaction should be represented in models used to predict weather and climate variability.

- Benchmarking three trade wind sites – the three ORS now provide accurate local climatologies of surface forcing and upper ocean variability.
- They form the basis for tracking anomalies in surface forcing and upper ocean heat content and identifying the spatial representativeness of such anomalies by looking at decorrelation scales in the atmosphere (in model and OA Flux fields) and in the ocean (in Argo float data).
- Quantifying the processes at work to maintain the state of the upper ocean – the combination of accurate local forcing and good time/space resolution in the upper ocean allows us to identify the major contributors to local heat, freshwater, and momentum balances.

INTRODUCTION

The Cooperative Institute for the North Atlantic Region (CINAR) is a regional CI that focuses on the U.S. northeast continental shelf (NES) large marine ecosystem (LME) that encompasses the shelf from Cape Hatteras to Nova Scotia - one of the world's most highly productive marine ecosystems. The structure and dynamics of the NES ecosystem are strongly influenced by local, regional, and basin-scale environmental forcings and by a range of human activities including fishing, the discharge of nutrients and other pollutants, and development along the coast. There is also a growing recognition of ecological impacts from climate change and ocean acidification.

CINAR is a consortium of five partner institutions that together span the geographic range of the NES and provide the required breadth, depth and quality of scientific expertise, instrumentation, models, and facilities to address many of NOAA's needs in the region. Partners include the University of Maryland Center for Environmental Science (UMCES), Rutgers University (RU), the Woods Hole Oceanographic Institution (WHOI), the University of Maine (UME), and the Gulf of Maine Research Institute (GMRI). The CINAR Program Office is located at WHOI.

1.1 Institute and Core Activities

1.2 CINAR Vision, Mission, Goals and Organization

Our vision for CINAR is as an essential component of the NOAA research and management capability in the northeast region, functioning as a mechanism that allows NOAA scientists to easily and rapidly obtain research assistance for ongoing projects, that contributes to the science planning process in NOAA, and that anticipates and responds to technical needs through the development of instruments, models, and approaches that contribute to management decisions.

CINAR's philosophy of operations focuses on research, transition of research to applications specific to NOAA's mission and goals, and a range of education and outreach activities to train new NOAA scientists, enhance knowledge and expertise of existing scientists, and communicate research results. Our overarching goal is to dramatically improve the predictive science that enables sound management, while concurrently informing the general public and stakeholders of the complexities and importance of ecosystem-based management of NES LME resources.

The mission of CINAR is engage NOAA and academic scientists in cutting-edge research that enables NOAA to make informed decisions about sustainable and beneficial management of the northwestern Atlantic shelf ecosystem.

Working within the geographic framework of the NES LME, the goals of CINAR are:

1) To establish CINAR as a leader in promoting "rational ocean stewardship" and serving as a model for development of similar ecosystem approaches to management in other regions;

2) To coordinate research, education and outreach with NOAA scientists in support of responsible stewardship of coastal and marine resources in the region;

3) To conduct research that identifies and evaluates linkages among productivity, fish and fisheries, pollution, climate change and ecosystem health;

4) To conduct research and develop decision-support tools for sustainable fisheries management;

5) To conduct research and develop tools to restore degraded habitats and support restoration and rebuilding of protected species to healthy population levels;

6) To improve integration and availability of ocean observations from global to local scales;

7) To provide mechanisms for transition of predictive/forecasting and monitoring tools into operational use for management;

8) To improve ability to distinguish shifts in marine resource status caused by human impact from those due to climate and other natural forcing; and,

9) To develop robust indicators of ecological health and socioeconomic benefits that can be utilized by resource managers.

CINAR Organization

CINAR is managed and administered through WHOI, Woods Hole, Massachusetts.
Donald M. Anderson, the CINAR Director, has overall management responsibility for CINAR providing leadership with NOAA and with the CINAR Council of Fellows. He is responsible for scientific leadership of CINAR and for ensuring maintenance and development of scientific programs and priorities. The CINAR Director has budgetary authority over Task 1 (administrative) activities and accountability for Task 2 and 3 activities, subject to review and advice of the Executive Board. The administrative structure of CINAR is shown in Figure 1.

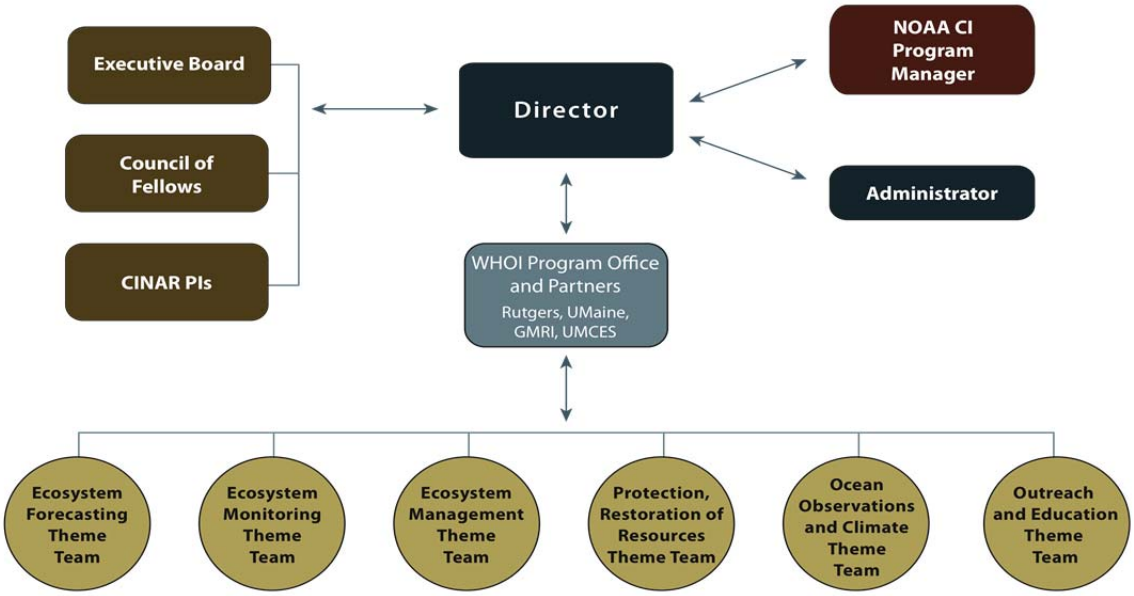


Figure 1. Organizational structure of CINAR

CINAR PIs

The CINAR PIs include Donald M. Anderson, *CINAR Director, Woods Hole Oceanographic Institution*; Oscar Schofield, *Professor, Institute of Marine and Coastal Science, Rutgers University*; Michael Roman, *Director, Horn Point Laboratory, University of Maryland Center for Environmental Science*; Peter Jumars, *Director, School of Marine Sciences, University of Maine*; and John Annala, *Chief Scientific Officer, Gulf of Maine Research Institute*. The CINAR PIs meet frequently in person or via conference call to discuss issues and to ensure that partner institutions are updated on CINAR activities.

CINAR Executive Board

The Executive Board consisting of senior employees from NOAA, WHOI, and at least one of the other CINAR consortium members, provides a senior management linkage to NOAA to guide the programmatic priorities and policy directions of CINAR. Members of the Executive Board participate in annual meetings, and represent the views of their program or branch within NOAA so as to facilitate beneficial interactions between NOAA scientists and CINAR. The Executive Board includes representatives from NOAA line offices and goal teams that have research interests in the North Atlantic region.

The CINAR Executive Board members are:

William Karp, Chair	NMFS NEFSC
Venkatachalam Ramaswamy	OAR Representative
Russell Callender	NOS Representative
Krisa Arzayus	Climate Goal Team Representative
Ned Cyr	NMFS/OST
Donald Anderson	CINAR Director
John Annala	CINAR PI, Gulf of Maine Research Institute
Leon Cammen	Director, National Sea Grant Program
Peyton Robertson	North Atlantic Regional Team Representative
Laurence Madin	WHOI Leadership
Philip Hoffman	OAR CI Program Director

CINAR Council of Fellows

Chaired by the CINAR Director, the Council of Fellows is the primary planning and consultative body of CINAR. Responsibilities include participating in conference calls and occasional in-person meetings and discussion of issues related to the administration and oversight of CINAR. NOAA Council members are expected to serve as a conduit for information in both directions between NOAA and CINAR, including the identification of research opportunities for the CINAR partners.

Membership includes: one senior representative from each CINAR partner institution (GMRI, RU, UMaine, and UMCES), the CINAR Director; a senior manager from the NEFSC; OAR Climate Program Manager (or designee); and NESDIS/NCDC representative. The OAR CI Program Manager will be a special advisor to the Council in an *ex officio* status.

The CINAR Council of Fellows members are:

Donald Anderson, Chair	CINAR Director
Oscar Schofield	CINAR PI, Rutgers
Michael Roman	CINAR PI, UMCES
Peter Jumars	CINAR PI, University of Maine
John Annala	CINAR PI, Gulf of Maine Research Institute
Paulinus Chigbu	MSI Representative / UMCES
Fred Serchuk	NMFS/NEFSC
Position to be filled	OAR/Climate Program Office
Ellen Mecray	NESDIS/NCDC
Philip Hoffman, *ex officio*	OAR CI Program Director

CINAR Theme Leaders

Includes individuals from the partner institutions with long-term and significant interactions with NOAA who will serve as representatives for their respective CINAR research theme. Each leader is supported by Theme Coordinators at each partner institution, each of whom represents a large group of participating investigators, as identified on the CINAR web site (www.cinar.org).

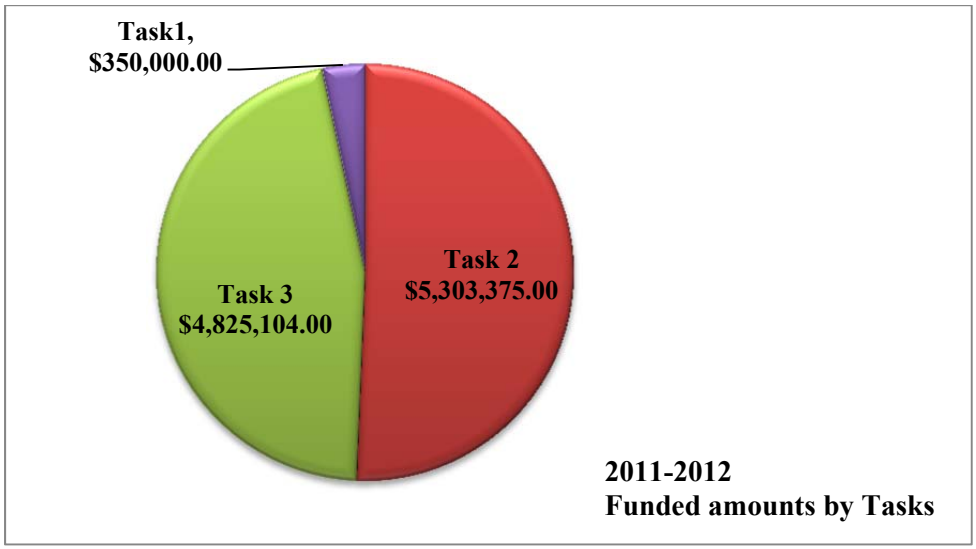
CINAR Research and Administrative staff

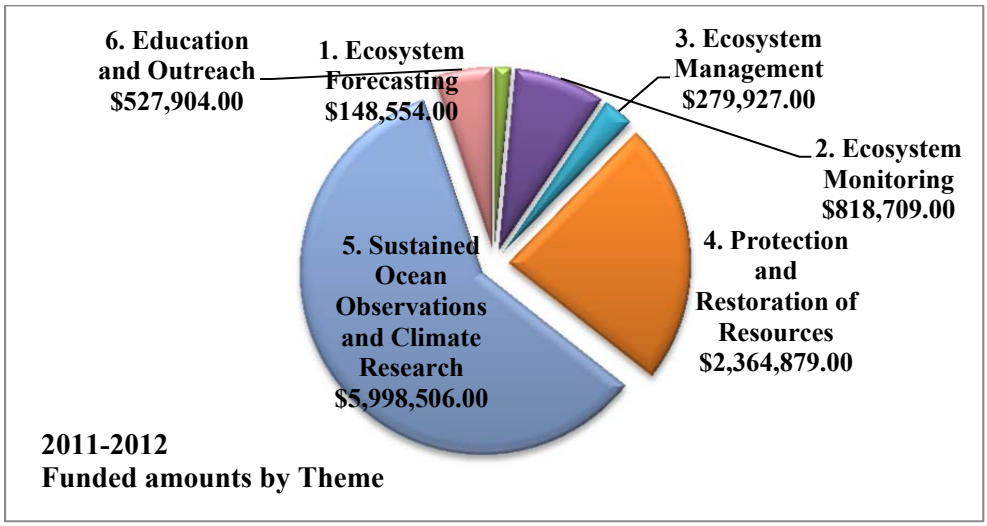
WHOI and the partner institutions provide the administrative staff for grants and contracts management, human resource management, systems administration, procurement, and all necessary support staff roles for CINAR activities. CINAR uses the services of researchers through an appropriate combination of tenured or tenure-track faculty in academic departments, and non-tenure track faculty. Each institution is responsible for appropriate oversight of faculty research activities. CINAR actively promotes undergraduate and graduate education through internships, cooperative experiences, graduate assistantships, and fellowships.

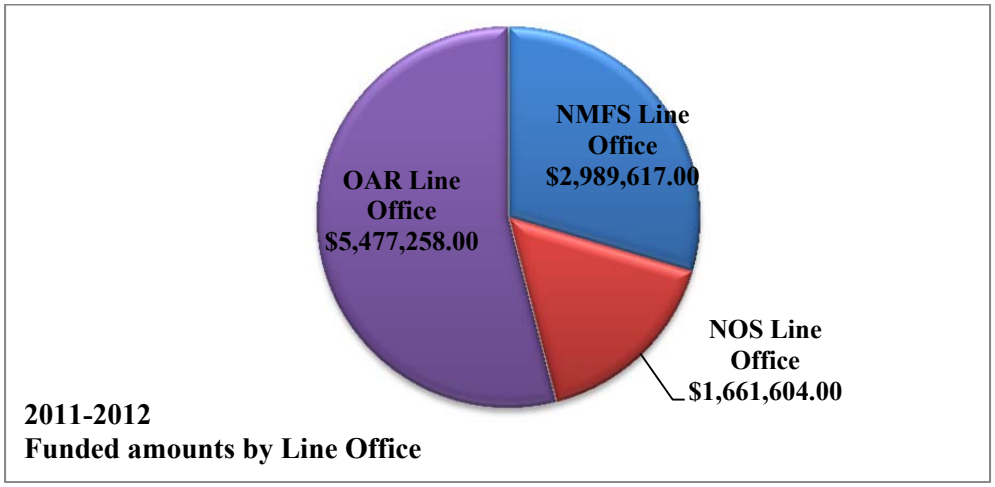
CINAR Program Office

Donald Anderson	CINAR Director
Judy Kleindinst	CINAR Administrator
Ann Stone	CINAR Administrative Professional

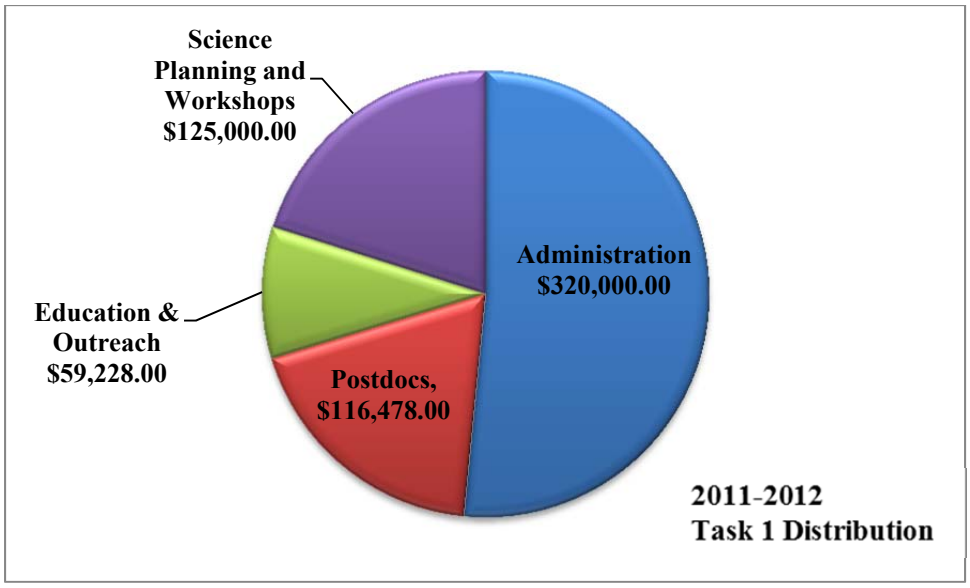
1.3 Distribution of NOAA Funding by Task, CINAR Themes and NOAA Line Office







1.4 Task I activities with Distribution of Funding



Task I funding is provided by three sources – OAR, NMFS and WHOI (cost sharing). In year 3, we received $110,000 from OAR, $240,000 from NMFS and $270,000 from WHOI as cost-sharing to cover salary and related costs for part of CINAR Director Anderson's time and for a CINAR Postdoctoral Scholar.

Data Management

The NSF funded Biological and Chemical Oceanography Data Management (BCO-DMO) Office continues to make available the New England Fisheries Science Center (NEFSC) EcoMon data on the hydrography and biology of Gulf of Maine. These
data can be accessed via the following URLs:

Hydrography
http://osprey.bcodmo.org/dataset.cfm?id=13663&flag=view&return=deploy

EcoMon 10m2:
http://osprey.bcodmo.org/dataset.cfm?id=13683&flag=view

EcoMon 100m3:
http://osprey.bcodmo.org/dataset.cfm?id=13684&flag=view

Information about the NEFSC and these two projects are available at:
http://osprey.bcodmo.org/program.cfm?flag=view&id=22&sortby=program

In addition, BCO-DMO has worked on Bottle and Underway data from Dennis McGillicuddy and Don Anderson's project, Investigations of *Alexandrium fundyense* dynamics in the Gulf of Maine. These CINAR-relevant data are still in preliminary form.

Education and Outreach

Through the WHOI cost-sharing for CINAR, we will appoint an 18-month Postdoctoral Scholar during each year of the cooperative agreement. Postdocs are selected from a national competition at WHOI of very strong applicants in all fields of oceanography. The CINAR Director convenes an ad hoc committee each year of CINAR investigators from each scientific department at WHOI to review the top 25 applicants and make recommendations for which ones CINAR is interested in supporting. Currently we have two CINAR Postdoctoral Scholars – Joel Llopiz and Robert Todd. Their reports begin on page 22.

Our next Postdoctoral Scholar will be Ke (Kevin) Chen, North Carolina State University. His report will be included in the next CINAR progress report.

In July 2011, CINAR Investigator Scott Gallager and colleagues presented a teacher's workshop, "*HabCam: using advanced imaging technology to study New England seafloor ecology*". The objectives of the workshop were to engage teachers and inform them about the regional seafloor and its characteristics, and introduce them to the region's biodiversity, and to introduce them to the HabCam portal http://habcam.whoi.edu/ that they could explore with their classes later. Teachers were provided with packets of laminated HabCam images of common and notable benthic organisms, along with two classroom lessons and worksheets for students to analyze the images and identify and record sediment types, common benthic species (such as fish, scallops, and lobsters) and animal behaviors captured by the camera. The packets and analysis procedures could form the basis for developing a future citizen science project aimed at analysis of HabCam data. The workshop was attended by middle and high school teachers from schools in Massachusetts, Vermont, and Rhode Island.

These workshops provide an opportunity for middle school and high school teachers to learn about science and engineering first-hand from the scientists who do the work. Up to 30 teachers are accommodated at one time. During the coming year, we will be instituting one workshop per year sponsored by CINAR and featuring a CINAR topic. We will involve investigators from the other CINAR partners as well as WHOI.

Executive Board meeting

We are currently working with our new Chair, Bill Karp, Interim Director, NEFSC to schedule an Executive Board meeting and plan an agenda. This was put on hold due to the transition at NEFSC with Nancy Thompson's departure early last year.

CINAR Workshops

The CINAR Program Office is actively working with investigators at all the partner institutions to strengthen existing relationships with NOAA programs and build new ones that can lead to funded research in support of the Institute's themes. A major activity in this regard has been the organization of joint workshops with NOAA to highlight CINAR expertise and capabilities regarding NOAA goals. The following workshops took place last year:

- ***Population Connectivity on the East Coast of the United States***
  Linthicum Heights, MD 22-24 February 2011

- ***Climate and Ecosystem Change in the NW Atlantic***
  Woods Hole, MA 01-03 March 2011

  A. Models and Ecosystem Indicators for Integrated Ecosystem Assessment: What can CINAR contribute?
  B. Forecasting the impact of Climate Change on Primary and Secondary Production in the CINAR Region

- ***The Role of Social Sciences in Ecosystem-Based Management***
  Woods Hole, MA 02-04 May 2011

Reports for each of these workshops are available at the CINAR Web Site: www.cinar.org. Further details on the latter two workshops are also available in a progress report (see page 67) as partial funding for these was provided by the NEFSC, with additional support through the CINAR Program Office (Task I). At the next Council of Fellows and Executive Board meetings, we will review the recommendations made from these workshops and discuss next steps. We will also discuss the need for additional future workshops.

The CINAR office is currently planning the following workshops:

- Innovative Sensors and Technologies to Transform Stock Assessments

- Education, Research Translation and Outreach associated with CINAR Science Programs

- Integrated Approaches to Ecosystem-based Fisheries Management: Combing Social and Ecological Perspectives Through Pilot Fishery Ecosystem Plans

PI Conference calls

Because of the consortium nature of CINAR, consisting of geographically separated partners, the CINAR PIs have periodic conference calls to discuss internal issues.

CINAR POST DOCTORAL SCHOLAR PROGRESS REPORT

NOAA Cooperative Agreement No. NA09OAR4320129 – **WHOI** – 34 Subpoint
April 01, 2011-March 31, 2012

Post Doctoral Scholar: Joel Llopiz - Woods Hole Oceanographic Institution

Related NOAA Goal Plan:
Goal 1. Protect, Restore and Manage the Use of Coastal and Ocean Resources through Ecosystem-based Management

CINAR Theme:
Theme II. Ecosystem Monitoring

PROJECT OVERVIEW

Joel Llopiz is nearing the end of his 18-month CINAR Postdoctoral Scholar position at Woods Hole Oceanographic Institution (WHOI) that began in December 2010. Prior to coming to WHOI, he held a postdoctoral position at the University of Miami's Rosenstiel School of Marine and Atmospheric Science where he also received his PhD under the supervision of Robert Cowen. His work has mostly focused on the larval stage of marine fishes and has specifically been related to the feeding ecologies of fish larvae, their trophic niches in planktonic food webs, and the influence that feeding has on larval fish growth and survival.

One of Joel's largest accomplishments in past year was writing a Sea Grant proposal that was successfully funded. With co-PI Simon Thorrold and collaborator Jon Hare at NOAA's Northeast Fisheries Science Center, this project will apply the recently developed technique of compound-specific stable isotope analysis to NOAA's collection of haddock scales that spans multiple decades. The promise in compound-specific stable isotope analysis lies in the how the isotopic signatures of certain essential amino acids do not change as they are transferred from resource to consumer. Therefore, the temporal variability in the signatures of these amino acids is a direct result of changes at the base of the food web. While it has been speculated that changes at the base of the Georges Bank food web have occurred, this study would be the first to directly test this hypothesis by analyzing haddock scales collected annually on Georges Bank from 1931 to 2009. Such information should make a strong contribution to our understanding of how climate and oceanographic variability can translate up the food web to influence the recruitment, survival, and trophic interactions of important fishery species, in addition to shedding light on ecosystem-level processes affecting fish populations in general. The work for this study is already well underway in the laboratory—after several weeks' efforts of gathering the scales from NOAA's warehouse.

On the publications front, Joel wrote a sole-authored literature synthesis and review manuscript last year that has been accepted for publication in *Journal of Marine Systems* that will be part of a special issue on comparing marine ecosystems. The synthesis compares the feeding dynamics of marine fish larvae from different latitudinal regions, and it represents the first quantitative review of the vast literature on the popular topic of larval fish feeding success and diets during their vulnerable larval period—a life stage critically important for determining adult population sizes and recruitment to the fishery.

Joel was also invited on two occasions this past year by prominent and established scientists to be a co-author on additional review papers. One of these works comprises an extensive quantitative synthesis on factors related to larval fish survival and match-mismatch dynamics (already in press with *Advances in Ecological Research*), while the other will be related to the influence of larval fish survival on observed latitudinal patterns in the population connectivity of demersal fishes (soon to be submitted to *Proceedings of the Royal Society B*). Additional manuscripts from Joel's previous postdoctoral work are in the late stages of preparation, with one to soon be submitted to a high-impact, multidisciplinary journal.

Another focus of Joel's work has been to use the compound-specific stable isotope approach on fish larvae to gather preliminary data that will form the basis for an upcoming NSF proposal for the August deadline. The proposed work will examine latitudinal patterns in the isotopic signatures in fish larvae, providing insight into how the base of planktonic food webs changes with latitude and an idea of the relative contribution of the microbial food web to the feeding and survival of fish larvae. The comparative approach over different latitudes, temperatures and planktonic ecosystems should provide some insight into the possible effects of a changing ocean on the processes influencing larval fish survival.

Associated with the Climate Impacts on Top Predators (CLIOTOP) program and his role as a working group co-chair, Joel traveled to Japan last September to help lead a workshop on the early life stages of tunas and other top predators. He also chaired a successful and well-attended session at the recent Ocean Sciences Meeting in Utah with a similar theme.

Finally, Joel has participated actively in the fieldwork associated with his other advisor's (Carin Ashjian) projects in the Arctic. Last August he traveled to Barrow, Alaska and participated on day cruises investigating the zooplankton that is critical to Bowhead whale survival. For 7 weeks in November and December, he also participated in a unique expedition to the Arctic aboard the USCG icebreaker *Healy*. This study sampled the zooplankton and other biological and physical parameters of the Bering, Chukchi, and Beaufort Seas during the relatively understudied wintertime. Joel hopes to be tackling a component of this work with the many collected samples and physical data. In addition to this and his other efforts described here, Joel is again teaching an undergraduate ichthyology course this spring semester at the New England Aquarium that is part of the Marine Studies Consortium.

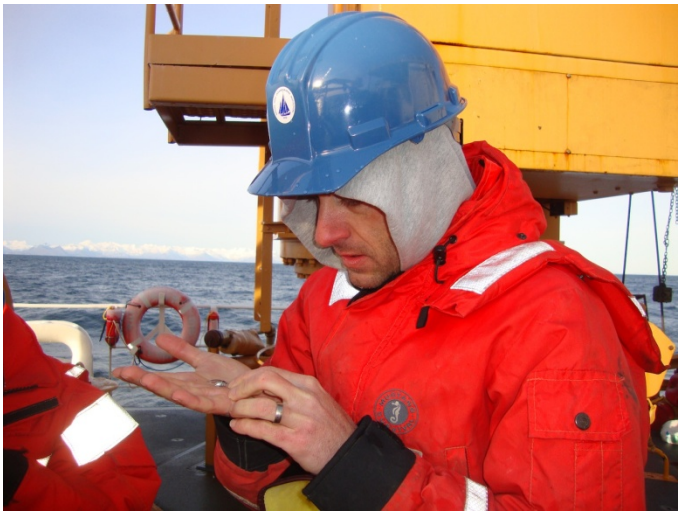
PUBLICATIONS

Peck MA, KB Huebert, JK Llopiz (In press) Marine fish larvae and their prey: extrinsic and intrinsic factors driving match-mismatch dynamics. Advances in Ecological Research

Llopiz JK (In press) Latitudinal and taxonomic patterns in the feeding dynamics of fish larvae: a literature synthesis. Journal of Marine Systems

D'Alessandro EK, S Sponaugle, JK Llopiz, RK Cowen (2011) Larval ecology of the great barracuda, Sphyraena barracuda, and other sphyraenids in the Straits of Florida. Marine Biology 158: 2625-2638 (feature article)

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS



CINAR Postdoctoral Scholar Joel Llopiz examines one of the few fish larvae collected on a winter expedition to the Bering and Chukchi Seas aboard the Coast Guard's icebreaker *Healy*.

A view from the *Healy's* bow of a dead-end path of broken sea ice that is the result of several back-and-ram attempts through a particularly thick area of ice.

CINAR POST DOCTORAL SCHOLAR PROGRESS REPORT

NOAA Cooperative Agreement No. NA09OAR4320129 – **WHOI** – 40 Subpoint
April 01, 2011-March 31, 2012

Post Doctoral Scholar: Robert Todd - Woods Hole Oceanographic Institution

Related NOAA Goal Plan:
Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme:
Theme V. Sustained Ocean Observations and Climate

PROJECT OVERVIEW
Robert Todd started as a CINAR Postdoctoral Scholar at the Woods Hole Oceanographic Institution (WHOI) in May 2011. He previously received his Ph.D. in physical oceanography from the Scripps Institution of Oceanography, UC San Diego under the supervision of Daniel Rudnick. His work generally focuses on upper ocean processes in coastal systems and is primarily observational.

As a CINAR Postdoctoral Scholar, Robert has been studying physical oceanography of the Middle Atlantic Bight (MAB) shelfbreak and continental slope regions in collaboration with his advisors, Glen Gawarkiewicz and Breck Owens, as well as others at WHOI and elsewhere. A permanent shelfbreak front in this region separates cooler, fresher continental shelf waters from warmer, saltier slope waters. Upwelling along the shelfbreak front supports increased productivity and important commercial fisheries. Despite decades of observational, theoretical, and numerical efforts, the MAB shelfbreak region remains poorly understood; the small spatial scales and inherent nonlinearity in the region contribute to the difficulty in understanding physical processes near the shelfbreak.

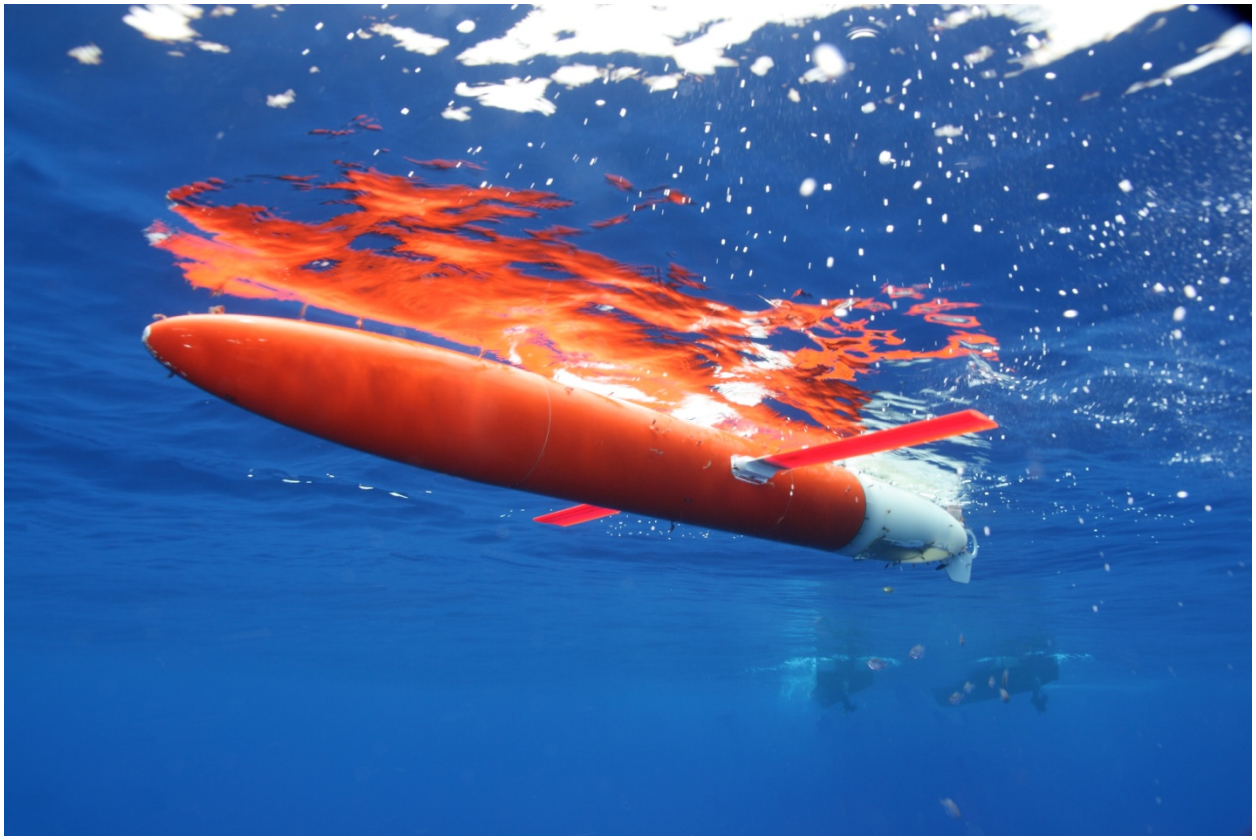
Robert has been analyzing temperature, salinity, density, and velocity observations collected by autonomous underwater gliders in spring 2006 and summer-fall 2007. These observations have high horizontal resolution (6 km between profiles over the continental slope, less than 1 km between profiles over the continental shelf) and are able to resolve many of the processes occurring in the MAB shelfbreak region. Robert's analysis has thus far focused on two topics: 1) interactions between anticyclonic eddies and the shelfbreak front, and 2) horizontal spatial scales. Glider observations of a large Gulf Stream warm core ring and a smaller anticyclone that both interacted with the shelfbreak front show good agreement with results from a laboratory simulation of anticyclones impinging on the shelfbreak by Claudia Cenedese (WHOI). A structure function analysis of observations from two alongshelf transects and 16 cross-shelf transects show that cross-shelf decorrelation (*e*-folding) scales increase from 20 km near the shelfbreak to 35 km or greater over the continental slope and that alongshelf variability has a dominant wavelength of 40 km near the shelfbreak and 175–250 km further offshore.

Additionally, horizontal variability in the cross-shelf direction and in the alongshelf direction near the shelfbreak is largely the result of interleaving of shelf and slope water masses while

alongshelf variability over the slope is the result of vertical displacement of isopycnal surfaces. Two manuscripts that describe these results are currently in preparation.

Additional activities during the reporting period include: completion and publication of the final paper from Robert's Ph.D. dissertation (Todd, et al. 2012, *J. Geophys. Res.*); department seminars at WHOI and the University of Rhode Island's Graduate School of Oceanography; attendance and presentation at a regional meeting (MABPOM) and a national meeting (2012 Ocean Sciences Meeting); participation in a 2-day research cruise to the MAB shelfbreak; and preparation of a collaborative research proposal that was submitted to NSF in February 2012.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS



A Spray glider, similar to those used in the work described above. The glider is a type of buoyancy-driven autonomous underwater vehicle. It profiles from the surface to 1000 m depth while gliding forwards at a speed of about 0.25 m s^{-1} (~0.5 kt). The glider carries a CTD and other instruments in the rear (white) portion of the fuselage. Photo by Robert Todd.

CINAR RESEARCH SUMMARIES

The following pages provide research summaries of the 34 CINAR projects funded during the period April 01, 2011 through March 31, 2012. The projects are organized by theme.

Theme I. Ecosystem Forecasting

1. David Mountain, University of Arizona and Donald Anderson, WHOI, *The Mid Atlantic Cold Pool and Stock Assessments: Developing Environmental Indices at the Range Limit of Species*

2. Josh Kohut, Rutgers University, *Evaluation of Broad and Fine Scale Models of Butterfish BIOMASS to by-Catch Reduction in the Longfin Inshore Squid Fishery in the Mid-Atlantic Bight*

3. Daniel McCorkle and Anne Cohen, WHOI, *Effects of Varied pCO2 on Atlantic Surf Clams – Culture Experiments*

Theme II. Ecosystem Monitoring

1. Mark Baumgartner, WHOI, *Autonomous Gliders for Real-Time Passive Acoustic Remote Sensing*

2. Mark Baumgartner, WHOI, *Foraging Ecology and Habitat of North Pacific Right Whales*

3. Mark Baumgartner, WHOI, *Characterizing North Atlantic Right Whale Habitat Through Integration Of Satellite Tagging, Acoustic, And Visual Survey Data*

4. David Fisichella, WHOI, *Hydrographic Support for a R/V Thomas Jefferson Cruise to the Gulf of Mexico as part of the Unified Command Response to the Deepwater Horizon Oil Spill*

5. Scott Gallager, WHOI, *2011 HABCAM Survey of George's Bank and Phase II of NOAA HABCAM Project*

6. Graham Sherwood, GMRI, *Inshore Gulf of Maine Herring Acoustic Survey*

7. Hanumant Singh, WHOI, *Development of Protocols and Tools to Access Fish Populations and Habitat Using the SeaBED AUV*

8. Hanumant Singh, WHOI, *Integrating a Forward Looking Sonar on the SeaBED AUV*

9. Hanumant Singh, WHOI, *Real Time Imagery from an Autonomous Underwater Vehicle to Enhance Adaptive Mission Execution*

10. David W. Townsend, UMaine, *Nutrient Dynamics on the NF Continental Shelf: Sample Analyses*

Theme III. Ecosystem Management

1. Donald Anderson, WHOI, *Task II: Workshops 2011 A & B*

2. Steve Eayrs, GMRI, *Facilitating the Submission of Electronic Vessel Trip Reports by Northeast Fishermen*

3. Di Jin, WHOI, *Vessel Safety & Fisheries Management*

Theme IV. Protection and Restoration of Resources

1. Cabell Davis, WHOI *High Resolution 3D Mapping using the VPR*

2. Cabell Davis, WHOI *Holocam and Video Plankton Recorder*

3. James Gilbert, UMaine, *Estimates of Harbor Seal Numbers in New England*

4. William Lange, WHOI *A Third Dimension: Applying Imaging and Visualization Technology to Battle of the Atlantic Shipwrecks*

5. Michael Moore, WHOI, *Human Interaction Investigations in Marine Mammals*

Theme V. Sustained Ocean Observations and Climate

1. Carin Ashjian, WHOI, *Bowhead Feeding in the Western Beaufort Sea Oceanographic Conditions Whale Prey Distributions and Whale Feeding and Foraging Behavior*

2. Mark Baumgartner, WHOI, *Bowhead Feeding in the Western Beaufort Sea Oceanographic Conditions Whale Prey Distributions and Whale Feeding and Foraging Behavior*

3. Riley Young Morse, GMRI, *FY 2011 IOOS Data Registry, Catalog and Viewer Development*

4. W. Brechner Owens, WHOI, *WHOI Contribution ARGO Float Program (2011-2012)*

5. Andrey Proshutinsky, WHOI, *NOAA State of the Arctic Report*

6. Albert Suchy, WHOI, *R/V ATLANTIS Use in Support of NOAA/PMEL Vents Research Cruise Embley*

7. Robert Weller and Albert Plueddeman, WHOI, *Ocean Climate Observations and Analyses (2011-2012)*

8. Lisan Yu, WHOI, *Global Ocean Surface Heat Flux Analysis*

Theme VI. Education and Outreach

1. Donald Anderson, WHOI, *US National Office for Harmful Algal Blooms*

2. Kate Burns, GMRI, *Research and Identify Options that can Assist the Evolution of Groundfish Sectors as Viable Business Organizations*

3. James Churchill, WHOI, *Improve the Fishery – Independent Acoustic and Larval Indices for use in the upcoming Benchmark Atlantic Herring Assessment*

4. Alexa Dayton, GMRI, *Marine Resources*

5. Robert Nelson, WHOI, *GC × GC Capacity Building in South Korea in the Wake of the Hebei Spirit Oil Spill*

THEME I. ECOSYSTEM FORECASTING

CINAR

Cooperative Institute for the North Atlantic Region

The Mid Atlantic Cold Pool and Stock Assessments: Developing Environmental Indices at the Range Limit of Species

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 27
April 01, 2011-March 31, 2012

David Mountain, University of Arizona and Donald Anderson, Woods Hole Oceanographic Institution

NOAA Program Manager: Jonathan Hare NOAA NMFS Oceanography Branch

Related NOAA Goal Plan: Goal 2. Climate Adaptation and Mitigation: An informed society anticipating and responding to climate and its impacts

CINAR Theme: Theme I. Ecosystem Forecasting

PROJECT OVERVIEW

The goal of this project is to develop environmental indices that capture the influence of oceanographic conditions on the dynamics of resource species in the Mid-Atlantic Bight (MAB), with specific reference to the local yellowtail flounder population. The dominant oceanographic feature in the MAB is a cold band of water that occurs at depth on the outer shelf during the summer and fall and is a remnant of the previous winter's cooling as the shallower waters in the region warm with seasonal heating. This feature is called the cold-pool. Various studies have related inter-annual changes in MAB water temperature with changes in the distribution and recruitment of various local resource species including yellowtail founder. Indices of variation in the temperature, development and spatial extent of the cold-pool will be developed for comparison with analyses of the changes the yellowtail founder distribution and recruitment being conducted by researchers at the Northeast Fisheries Science Center. Specifically using historic hydrographic data, candidate indices will be developed for the cross-shelf extent and minimum temperature of the cold-pool in the fall along a number of sections across the MAB. Indices also will be developed for the mean and minimum temperature along the mid-line of the cold-pool. Identification of suitable environmental indices that exhibit predictive power for yellowtail flounder recruitment could aid fishery management interests in managing this important resource.

ACCOMPLISHMENTS

All indices of average shelf water temperature, salinity and volume in the Middle Atlantic Bight (MAB) developed in the first year of this project were extended through 2010. An index of bottom temperature in the area characteristically occupied by yellow tail juveniles also was developed. A meeting with the other investigators on the project was held on December 6, 2011 in Narragansett, RI. Progress to date was reviewed and plans for analyses in the coming year were made. To consider the importance of bottom habitat on the distribution and survival of yellow tail data on bottom habitat type on a grid for the MAB was obtained from R. Gamble (NMFS Woods Hole Lab). An analysis capability to determine the yellow tail catch on NMFS trawl surveys as a function of bottom temperature, depth and habitat type was developed and demonstrated. Comparison of data from different years indicates how the species moved in depth and bottom habitat type in response to changing bottom temperatures.

HIGHLIGHTS

A year-to-year comparison of the temperature at which the yellow tail were caught on trawl surveys to the regional average bottom temperature indicated that the fish changed their distribution to compensate for about half of the region temperature change. At regional bottom temperatures above (below) 9 c, for each 1 c increase (decrease) in bottom temperature the catch temperature increased (decreased) by only half a degree.

SOCIETAL BENEFITS

Bottom temperature indices and their influence on yellow tail recruitment have been provided to the NMFS stock assessment scientists for possible use in the stock assessment process.

Evaluation of Broad and Fine Scale Models of Butterfish BIOMASS to by-Catch Reduction in the Longfin Inshore Squid Fishery in the Mid-Atlantic Bight

NOAA Cooperative Agreement No. NA09OAR4320129 **Rutgers** Subpoint 02
April 01, 2011-March 31, 2012

Josh Kohut- Rutgers University

NOAA Program Manager: John Hoey - NMFS/NEFSC- Narragansett Lab

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme I. Ecosystem Forecasting

PROJECT OVERVIEW

Through coordination between government and academic research institutions, fisheries management institutions, and commercial squid fishermen and we intend to evaluate existing auto-correlative and environmentally based models of butterfish biomass with an at sea trial and demonstrate the feasibility of employing real-time temperature data delivered automatically from industry boats.

Task 1: The habitat and auto-correlative models developed from a previous project will be evaluated over an 8-day at sea trial designed to quantify the effectiveness of these models to predict regions of high butterfish biomass at broad (habitat) and fine (auto-correlative) scales within the loligo fishing grounds concentrated near the shelf break during the winter trimester. The intent is to assess the skill of the model to predict regions that will minimize by-catch. Finer scale sampling will evaluate the output of the auto-correlative model.

Task 2: Building on relationships with the industry, we will enlist two to three larger vessels with high operating costs that will not be constrained to a scientific survey design to further test and refine the dynamic habitat and auto-correlative models, report by-catch biomass as well as near real time reporting of sub-surface temperature and hydroacoustic data, and document observed variables that impact decisions about how and why the fishers trawl at certain locations and times.

Task 3: Convene a 1-day workshop to bring together partners in the industry with project partners to define the expectations of the real-time reporting tasks. The purpose of the workshop will be to update the industry partners on the status of the models to be evaluated and introduce them to the temperature and real-time reporting tasks to be employed on their ships. The goals here will be to ensure that they are comfortable with the systems being deployed on their ships and are comfortable with the data sharing aspects of the work.

ACCOMPLISHMENTS

Our time from April 2011 – March 2012 was spent performing a field evaluation of the butterfish model, reaching out to the fishing and scientific communities, and hosting the workshop to initiate vessel-of-opportunity surveys with the industry.

We used a model co-developed with scientific and industry partners as a basis for an experimental "operational" habitat model for butterfish, which was qualitatively evaluated with fisherman prior to field work as outlined in the outreach section. We coupled the operational habitat model to MARACOOS data streams in order to project habitat nowcasts. The georectified format chosen could be converted to allow visualization in Google Earth and could be sent over a satellite communication system from shore to ship at a reasonable cost. An openGIS software application allowed the scientists and fishermen to collaboratively route the cruise adaptively based upon nowcasts of the habitat model.

Our field evaluation of the habitat model was performed from December 10-17, 2011 aboard the 24 m Fishing Vessel "Karen Elizabeth" owned by Chris Roebuck. Model "nowcasts" for 05:00 GMT (Night) and 17:00 GMT (Day) were transmitted to the ship daily; these times produced low and high predicted biomass of butterfish in bottom trawl collections, likely due to diel vertical migrations. Sampling was performed with Chris Roebuck's bottom trawl. At each sampling site we towed the net twice along the bottom for 20 minutes over a distance of 2.02 km (1.6-2.7 km; speed = 1.68 m s^{-1}). One tow was made parallel to the isobaths and a second tow was performed across isobaths. The biomass of all species collected was measured and a subsample (N>20) of butterfish were measured for fork length. A sensor (Vemco 8 bit Minilog-TD 64K) attached to the port net door was used to record *in situ* temperatures at one second intervals while observations of acoustic backscattering on 200 kHz, 50 kHz, and 38 kHz fishery hydroacoustic machines were recorded.

Time of day and habitat hotspot (N=3) were used to stratify our field evaluation survey. Visualizations of the model indicated there were three habitat hotspots during the autumn located near the edge of the mid-Atlantic Bight continental shelf: south of Martha's Vineyard, east of Delaware Bay, and east of Chesapeake Bay. These spatial and temporal patterns were generally confirmed in interviews with industry collaborators.

Within each of the three hotspots and two times of day we sampled sites predicted to be "good" (predicted biomass >66% quantile of all predicted values) habitat and "poor" (<33% quantile) habitat in model "nowcasts", as well as a third site representing "good" habitat on the basis of the practical ecological knowledge of the fisher. The third site selected by the fisher allowed us to evaluate the accuracy of the model with respect to extent and resolution, as well as other unknown factors.

We are currently evaluating the results of the experiment. Details on the workshop and other outreach are described in the outreach section below.

HIGHLIGHTS

- 8-day at-sea evaluation of butterfish habitat model
- Workshop to initiate industry vessel-of-opportunity surveys
- Continued frequent interactions with industry partners

SOCIETAL BENEFITS

This research has shown that incorporating the knowledge of fishermen can positively impact the results of scientific research. The at-sea evaluation of the butterfish model identified the scales over which the model can be applied. Over the Mid-Atlantic Bight Scale, the model did a good job at identifying the preferred offshore butterfish habitats. The model did not however resolve the fine scales used by the fisherman within this coarser grid. The evaluation identified a role the model could play in guiding an industry based survey focused on small pelagic fish like butterfish, extending the coverage of the fishery-independent survey and sampling habitat regions not currently sufficiently sampled.

EDUCATION AND OUTREACH ACTIVITIES

- During the evaluation and the weeks leading up to it, a blog was maintained to update interested parties in the progress of the project. Various parties made contributions at sea and ashore at MARACOOS. http://ecologyofcoastaloceanseascapes.blogspot.com/
- Before the evaluation, the PIs had a call with fishermen from Cape May to discuss the results of the experimental operational habitat model to see if a hindcast of the model matched what the fishermen were observing. The model in hindcast mode was also put on the blog (http://ecologyofcoastaloceanseascapes.blogspot.com/2011/12/https1097_01.html) and the link was sent to Rhode Island fishers including Geir Monsen, Chris Roebuck and others. These parties were interviewed about the qualitative accuracy of the model via email. Fishers stated that the model appeared to be accurate at a broad scale and over time.
- The work was presented "Live" at the Mid-Atlantic Regional Association Coastal Ocean Observing System (MARACOOS) annual meeting in Washington, DC in December.
- This meeting was during the last few days of the evaluation, allowing us to present model output as we were getting it, as well as real-time updates from the ship.
- An industry workshop was held in Montauk, NY on March 29, 2012 to provide a status report, review existing models, and determine the best way to communicate habitat models to industry. We also discussed with the industry how to most effectively implement ship-of-opportunity surveys.
- Presentations:
  - Manderson, Kohut, Hoey, DiDomenico 2012 "The butterfish smackdown": Steps towards the development of an operational seascape ecology in support of ecosystem co-management. Abstract accepted 6th World Fisheries Congress which is being held in Edinburgh on the 7th - 11th May 2012.
  - Kohut et al (2012 Collaborative development of regional scale, dynamic habitat models in the context of Squid/Butterfish bycatch. A Workshop to Develop a Framework for Quantitative Seascape Ecology Supporting Ecosystem Assessment and Management. MARCH 1 & 2 Rutgers, New Brunswick, New Jersey

- Kohut et al (2012). Butterfish Smackdown:: Incorporating fisher knowledge into a regional scale "operational" habitat model for a keystone pelagic fish . Meeting of the ICES Working Group for the NorthWest Atlantic Regional Sea
- Manderson et al., 2011. Seascapes are not landscapes: A different view of habitat is required for the management of ecosystems in the sea. Invited talk, The School of Marine Science and Technology, University of Massachusetts, Dartmouth. November 2011
- Axellson et al. 2011. “The Butterfish smackdown”: towards the development of an operational seascape ecology in support of regional ecosystem management. MidAtlantic Chapter of American Fisheries Society. Annual Meeting. October 2011
- Manderson et al 2011. Marine Habitat Dynamics. Why should I care about that? NEFSC ECOAPP research Retreat, Newport Rhode Island, September 2011

Effects of Varied pCO_2 on Atlantic Surf Clams – Culture Experiments

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 43
April 01, 2011-March 31, 2012

Daniel McCorkle and Anne Cohen-Woods Hole Oceanographic Institution

NOAA Program Manager: James Widman –Culture Systems & Habitat Eval Branch

Related NOAA Goal Plan: 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: I. Ecosystem forecasting

PROJECT OVERVIEW

We proposed to work with colleagues at the NMFS laboratory in Milford CT (Lisa Milke and James Widman) to carry out two ocean acidification experiments on the Atlantic surf clam, *Spisula solidissima*. These included a short-term experiment (2-3 days post-fertilization) to investigate the impact of elevated pCO_2 on larval development and initial calcification, and a longer-term experiment (~21 days) to investigate OA impacts on surf clam development through metamorphosis. This collaboration was developed in order to combine Widman's and Milke's expertise in the physiology and development of *S. solidissima* with Cohen's and McCorkle's ocean acidification and biomineralization expertise.

ACCOMPLISHMENTS

We carried out three ocean acidification culture experiments with the surf clam (*Spisula solidissima*) during the summer of 2011 – two short-term (3-day) experiments, and one longer-term (21-day) experiment. The treatments for these experiments were:

Short term 1: pCO_2 (ambient (~400 ppmv) and 1200 ppmv) X feeding (unfed and fed)
Short term 2: pCO_2 (ambient (~400 ppmv) and 2200 ppmv) X feeding (unfed and fed)
Long term 1: pCO_2 only (ambient, 1200 ppmv, and 2200 ppmv), all fed

The two short-term experiments provided an initial assessment of the response of *S. solidissima* to elevated pCO_2, and also of the ability of enhanced nutrition to compensate for the impact of elevated pCO_2. The long-term experiment was designed to yield response curves (i.e, survival, shell length, and shell mass vs pCO_2), with sampling every 3 days through metamorphosis. The experiments were carried out using the CO_2 enrichment culturing facilities in the Marine Calcification Laboratory at WHOI, carbonate system analytical capabilities in co-PI McCorkle's lab, and microscopic imaging and image analysis capabilities in co-PI Cohen's lab.

In the first short-term experiment (1200 ppmv) we observed a clear impact of feeding on shell mass – fed specimens were more massive than unfed. The sensitivity to pCO_2 was similar for fed and unfed treatments. In the second short-term experiment (2200 ppmv) the shell weights of all

of the 2200 ppmv treatment specimens were lower than the either ambient or 1200 ppmv in the 1st experiment. However, the weights of unfed specimens at 2200 ppmv were slightly higher than 2200 ppmv-fed, although the two were not significantly different. Both of these short-term experiments suggest that feeding does not alter the sensitivity of surf clam shell mass to elevated pCO_2.

In the long-term experiment, survival decreased as pCO_2 increased at each sampling point (days 3, 9, and 15); by day 21, survival was too low for reliable results. Shell length at day 3 mirrored pCO_2 (length decreased by about 5 % as pCO_2 increased from ambient to 2200 ppmv). However, overall we saw no significant treatment effect on shell length – beyond day 3, although the ambient specimens tended to be the largest, the differences between treatments were not significant, and the order of average lengths did not consistently mirror pCO_2 level.

HIGHLIGHTS

Our experiments suggest that:

- Elevated pCO_2 decreases the 15-day survival of larval surf clams.
- Elevated pCO_2 does not have a strong effect on the length of larval surf clams.
- Feeding does not appear to alter the sensitivity of surf clam shell mass to elevated pCO_2.

SOCIETAL BENEFITS

The oceans have absorbed about 25% of the CO_2 emitted by fossil fuel burning and other anthropogenic activities since the mid-1800's, leading to a decrease in seawater pH and carbonate ion concentration. These changes may make it harder for molluscs to make their shells, and larval shell formation may be particularly vulnerable to increasing CO_2. Our results help to document and quantify these ocean acidification impacts, with the goal of informing management practices.

EDUCATION AND OUTREACH ACTIVITIES

To date, one presentation (Widman et al., 2012) on March 28, 2012 at the 104th National Shellfisheries Association Annual Meeting in Seattle WA.

Cohen and McCorkle hosted Oberlin College undergraduate Gail Schweiterman for three weeks in January 2012. Gail worked on imaging and image analysis of larval shellfish from summer 2011 OA experiments.

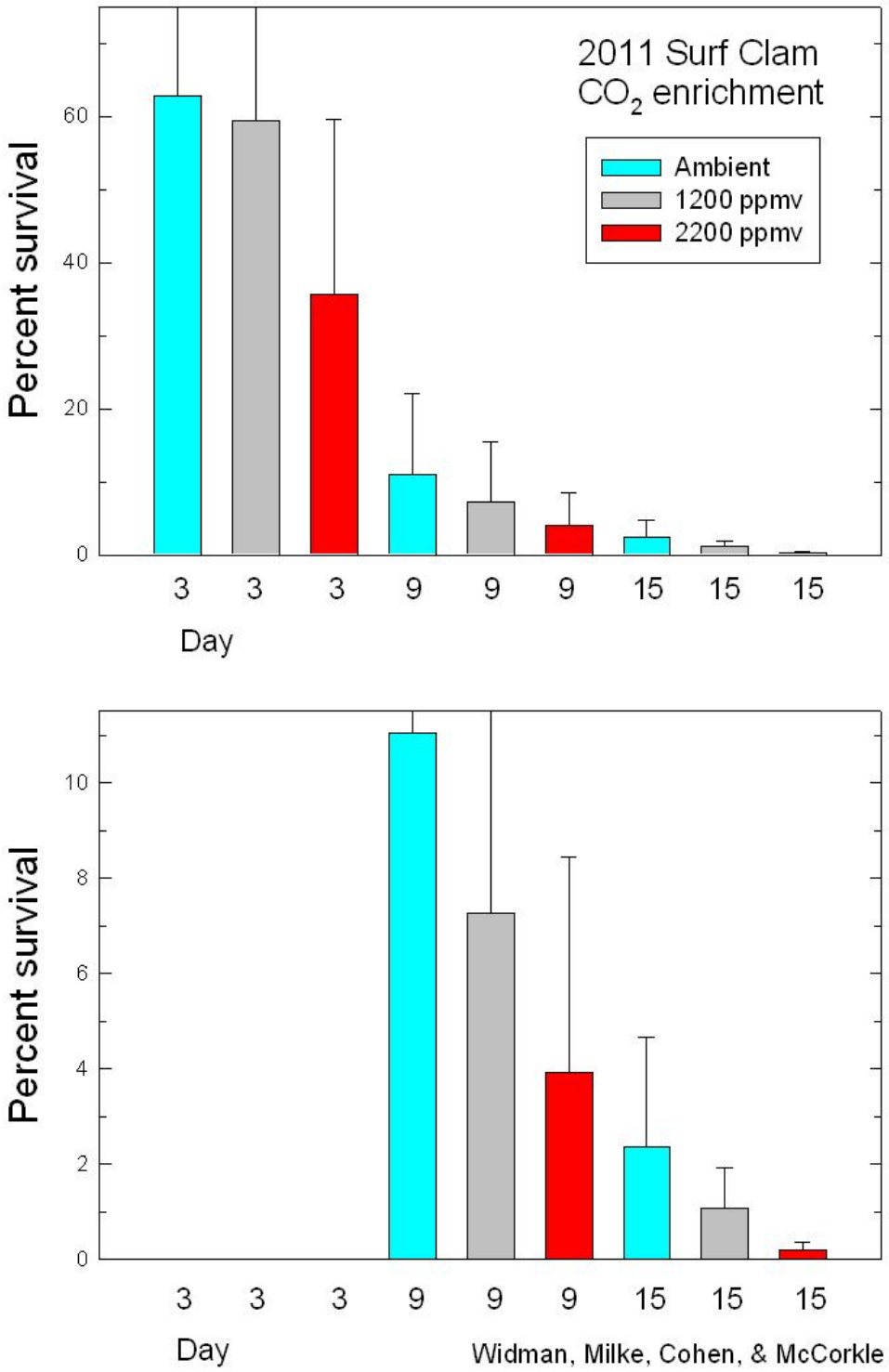


Figure 1. Percent survival (relative to inoculation) during the 2011 long-term surf clam experiment. Mean +/- SD of replicate containers. (Counts from J. Widman, NOAA-NMFS.)

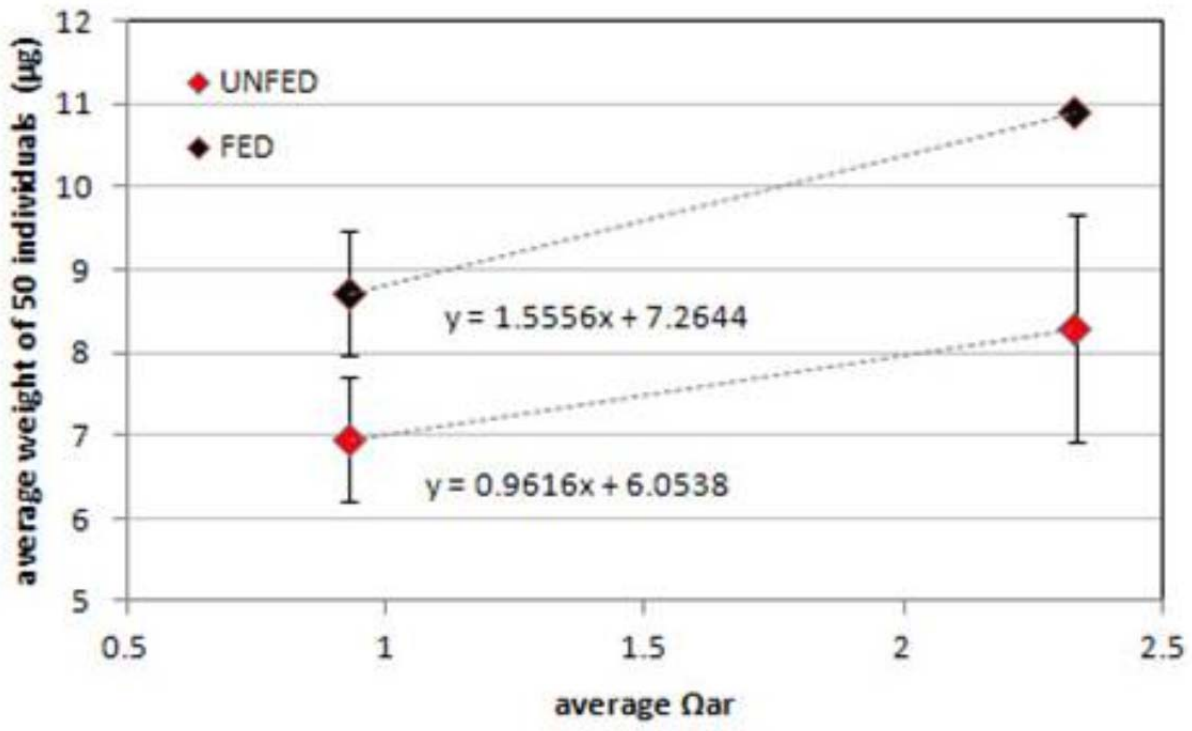


Figure 2. Average weight of 50 surf clams after ~70h (short-term surf clam experiment 1) under two different aragonite saturation states and two different feeding regimes. Mean ± SE of replicate containers. (Weight data from Cohen lab, WHOI; carbonate chemistry (saturation state) data from McCorkle lab, WHOI.)

THEME II. ECOSYSTEM MONITORING

CINAR

Cooperative Institute for the North Atlantic Region

Autonomous Gliders for Passive Real-Time Acoustic Remote Sensing

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 26
April 01, 2011-March 31, 2012

Mark F Baumgartner- Woods Hole Oceanographic Institution

NOAA Program Manager: Sofie Van Parijs-NMFS

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme II. Ecosystem Monitoring

PROJECT OVERVIEW

The overarching goal for this project is to explore the capability for autonomous gliders to provide real time locations of marine mammals as part of the NOAA Northeast Fishery Science Center's ongoing efforts to monitor and assess marine mammal stocks. Our specific objectives for the work are (1) to demonstrate the efficacy of near real-time detection, classification, and reporting of baleen whale calls from ocean gliders, and (2) to validate the performance of the detection/classification/reporting system using concurrent visual and acoustic observations of baleen whales.
This project relies on two enabling technologies: Slocum coastal gliders and the DMON acoustic instrument. Gliders are autonomous vehicles that can move both vertically and horizontally, carry a full suite of oceanographic sensors, and can report location, sensor data, and vehicle status remotely via Iridium satellite communications. Slocum gliders can sample at temporal scales of several weeks and spatial scales of several hundreds of kilometers. The DMON is a new instrument developed at WHOI capable of recording broadband acoustic data (10 Hz to 60 kHz) and analyzing those data in near real time to detect and classify species-specific calls. Integration of the DMON with Slocum ocean gliders allows summary detection/classification data to be sent to shore-based researchers via the gliders' native Iridium satellite communication system. The development of the DMON, its integration into gliders, and the development of detection/classification algorithms for baleen whales has been supported by the Office of Naval Research (ONR), and is now available for evaluation by NOAA as a research and management tool.

ACCOMPLISHMENTS

In 2010, we deployed three DMON-equipped ocean gliders in the Great South Channel (southwestern Gulf of Maine) for just under 4 weeks, and completed repeated longitudinal and latitudinal transects (Figure 1) during which they recorded acoustic data from a variety of sources. The Great South Channel is of particular management interest because of the seasonal occurrence of the highly endangered North Atlantic right whale. In addition to the right whale, the Great South Channel is a seasonal habitat for humpback, fin, sei, and minke whales during the springtime. Each glider completed four transects across the Channel between Nantucket

Island and Georges Bank. During 2011, we successfully (1) ported the low frequency detection and classification system (LFDCS; Baumgartner and Mussoline 2011) to the programmable DMON, (2) conducted bench testing of the DMON/LFDCS using synthetic and recorded audio data, (3) integrated the DMON/LFDCS with the glider to allow detections to be relayed to a shore-based computer using Iridium satellite communications, and (4) developed shore-side software to display all detection data on the web in both tabular and graphical formats in near real time. Initial field trials of the system with an ocean glider in spring 2011 produced in-situ detection, classification, and reporting of sounds (including both summaries of call types and individual pitch tracks), but a catastrophic leakage of an instrument attached to the glider, subsequent buoyancy pump failure, and the early recovery of the glider precluded a full assessment of the DMON/LFDCS. With funding from ONR, we will conduct additional in-situ testing of the DMON/LFDCS during the late summer and fall of 2012.

HIGHLIGHTS

Successfully deployed 3 ocean gliders in the southwestern Gulf of Maine during spring 2010 for 4 weeks; gliders recorded a variety of baleen whale calls, including those from humpback, fin, sei, and North Atlantic right whales.

- Completed manuscript on a generalized baleen whale call detection and classification system, and the paper has been published by the Journal of the Acoustical Society of America.
- Implemented the generalized low-frequency call detection and classification system on the DMON, and integrated the system with both glider and profiling float controller software.

SOCIETAL BENEFITS

This research project will improve our understanding of the distribution and habitat of endangered baleen whales in the Gulf of Maine and will provide a new monitoring tool for NOAA's mandated marine mammal assessment responsibilities.

Foraging Ecology and Habitat of North Pacific Right Whales

NOAA Cooperative Agreement No. NA09OAR4320129 WHOI Subpoint 38
April 01, 2011-March 31, 2012

Mark F Baumgartner-Woods Hole Oceanographic Institution

NOAA Program Manager: Philip Clapham-NMFS

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme II. Ecosystem Monitoring

PROJECT OVERVIEW

The eastern stock of North Pacific right whales (*Eubalaena japonica*) likely numbers fewer than 50 animals, and is seriously endangered. During the summers of 2008 and 2009, we participated in collaborative research with the NOAA National Marine Mammal Laboratory to study the distribution, behavior, and ecology of the North Pacific right whale in the southeastern Bering Sea. Our objectives were to (1) study the foraging ecology of right whales by attaching instruments to the whales and intensively sampling both oceanographic conditions and prey distribution in proximity to the tagged whales, (2) conduct broadscale oceanographic sampling to understand the processes that lead to the formation of prey aggregations, (3) collect zooplankton samples to identify the primary prey of the whales and to characterize the regional distribution, abundance, and community composition of zooplankton, and (4) collect acoustic recordings and conduct repeated oceanographic and prey sampling in proximity to whales over time scales of tens of hours to assess relationships between right whale calling activity and both oceanographic conditions and the vertical migration behavior of their prey.

ACCOMPLISHMENTS

During the 2008 and 2009 cruises, 139 profiles were collected with a conductivity-temperature-depth instrument, fluorometer, optical plankton counter, and video plankton recorder during (1) cross-isobath oceanographic surveys, (2) anchor station studies, and (3) during right whale tagging operations. In addition, 19 zooplankton tows were conducted both in the vicinity of right whales and in their absence. The optical plankton counter data have been calibrated with the zooplankton net data to allow estimation of the abundance and distribution of late-stage *Calanus marshallae* at all oceanographic stations. To date, all cruise data have been fully analyzed, and manuscript preparation is underway. Submission of a manuscript to Marine Ecology Progress Series summarizing our results is expected by June 1, 2012.

HIGHLIGHTS

- Zooplankton community composition on the southeastern Bering Sea shelf is much more diverse than in North Atlantic right whale habitats.
- Our observations suggest that the copepod *Calanus marshallae* is the primary prey of North Pacific right whales on the southeastern Bering Sea shelf. However, *Pseudocalanus* spp. may serve an important secondary food resource.
- No evidence was found to indicate *C. marshallae* undergoes a diel vertical migration; however, this behavior may be variable over time scales of days to weeks.
- Right whale spatial distribution is strongly influenced by *C. marshallae* abundance (Figure 1).

SOCIETAL BENEFITS

NOAA has a mandate to protect and conserve endangered marine mammals, including the North Pacific right whale. This research will improve our understanding of the distribution and habitat requirements of right whales, which in turn will (1) improve efforts to mitigate human-related effects on the population (e.g., ship strikes, fishing gear entanglements), and (2) aid in predicting how climate change may affect this critically endangered population.

EDUCATION AND OUTREACH ACTIVITIES

Esch, H.C., P. Tyack, J. Lynch, and M.F. Baumgartner. 2011. Modeling probability of detection of North Pacific right whale calls: implications for abundance estimation using passive acoustics. 19th Biennial Conference on the Biology of Marine Mammals. The Society for Marine Mammalogy. Tampa, Florida, USA. November 27 – December 2, 2011.

Esch, H.C., M.F. Baumgartner, C. Berchok, and A.N. Zerbini. 2009. Fine-scale temporal variability of North Pacific right whale call production. 18th Biennial Conference on the Biology of Marine Mammals. The Society for Marine Mammalogy. Québec, Canada. October 12-16, 2009.

Baumgartner, M.F., H.C. Esch, and A.N. Zerbini. 2009. Association between North Pacific right whales and a subsurface front in the southeastern Bering Sea. 18th Biennial Conference on the Biology of Marine Mammals. The Society for Marine Mammalogy. Québec, Canada. October 12-16, 2009.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

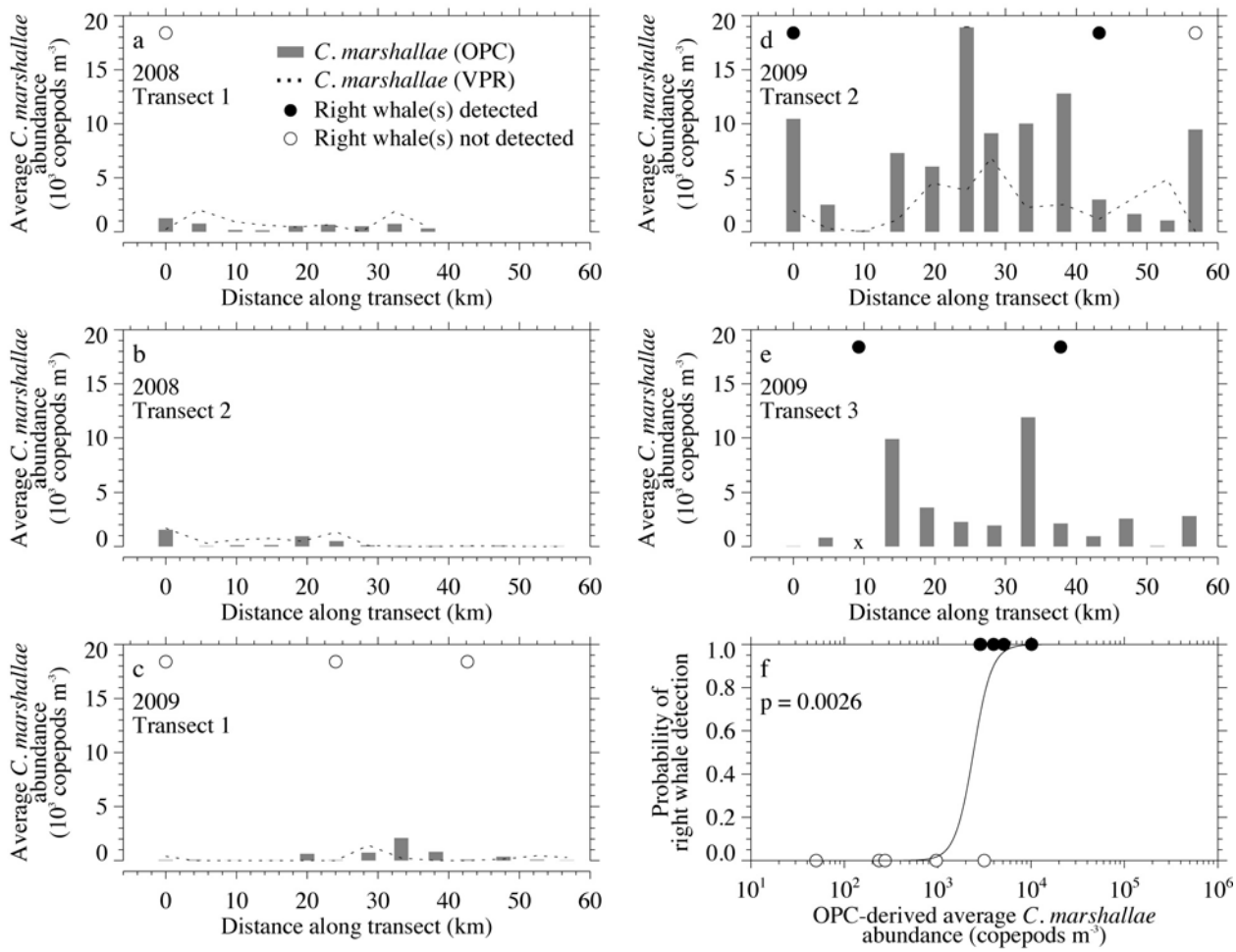


Figure 1. Results of each cross-isobath transect in the southeastern Bering Sea. The OPC- and VPR-derived average water column abundance of the copepod *Calanus marshallae* is shown as gray bars and a dotted line, respectively. The closed and open circles indicate whether right whales were detected or not detected, respectively, on sonobuoys deployed along the transect. The relationship between right whale detections and *C. marshallae* abundance is shown in (f) using logistic regression.

Characterizing North Atlantic Right Whale Habitat Through Integration Of Satellite Tagging, Acoustic, And Visual Survey Data

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 39
April 01, 2011-March 31, 2012

Mark F. Baumgartner-Woods Hole Oceanographic Institution

NOAA Program Manager: Sofie Van Parijs-NMFS

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme II. Ecosystem Monitoring

PROJECT OVERVIEW

A tremendous amount of habitat research has been conducted in the small-scale high-use areas occupied by North Atlantic right whales, such as Cape Cod Bay, Great South Channel, and the Bay of Fundy using a variety of tools and approaches. There are only a few methods that have attempted to characterize right whale movements, occurrence, or distribution over larger spatial scales or longer temporal scales. These include broadscale aerial surveys, satellite tagging, and long-term passive acoustic monitoring. Each of these methods provides a very different view of right whale occurrence and habitat, and each of these methods has advantages and limitations depending on the questions and spatial/temporal scales of interest. While habitat modeling can be conducted independently with any one of these methods, to characterize right whale distribution and habitat over large spatial scales and long temporal scales (e.g., annually throughout the Gulf of Maine and Scotian Shelf), it would be extremely useful if data from these three methods could be combined into a single analysis. Techniques to accomplish such an analysis have yet to be developed.

The objective of the this project is to develop a method to combine data from visual surveys, satellite tagging, and passive acoustic monitoring into a single framework to characterize the occurrence of right whales with respect to environmental conditions. This method will allow researchers and managers to reasonably extrapolate the relative probability of right whale occurrence in areas that have sparse occurrence data based solely on oceanographic conditions in those areas.

ACCOMPLISHMENTS

During the reporting period, we have developed a framework in which data from the three disparate sampling methods can be combined for a single analysis. The framework includes creation of tables of occurrence by area and day of the year for each of the three data collection methods. Each entry in the table corresponds to presence, absence, or no data available. The latter designation indicates that no effort was expended to determine presence or absence; for aerial surveys, this means no survey was conducted in the area; for passive acoustic data, this

means that no acoustic recorders were deployed in the area; for satellite tagging data, this means that no tag was attached to a whale, no tags were transmitting, or tagged whales could not have possibly reached the area. For both aerial surveys and acoustic recorders, there will be a single annual table that covers all areas. For satellite tagged whales, there will be a single table for each tagged whale. All of the occurrence tables will be aggregated into a single table using a logical "or". For example, a presence will be coded in the aggregate table for area C on day 10 if a presence appears in any of the occurrence tables for area C on day 10. Using this aggregate table, the minimum daily probability of occurrence in an area can be computed over any time scale as the number of coded ones in the table (indicating presence) for that time period divided by the total number of both ones and zeros for that time period.

An "area" is not defined strictly geographically, but instead is defined as "an oceanographically homogenous region." This definition is critically important, as the presence of one or more whales in a particular location will, in essence, be extrapolated over an area that is oceanographically similar to that location. The underlying assumption of this definition is that if a whale is seen in one area with a set of particular oceanographic conditions, it is more likely that other whales will be in other locations with similar oceanographic conditions. This assumption underlies all habitat modeling efforts, and this project makes the same assumption. The operational delineation of areas is challenging, however. Ideally it will be based on the habitat preferences of right whales derived from other studies. In this project, we are using the surface temperature, surface salinity, bottom temperature, bottom salinity, and surface stratification taken from a climatology of the Gulf of Maine and Scotian Shelf, since Baumgartner and Mate (2005) found that the distribution of satellite-tagged right whales was related to some of these variables. A cluster analysis will be used to identify areas with similar oceanographic properties (e.g., Figure 1). The occurrence tables will be constructed with the areas derived from this cluster analysis. The final product of this habitat analysis will be monthly maps of minimum daily probability of occurrence for each oceanographically distinct area.

HIGHLIGHTS

- Development of the framework has been completed.

SOCIETAL BENEFITS

NOAA has a mandate to protect and conserve endangered marine mammals, including the North Atlantic right whale. Our research will improve our understanding of the distribution and habitat requirements of right whales, which in turn will improve efforts to mitigate human-related effects on the population (e.g., ship strikes, fishing gear entanglements).

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

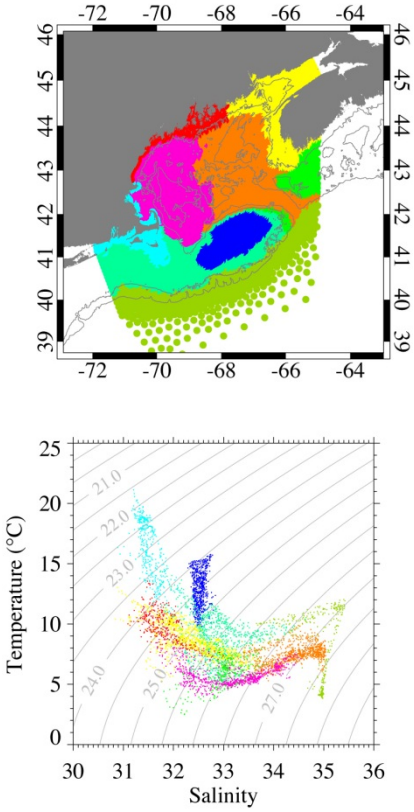


Figure 1. (top) Gulf of Maine with areas indicated in color. (bottom) Areas indicated on a temperature-salinity plot. Areas were derived from a cluster analysis of bottom temperature and salinity, latitude and longitude, and stratification in the upper 50 m of the water column.

2011 HABCAM Survey of Georges Bank and Phase II of NOAA HABCAM Project

NOAA Cooperative Agreement No. NA09OAR4320129WHOI Subpoint(s) 29,30,31,and 32
April 01, 2011-March 31, 2012

Scott Gallager-Woods Hole Oceanographic Institution

NOAA Program Manager:Russell Brown-NMFS/NEFSC- Ecosystem Survey Branch

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme II. Ecosystem Monitoring

PROJECT OVERVIEW

Phase II: Objectives:
To conduct a regional scale survey of Georges Bank between June 8 and 30 on the 3rd leg of the annual scallop survey

To design and construct a towed vehicle, support software development for stereo imaging, field testing the new system, and transition into operational oceanography.

Tasks:
1. To design and construct a towed vehicle,
2. To purchase and integrate a suite of environmental sensors,
3. To display and extract data from stereo image pairs and to measure targets in a web-enabled GUI
4. To field test all hardware and software for HabCam V4 for preparations for the scallop survey in the summer of 2012,
5. To transition HabCam technology into NOAA operations
6. To provide Kits and Spares
7. Deliverables

Task 1. To design and construct a towed vehicle
The tow body was constructed from 2" schedule 80 square 304 Stainless Steel. The frame is 5.5' wide by 10' long with a 2m high tail piece. The Camera Subsystem is mounted near the aft end with the four strobes in a circular arrangement around the cameras. A side scan sonar (Teledyne Benthos C3D) is mounted on a tail piece located 2 m higher than the frame to elevate the unit as far from the seafloor as possible. The vehicle is towed from a hard two point bridle while role and pitch are controlled with vertical and horizontal stabilizers. Payload space is allocated for housing a suite of environmental sensors as well as space for future installation of instruments such as the Video Plankton Recorder, Acoustic Doppler Current Profiler, and Doppler Velocity Logger for ground tracking. This task was completed as of April 13, 2012.

Task 2. To integrate a suite of environmental sensors.

The NOAA HabCam camera system is designed to collect as much environmental data as possible thereby contributing to the description of habitat. The telemetry housing has eight serial ports and four Ethernet ports for external sensors. The following sensors were purchased, calibrated and incorporated into the HabCam vehicle.

1. A CTD to measure (C) conductivity, (T) temperature, and (D) depth as pressure (Sea Bird SBE 49) operating at 10 Hz and has an integrated pump

2. Chlorophyll, backscattter @650nm, CDOM fluorescence (WetLabs ECO triplet)

3. Visible spectrum attenuation coefficient (HOBI Labs a-Sphere) with Sea Bird 5 external pump. The a-Sphere developed by HOBI Labs is a spherically integrating spectrophotometer, which measures the spectral absorption coefficient over the full visible spectrum. Water is continuously pumped through a spherical chamber. Multi-spectral light entering through an aperture reflects off the wall many times, distributing the light uniformly over the internal surface. More importantly for absorption measurements, the multiple reflections in the integrating sphere causes photons to traverse a total distance much greater than the dimensions of the cavity. This greatly increases the effective path length and therefore the sensitivity of the measurement. *a*-Sphere's 10 cm sphere gives effective path lengths of up to 2 meters. An integrating sphere has walls with high diffuse reflectivity. At the same time, the integrating cavity's sensitivity to scattering is very low, because the cavity captures and reflects scattered photons just as efficiently as unscattered ones. The only error introduced by scattering is a slight increase in the total path length traversed by scattered photons, but this error is not significant in most practical cases. In comparison, a standard spectrophotometer which uses a straight tube has a very short path length of 10 cm and measures both absorption and scattering, but scattering is undefined and difficult to quantify. The measurement, therefore, requires extensive calibration with ultrapure water and is not useful for routine measurements without great effort. The a-sphere provides full spectrum measurements at a frequency of one per second. These will be used specifically to color correct HabCam images by applying the measured attenuation coefficient for each image in a relationship using Beers Law for attenuation in the Red, Blue and Green bands. Since spectral data are acquired at 1 Hz and images at 5-6Hz, the application of RGB attenuation coefficients will be updated every 5th or 6th image. Attenuation coefficients will be recorded in the database as well as in the header of each raw tiff image. Data from the a-sphere will also be used in the traditional sense for assessing bio-optical characteristics of the seawater near the seafloor and possibly for measuring nutrients such as nitrate, nitrite and phosphate.

4. Dissolved Oxygen (Sea Bird SBE 43)

Other desirable sensors to be purchased at a later time include the following:

5. PAR downwelling irradiance (BioSpherical QSP 2200)
6. Three-axis current vector and plankton backscatter (RDI 600 kHz ADCP)
7. Along track workhorse navigator Doppler velocity logger for bottom tracking and position information (RDI Workhorse DVL 1200k Hz)

ACCOMPLISHMENTS

Tasks 1-3 have been completed.

The remaining tasks are on schedule for completion before June 1st.

A new website has been established to allow the public to see how the project is progressing with a basic description and daily to weekly updates. http://habcam.whoi.edu/habcamIV.html

This link has been very useful in communicating the status of the project and for generating milestone completion reports.

SOCIETAL BENEFITS

Data products produced from the development of a HabCam system for NEFSC will be integrated directly into the National Marine Fisheries Sea Scallop Stock Assessment Program. These data will allow for more accurate assessments of existing stocks and the setting of Total Allowable Catch limits. HabCam data products will be used to help improve the accuracy of scallop stock assessment. Consequently, improved accuracy in stock assessments will facilitate better management practices ultimately benefitting the commercial scallop industry. Currently, the scallop industry is constrained by regulations that limit yellowtail bycatch. Rapidly providing maps of yellowtail abundances and distributions from HabCam imagery will help scallop managers to set appropriate bycatch limits using valid in-season data.

EDUCATION AND OUTREACH ACTIVITIES

- We held a booth at the working waterfront festival in New Bedford, September 2011
- We held a workshop sponsored by Sea Grant to bring teachers to WHOI and experience an immersion course and hands on activities in HabCam activities. Benthic ecology was featured in the workshop
- We worked with Zepher Foundation to develop a program for bringing HabCam imagery and data products into k-12 classrooms.
- We have been collaborating with Citizen Science Alliance to develop a crowd sourcing software product to allow anyone to access HabCam imagery and produce scientific valid results. The beta version of this site will go on line next month.

PUBLICATIONS

None to date under this funding.Attended the Fisheries Society and presented a paper on the use of HabCam technology in fisheries science.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

Please see http://habcam.whoi.edu for further information on this project anmd an extensive gallery f images.

Also the public site describing the project: http://habcam.whoi.edu/habcamIV.html

Hydrographic Support for a R/V Thomas Jefferson Cruise to the Gulf of Mexico as part of the Unified Command Response to the Deepwater Horizon Oil Spill

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 35
April 01, 2011-March 31, 2012

David C. Fisichella-Woods Hole Oceanographic Institution

NOAA Program Manager: Kelly Taranto-NMFS/NEFSC

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme II. Ecosystem Monitoring

PROJECT OVERVIEW

This activity is the result of a cooperative agreement between NOAA and the Woods Hole Oceanographic Institution (WHOI) to conduct a rapid response research cruise to an area west of the Deepwater Horizon site for the purpose of understanding of the trajectory and position in the water column of the oil and dispersant. To accomplish this, the NOAA vessel R/V *Thomas Jefferson* was deployed from New Orleans under the direction of NOAA scientist Dr. Steve Murawski to perform hydrographic stations on east-west transects. In accordance with the cooperative agreement WHOI provided hydrographic services to augment the resources and capabilities available aboard the *Thomas Jefferson*. The final, complete hydrographic data package was delivered to NOAA after completion of the cruise.

ACCOMPLISHMENTS

The ten-day cruise successfully completed its objectives. This success was in large part due to the completion of the following activities:

WHOI personnel:

- Assembled and mobilized hydrographic equipment (rosette, Niskin bottles and CTD)
- WHOI personnel completed all of the necessary HAZWAPA training and requisite inoculations on short notice
- Assisted in developing the mission plan in conjunction with NOAA ship operations
- Managed and conducted hydrographic operations
- Completed turnover samples and raw CTD data to NOAA for handling in accordance with agreed protocols
- Completed demobilization of all equipment for return to WHOI

WHOI provided the following equipment for this effort:

- Stainless steel rosette frame
- 12 3.3 liter PVC sampling bottles with WHOI-applied spray-on Teflon internal coating
- SBE32 pylon to trigger release
- SBE9 CTD with single temperature, conductivity and oxygen sensors
- Benthos PSA916 altimeter
- Deck unit for CTD and computer for data acquisition
- Approximately 1800 m Rochester A301592 0.332 inch 3 conductor spare instrumentation cable

SOCIETAL BENEFITS

The impact of the Deepwater Horizon spill on the Gulf of Mexico and the surrounding shoreline cannot be understated. The ability of this hydrographic team to respond quickly and professionally allowed the collection of critical data that was subsequently used to decide the course of further mitigation and legal actions.

EDUCATION AND OUTREACH ACTIVITIES

WHOI team members provided interviews with local and national media about the research effort and methods used.

Inshore Gulf of Maine Herring Acoustic Survey

NOAA Cooperative Agreement No. NA09OAR4320129 **GMRI** Subpoint 13
April 01, 2011-March 31, 2012

Graham Sherwood -The Gulf of Maine Research Institute

NOAA Program Manager: Michael Jech-NMFS/NEFSC

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme II. Ecosystem Monitoring

PROJECT OVERVIEW

The goals of this project are to 1) use acoustics to estimate abundance and biomass of herring in coastal waters of Maine (Area 1A), and 2) combine our results with results from the NMFS offshore survey to generate a synoptic "snapshot" of the status of the Gulf of Maine herring complex. We will use a spatially- and temporally-comprehensive survey design, coordinated with the NMFS offshore survey using comparable acoustic systems.

Our objectives are:

1. Document the spatial extent of the herring complex across a broad time frame when herring are known to aggregate, spawn, and migrate through coastal Maine waters.

2. Estimate abundance and biomass for inshore Gulf of Maine herring for comparison with stock assessment estimates (the entire complex) and assumed allocations of the entire complex to inshore and offshore components.

Funds from the Maine Technology Asset Fund (MTAF) will be used to purchase equipment for conducting the surveys. This includes ten ES70 echosounders with 38- and 200-kHz single beam transducers to be outfitted on ten lobster boats with homeports distributed equidistant across the coast. MTAF funds also will be used to purchase other infrastructure equipment such as an EK60 split-beam echosounder (38- and 200 kHz transducers), computers, Echoview software, data storage, and other associated equipment. Funds from this CINAR proposal will be used to cover operating costs for surveys, staffing, supplies, and maintenance, and represent required match for the MTAF award.

ACCOMPLISHMENTS

We are in the early phases of implementing this project. All 10 lobster vessels have been indentified and a meeting was held in Belfast, Maine on March 21st to go over project goals and expectations with all of the participating fishermen. Acoustic equipment has been selected in consultation with SIMRAD and Mike Jech of the Science Center and our first order for the ES70 systems has been placed. Orders for the EK60 system and all related equipment and software will be placed in coming weeks.

HIGHLIGHTS

No research has yet been undertaken. The survey will commence in August of this year.

SOCIETAL BENEFITS.

The intended purpose of this research is to provide current estimates of Atlantic herring abundance and biomass. Results of this study will inform management decisions that could contribute to maintaining a sustainable population of Atlantic herring in the Gulf of Maine. More accurate estimates of herring abundance in the Gulf of Maine may contribute to more predictable bait supply for the Gulf of Maine lobster industry which relies heavily on this resource.

Development of Protocols and Tools to Access Fish Populations and Habitat Using the SeaBED AUV

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 52
April 01, 2011-March 31, 2012

Hanumant Singh-Woods Hole Oceanographic Institution

NOAA Program Manager: Elizabeth Clarke-Northwest Fisheries Science Center

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme II. Ecosystem Monitoring

PROJECT OVERVIEW

Over the last few years our laboratory has built various tools and components are used to process and analyze the imagery associated with the AUV. These tools work well when used in isolation but there is a lot of potential for further enhancement of these tools if they could be used to complement each other. Thus this proposal seeks to work on the following goals.

1. To extend our ability to count fish and classify habitat by using large scale mosaics as opposed to individual fish.
2. To extend our ability to construct automatic large area mosaics by utilizing the multibeam data to assist in the warping of the unstructured 3D terrain underwater.
3. To combine the forward looking imagery associated with the BlueView Imaging sonar with the multibeam data.
4. To combine the forward looking imagery with the forward looking sonar and multibeam to examine fish avoidance and other phenomenon of interest.

ACCOMPLISHMENTS

Our fundamental contribution has been in the use of graph based techniques for the simultaneous fusion of the optical and acoustic imaging methodologies. This technique includes in its optimization the role of attitudinal offsets and other calibration methodologies that have so far always been treated independently of the sensors.

These techniques can now be applied in a straightforward manner by technicians and other fisheries personnel without regard to the complexities of the underlying mathematical structures that has so far hampered the use of such techniques in the past.

HIGHLIGHTS

- Multisensor fusion of optical and acoustic imagery for large scale mapping across a variety of sensors

EDUCATION AND OUTREACH ACTIVITIES

Graduate student Clayton Kunz completed his doctoral dissertation (partially supported through this program) entitled “AUV Navigation and Mapping in Dynamic Unstructured Environments”.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

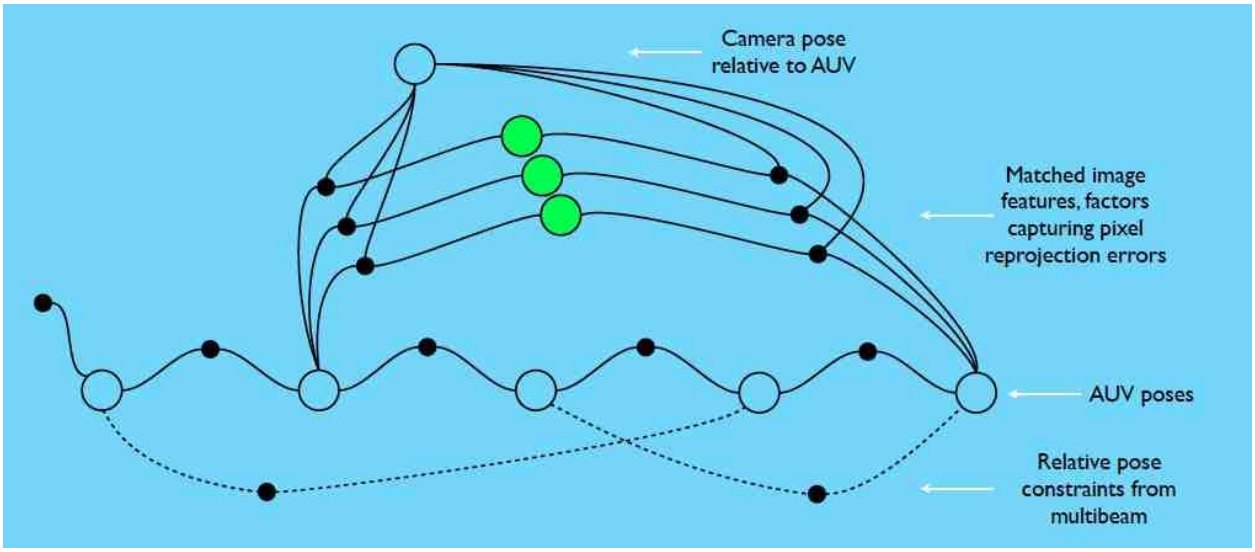


Figure: Graph based techniques are now allowing us to provide a mathematical framework that allows us to combine optical and acoustic imagery into a consistent representation that respects the constraints associated with offsets and calibration data while presenting a simplified front end to the fisheries end-user community.

Integrating a Forward Looking Sonar on the SeaBED AUV

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 49
April 01, 2011-March 31, 2012

Hanumant Singh-Woods Hole Oceanographic Institution

NOAA Program Manager: John Rooney-Pacific Island Fisheries Science Center / Coral Reef Ecosystem Division

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme II. Ecosystem Monitoring

PROJECT OVERVIEW

This project proposed the development and integration of the necessary hardware and software components to integrate the BlueView P900-130 high-resolution sonar to the SeaBED AUV, thereby enhancing its utility as a non-extractive, fisheries independent data collection tool. This development and integration includes the hardware necessary to mount and interface the BlueView Technologies sonar to the existing SeaBED AUV physical, power, and data collection platforms. The sonar itself was to be procured by PIFSC and made available for integration.

ACCOMPLISHMENTS

The Seabed AUV operated by NOAA's Pacific Island Fisheries Science Center has been very successfully been used for video transect surveys.
However, to address the limitation of low ambient light levels affecting video data collection and to strengthen the capability to identify and enumerate demersal fishes as well as to describe potential behavioral modifications, we had proposed to integrate a high-resolution imaging sonar into the SeaBED AUV's existing suite of sensors. Mounted horizontally and pointing forward of the AUV, the sonar imaging system serves to enhance sighting, quantification, and sizing of demersal fishes. As sonar is unaffected by low-light conditions, the proposed acoustic imaging system improves the SeaBED AUV's forward-looking video sensor range in light-limited conditions (e.g. depth > 100 m, low visibility, nighttime deployments). Furthermore, the videolike display of the high-resolution sonar data aids in determination of potential behavioral modifications of certain fish species, thereby enabling refinement of sampling design and AUV operation to minimize those behaviors. Used in conjunction with the optical imagery enabling species identification for fishes that are within range, these two tools should provide a synergistic and powerful combination for addressing the ASTWG themes of near-boundary assessments of living marine resources and remote species identification and enumeration.
While the system has integrated on the AUV NOAA researchers are now beginning to use it for its intended purpose and we are excited about the data this will generate.

HIGHLIGHTS

- A Blueview imaging system was successfully integrated on the NOAA AUV.

Real Time Imagery from an Autonomous Underwater Vehicle to Enhance Adaptive Mission Execution

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 55
April 01, 2011-March 31, 2012

Hanumant Singh-Woods Hole Oceanographic Institution

NOAA Program Manager: M. Elizabeth Clarke-Northwest Fisheries Science Center

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme II. Ecosystem Monitoring.

PROJECT OVERVIEW

This effort was aimed at integrating the WHOI Acoustic Modems with co-processors and PSK coding at the Woods Hole Oceanographic Institution. This will include the integration of both software and hardware and testing of systems. After integrating the hardware and software systems, the systems were to be tested during real missions in both the Western Pacific and West Coast to 1) obtain real-time imagery and 2) use information from imagery to remotely adjust the mission track.

ACCOMPLISHMENTS

The system was integrated as proposed. In addition, graduate student Christopher Murphy, who was working in this area (funded through this and other grants) defended his doctoral dissertation entitled “Progressively Communicating Rich Telemetry from AUVs via Relays”. The results have also been submitted for publication in the Journal of Oceanic Engineering.

Encoding and transmitting imagery at the extremely low data rates available on conventional modems is not possible with conventional (jpeg, jpeg2000) coding schemes. Our methodology utilizes a multi-step approach that initially classifies and segments the imagery into multiple classes, discretizes the space via an arithmetic coding scheme, and then reconstructs a texture synthesized version on the surface.

HIGHLIGHTS

- Routine telemetry of underwater imagery from AUVs across the horizontal channel

EDUCATION AND OUTREACH ACTIVITIES

Contributed (in part) to the doctoral dissertation of Christopher Murphy.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

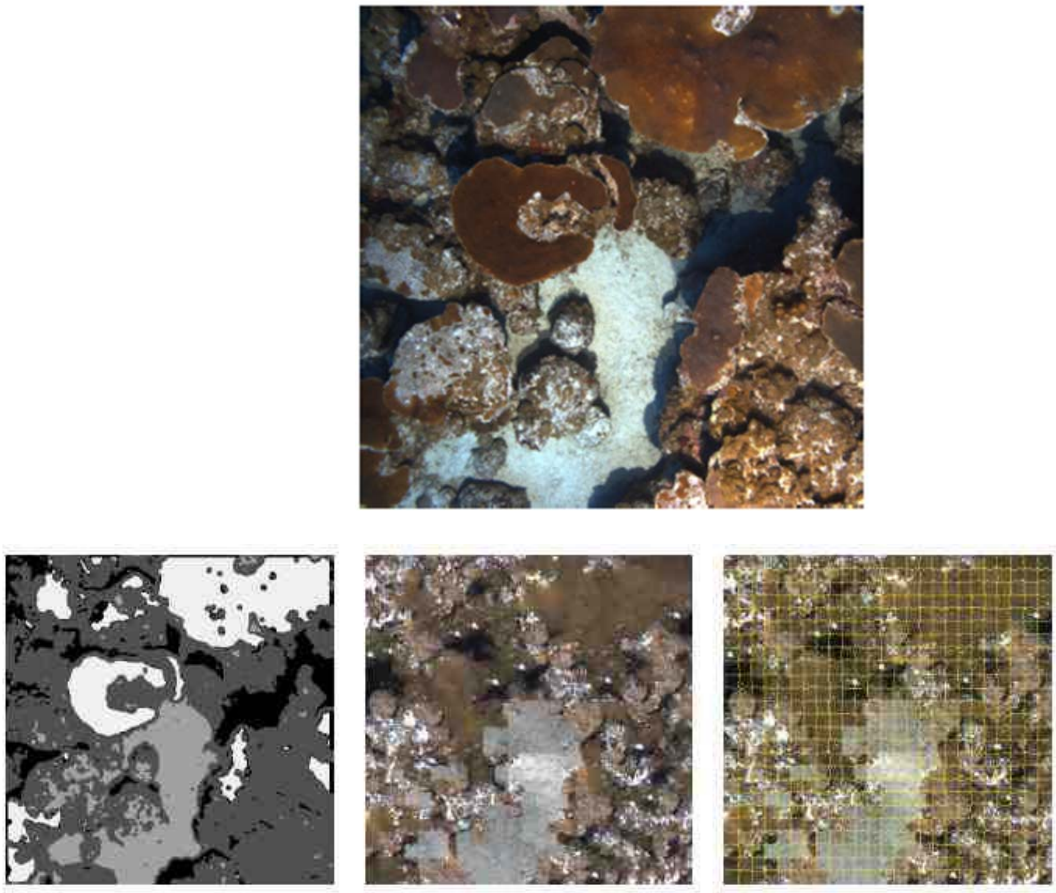


Figure 1. Original image(top) and intermediate stages of processing for very high level compression of underwater imagery for real-time transmission. Bottom Row (left) segmented image (center) reconstructed based on texture synthesis and (right) tiles used for texture synthesis.

Nutrient Dynamics on the NF Continental Shelf: Sample Analyses

NOAA Cooperative Agreement No. NA09OAR4320129 **UMaine** Subpoint 01
April 01, 2011-March 31, 2012

David W. Townsend-University of Maine

NOAA Program Manager: Jon Hare -NMFS/NEFSC- Narragansett Lab

Related NOAA Goal Plan: Goal 2. Climate Adaptation and Mitigation: An informed society anticipating and responding to climate and its impacts

CINAR Theme: Theme II. Ecosystem Monitoring

PROJECT OVERVIEW

The accelerated melting of the Greenland ice sheet and the Arctic ice cap in recent decades appears to be influencing marine ecosystems far removed from the Arctic Ocean via changes in the circulation of the Labrador Sea and the Northwest Atlantic continental shelf and slope waters. This has resulted in an increased baroclinic transport of low salinity shelf waters to regions farther south. Consequently, we are seeing changes in the water properties and nutrient regime in the Gulf of Maine over the past several decades. Retrospective analyses of hydrographic and nutrient data back to the 1960s have revealed that deep water layers in the Gulf (>100m) have become fresher and cooler, with lower nitrate but higher and more variable silicate concentrations over a period coincident with recent, rapid melting in the Arctic (Townsend et al. 2010). There is growing evidence that those changes in the nutrient regime may also be forcing changes in the structure of the planktonic ecosystem (McGillicuddy et al., 2011).

In order to begin to monitor this apparent change in the ecosystem of the Northwest Atlantic continental shelf, we are analyzing samples collected as part of the *NOAA Northeast Fisheries Science Center's Ecosystem Monitoring Program* (EcoMon Program) in collaboration with Dr. Jon Hare. The EcoMon Program conducts survey cruises approximately four times each year in shelf and slope waters of the Gulf of Maine – Georges Bank – Mid-Atlantic Bight. As part of their standard sampling, they perform a CTD cast at each station and, when possible (given constraints for water sample allocation) they collect water samples for nutrient analyses. Samples are filtered and frozen at sea and then delivered by overnight courier to the University of Maine where they are analyzed for nitrate plus nitrite, silicate, phosphate and ammonium using standard autoanalyzer techniques. Those data are delivered to NOAA following each cruise.

ACCOMPLISHMENTS

As of this writing (March 27, 2012) we have received and processed samples from the 7 cruises summarized in Figure 1, which shows station locations for each cruise and the number of samples analyzed. Upon completion of our nutrient measurements we combine the resulting data with the CTD data and produce profiles of the hydrography and nutrient properties. We plan to

continue to study – with our NOAA and Woods Hole Oceanographic Institution colleagues – the hydrographic and nutrient data collected on future ECOMON cruises, as the data density becomes suitable for more in depth analysis. As with all of our nutrient data processed in our laboratory, we are incorporating them into our regional nutrient and hydrographic database (Rebuck et al., 2009).

HIGHLIGHTS

- Results continue to provide evidence of shelf waters becoming fresher and colder, with proportional changes in nitrate and silicate (e.g., Townsend et al., 2010) as reported in our progress report from one year ago.
- Analyses of data collected by the February, 2011 ECOMON cruise, by McGillicuddy et al., (2011) showed that freshening of waters in the Gulf of Maine observed in 2010 continued into 2011, with water masses entering the Gulf of Maine through the Northeast Channel being among the freshest on record.
- Our continued analyses of the nutrient samples collected on the ECOMON cruises will be extremely important in our interpretations of conditions of Paralytic Shellfish Poisoning (PSP) from *Alexandrium* populations.

SOCIETAL BENEFITS

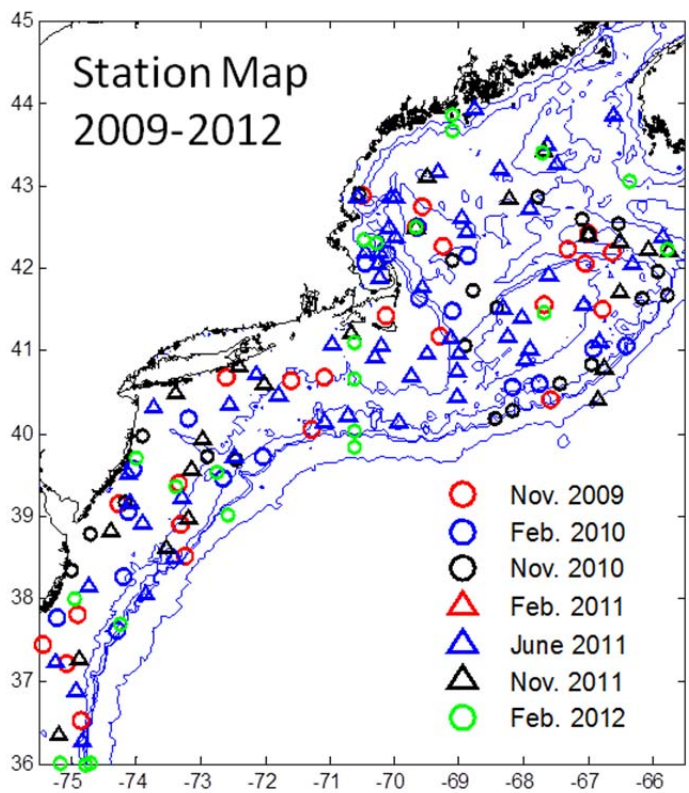
- This research is providing baseline data for future interpretations of climate change-induced alterations to the marine environment of the Northwest Atlantic continental shelf.
- Our data have already provided evidence in support of earlier expressed concerns about far-field effects of Arctic melting.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

Table 1. Cruises, stations and samples analyzed to date.

Cruise	No. Stations	No. nutrient samples
Nov. 2009	26	88
Feb. 2010	19	64
Nov. 2010	25	94
Feb. 2011	1	11
Jun. 2011	38	182
Nov. 2011	13	65
Feb. 2012	22	130

Figure 1. Station locations where nutrient samples have been collected as part of seven ECOMON cruises, as indicated.



THEME III ECOSYSTEM MANAGEMENT

CINAR

Cooperative Institute for the North Atlantic Region

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 45 and 46
April 01, 2011-March 31, 2012

Donald M. Anderson-Woods Hole Oceanographic Institution

NOAA Program Manager: Michael Fogarty-NEFSC

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Ecosystem Management

PROJECT OVERVIEW

As mentioned in the Executive Summary, CINAR Theme Leaders worked with the Council of Fellows to design a series of workshops, organized around CINAR themes. The goal for each was to outline NOAA's needs in a particular area, as well as their plans for future programs. This is an opportunity for new approaches and technologies to be highlighted in a common effort to identify gaps or impediments as well as potential solutions. Two workshops were supported with funding from the NEFSC.

ACCOMPLISHMENTS

- ***Climate and Ecosystem Change in the NW Atlantic***

    A. Models and Ecosystem Indicators for Integrated Ecosystem Assessment: What can CINAR contribute?
    B. Forecasting the impact of Climate Change on Primary and Secondary Production in the CINAR Region

A total of 21 CINAR investigators and 19 NOAA managers and scientists attended the two-day workshop held in Woods Hole.

The working group on climate variability and change outlined a strategy for advancing the ability to forecast impact of climate change on key ecosystem processes in the NW Atlantic. Because of the long history of physical and biological measurements, this region provides an ideal test bed for understanding climate ecosystem interactions and for developing forecasts of future ecosystem change. The forecasting task is complicated, however, by the region's complex oceanography, with strong influences from the warm Gulf Stream and cold Labrador Current. Nevertheless, workshop participants were optimistic about the potential for relating projections from global climate models to regional processes, and recommended a strategy for developing these much needed forecasts. The strategy has three core components:

- Concerted development of a range of climate model downscaling approaches (statistical and dynamical) and high resolution climate simulations in order to relate global and basin scale climate dynamics to responses within the CINAR region.
- The development of robust physical biological modeling frameworks for regional climate ecosystem hindcasts and forecasts.
- Synthesis of past observations and targeted augmentation of observing systems to capture climate driven ecosystem changes and assess the reliability of regional climate ecosystem models.

The working group on Integrated Ecosystem Assessment (IEA) addressed ways that the CINAR academic partners and NOAA partners could work in concert to advance relevant indicators and model development. The discussion topics included the current status and future development of IEAs, identification of current observational gaps and how CINAR partnerships might be developed to fill them, potential applications of new technologies for observing and modeling, challenges that must be met to exploit untapped datasets, and needs for new partnerships to advance collaborative research. A roadmap for CINAR sponsored progress emerged, with discussions highlighting particular topics that should receive attention within future working groups, as well as some other areas where CINAR should place high priority:

- Promotion of CINAR as a vehicle to facilitate partnership development
- Enhancement of CINAR sponsored graduate student and post doctoral training opportunities
- Establishment of a forum for discussion/exploration of candidate indicators (or refined indicators)
- Creation of a process to identify new indicators, with corresponding reference points for application in the IEA
- Identification of IEA indicators that relate drivers to states, and need for new research to understand the processes involved
- Identification, prioritization, quality control, and accessibility of existing data sets in support of Integrated Ecological Assessment
- Need for new research to constrain important model parameters (e.g., species specific fish consumption rates) and their uncertainties
- Need for socioeconomic information to understand anthropogenic drivers that impact resources
- Need to understand ecosystem impacts of non living resource exploitation
- Need to understand and properly measure “reference points” (values at which major ecosystem or component species shifts are predicted)
- Need for time series observations of nutrients, pH, oxygen and zooplankton
- Need for information on undersampled species (e.g., euphausiids, gelatinous zooplankton)
- Development of new observing technologies, new modeling techniques, and approaches for linking stationary sentinel station time series with mobile observing systems

At present, NOAA’s climate modeling work provides the capability to make predictions about changes across broad spatial scales. Developing the capacity to predict changes at a regional scale and to extend the predictions of physical change to estimates of ecosystem response is a major challenge. It will require high resolution models of both physics and biology, sustained

observations of processes in the region, and additional targeted studies on specific processes as well as evaluation of new modeling and observing technology. NOAA is charged as well with leadership in the development of Integrated Ecosystem Assessments (IEAs), an ongoing process that provides multidisciplinary ecosystem analysis, including identification and interpretation of climate forced impacts, for incorporation into management decision making. The effectiveness of the IEA depends on the development and interpretation of a set of crucial indicators that capture the ecosystem state and its responses to change. To be successful, both regional climate modeling and assessment of ecosystem impacts will require pooling of resources both within and outside of NOAA. The CINAR institutions have world class capabilities in these areas as well as a strong track record of collaboration, both among the institutions and with NOAA scientists. This workshop takes concrete steps toward development of cooperative partnerships to achieve effective regional management responses to the challenges imposed by global environmental change.

- ***The Role of Social Sciences in Ecosystem-Based Management***

A total of 16 CINAR investigators and 7 NOAA managers and scientists attended the two-day workshop held in Woods Hole.

While much scientific attention has been directed at the ecological aspects of marine fisheries, arguably less effort has been devoted to research on the social science aspects of EBFM. The main purpose of the workshop was to begin to set right this imbalance by taking steps toward a conceptual framework for the contribution of the social sciences to EBFM and the identification of critical topics for social science research.

The workshop participants agreed that the development of a conceptual framework for social science research in EBFM was an appropriate and productive endeavor. A conceptual framework could help to correct an imbalance in scientific research relating to EBFM, which to date has emphasized the natural sciences, and it would be heuristically useful for articulating a wide range of relevant social scientific questions.

The workshop participants felt that the convening of a second workshop to further articulate a conceptual framework for EBFM would be useful. A second workshop could involve advance work by small teams integrating researchers from the different social science fields with marine ecologists, particularly those involved with NEFSC's Ecosystem Assessment Program.

Small teams could undertake pilot studies to think through integrated approaches to EBFM for genuine situations in both the Mid-Atlantic and New England. Some of the pilot studies could be based upon the notion of “ecological production units” that define the boundaries and significant elements of place-based natural systems including fisheries but also other activities. Other pilot studies could build upon existing species-specific fishery management units, addressing the question of how they might evolve into more ecological approaches to management, sensitive to trophic linkages and dynamics, and their relationships to human valuations, cultural diversity, and governance traditions.

HIGHLIGHTS

- A follow-on workshop on Ecosystem Based Fisheries Management "*Integrated Approaches to Ecosystem-Based Fisheries Management Combining Social and Ecological Perspectives through Pilot Fishery Ecosystem Plans"* has been funded. That workshop is currently being planned and we will report on outcomes in our next progress report.

SOCIETAL BENEFITS

Each workshop has provided a specific set of recommendations on programs or collaborative efforts required to address NOAA's needs.

EDUCATION AND OUTREACH ACTIVITIES

There have been no outreach activities outside of the CINAR community, other than to publish the workshop reports on our Web Site. However, plans are underway for a workshop, entitled, "*Education, Research Translation and Outreach associated with CINAR Science Programs*" which will involve results from all of the CINAR workshops.

PUBLICATIONS

Workshop reports are published on the CINAR Web Site – www.cinar.org.

Facilitating the Submission of Electronic Vessel Trip Reports by Northeast Fishermen

NOAA Cooperative Agreement No. NA09OAR4320129 **GMRI** Subpoint 01
April 01, 2011-March 31, 2012

Steve Eayrs-The Gulf of Maine Research Institute

NOAA Program Manager: Joan Palmer -NMFS

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme III. Ecosystem Management

PROJECT OVERVIEW

The overall objectives of this project are to test the efficacy of three different computer software options across a range of commercial fishing vessels to transmit electronic vessel trip reports (eVTRs) and identify issues pertaining to electronic data transmission and software operation. These options were tested on a range of 30 vessels over the course of 2010 (the eVTR Pilot phase, during which time fishermen were required to transmit using both electronic and handwritten options). The goals of the project this year were to expand upon that testing and begin outfitting additional boats with eVTR hardware and software.

In July 2011 eVTR was made compliant with NMFS's VTR reporting and data security regulations. Since that time we have equipped another 13 vessels with hardware and software to begin reporting their VTRs electronically. The captains of each vessel were also provided one on one training in the use of the software. Of those 13, 9 are from the Port Clyde Sector, 2 from Northeast Fishery Sector (NEFS) 10 (part of the Northeast Seafood Coalition), and 2 from Northeast Coastal Communities Sector (NCCS). Currently the largest obstacle to eVTR uptake by fishermen is the politics revolving around different sectors, and the cost and availability of suitable software programs. The New England Fisheries Science Center (NEFSC) has developed and released eVTR software known as Fisheries Logbook Data Recording System or FLDRS at no cost to fishermen. This software is currently being used by the Port Clyde Sector, the Cape Cod Hook Sector, and a small number of willing participants within the NCCS sector. Some sectors are yet to decide which software to use, being reluctant to use the FLDRS software that they perceive is too narrow in scope and does not provide additional data useful to sector management. They also have concerns over data flows from fishermen back to the sector, via the current eVTR pathway. Furthermore, the Northeast Seafood Coalition have recommended their members delay eVTR transmission until their own software known as Fishtrax is developed and tested. Sectors within the Northeast Seafood Coalition and the Sustainable Harvest sector comprise approximately 70% of the groundfish fleet and this means many fishermen are unwilling to commit to this project at this time. This has therefore limited the current scope of work to just a small number of fishermen. Ultimately this has resulted in a slower uptake in eVTR options from the majority of New England groundfish fleet than anticipated.

As more fishermen become familiar with eVTR transmission and associated benefits we expect to be busy over the next year as uptake of eVTR options increases. Also expected are new software options, including completion of Fishtrax, modifications to existing software on a sector by sector basis, and continuing support of existing installations. We will also continue to act the conduit between fishermen, the NEFSC, and all other parties, relaying information and feedback.

PROJECT OVERVIEW

During the past 12 months we have trained thirteen fishermen and set up their vessels with new hardware and eVTR software. Of the thirteen fishermen we have setup, four are currently reporting electronically (using FLDRS); three of these fishermen are in the Port Clyde sector, and one is from the NCCS. These fishermen have combined transmitted ~50 reports over the past 7 months. This is a high number given these boats were not fishing the entire time, some were hauled out for annual maintenance, some took time to prepare for shrimp fishing, and time was lost due to poor winter weather. The primary hindrance to the remaining nine fishermen beginning their reporting was largely attributed to timing of the fishing seasons. By the time eVTR regulations were developed and implemented the groundfish season was starting to wind down, and as such, many captains decided to wait until the start of the next season (May, 2012) before they commence eVTR transmission. We expect most of these fishermen to complete registration for eVTR prior to this time and be ready as the new season commences. We are also anticipating increased interest from additional fishermen as May approaches. The Port Clyde sector has expressed interest in equipping all their members with eVTR prior to May.
Given the complexity of the fishing industry, outfitting a vessel with eVTR is not necessarily an easy task. A good bit of time is spent building and maintaining a relationship with fishermen and sector managers to educate them of the merits of eVTR transmission, including transmission options, data security, timeliness of data receipt, user-end error reduction, and ease of use. This has included numerous phone calls, one-on-one meetings, and presentation at industry meetings and other fora. We've highlighted the benefits in timely data transmission to sector managers, including information that is largely error free and comprehensible. As queries, issues, and problems have been raised by fishermen or sector managers we have passed these through to NMFS and worked closely with them to ensure resolution.

Working with each fisherman usually commences when a sector manager informs us that one or more fishermen in the sector are interested in eVTR transmission. We then contact the fishermen, explain eVTR options, and field any initial questions. We also assess their hardware needs. We then visit the fishermen on his vessel, install the hardware and software, and give him a one-on-one walkthrough of software operation and data transmission procedure/options. To assist the fishermen we also provide training guides (with screenshots and step-by-step instructions) for the software/upload procedure. If a fisherman needs further support, has a problem, or if the software needs an update/modification we will revisit the vessel and assist with those tasks.

HIGHLIGHTS

- Trained 13 fishermen over the past twelve months in the use and operation of electronic logbook software to transmit logbook data electronically and outfitted their vessels with appropriate hardware and software
- Established GMRI as the point of contact with fishermen/sector managers/NMFS managers regarding eVTR issues and operation
- Overcame a variety of technical issues and facilitated the spread of accurate information on eVTR transmission options, data requirements, timeliness of data flow, and use to industry.

SOCIETAL BENEFITS

- Data transmission is simpler, easier, less expensive and time consuming for fishermen, thus they can spend more time focusing on fishing activity and safety
- More accurate, appropriate, and responsive analysis and management by Sector managers, NEFSC staff, and others with access to eVTR data
- Less chance of errors associated with poor handwriting and incomplete data entries in paper logbooks.

EDUCATION AND OUTREACH ACTIVITIES

- Project staff from GMRI gave an oral presentation on eVTR at the American Fisheries Society Annual Symposium in Seattle, WA in 2011.
- Project staff from GMRI gave an oral presentation on eVTR at Northeast Consortium Annual Conference in Portsmouth, NH, in 2011.
- Project staff from GMRI gave an oral presentation on eVTR at the Maine fishermen's forum in Rockland, ME, in 2012.
- Project staff from GMRI gave an oral presentation on eVTR at a general meeting for fishermen in the Port Clyde Community Groundfish Sector, in Rockland, ME, in 2012.
- Project staff from GMRI gave a poster presentation on eVTR at the New Bedford Working Waterfront festival general in New Bedford, MA, in 2011.
- Project staff from GMRI gave a poster presentation on eVTR at the Innovation in fisheries workshop in Portland, ME, in 2011.
- Project staff from GMRI wrote a general article describing the eVTR project in National Fishermen (November 2011, page 14), Commercial Fishing News (see attached copy), and the Fishermen's Voice (a local Maine industry paper).

PUBLICATIONS

This project does not currently lend itself to journal publication of results

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

See attached eVTR poster and hand out (derived from the poster) that we produced for meetings/conferences.

Facilitating the use of Electronic Vessel Trip Reports (eVTR) in the Northeast groundfish fishery

Gulf of Maine Research Institute
Science. Education. Community.

Croy Carlin, Adam Baukus, and Steve Eayrs (Gulf of Maine Research Institute), Joan Palmer (NEFSC)

Background

In 2010 the Gulf of Maine Research Institute (GMRI) and the Northeast Fisheries Science Center (NEFSC) began a collaboration to prepare fishermen in the Northeast groundfish fishery with equipment and skills to electronically transmit the vessel trip report.

In June 2011 the Northeast Regional Office (NERO) announced these fishermen could submit their reports (VTR) electronically and replace the submission of paper trip reports.

Project scope

This project has several core activities:

- Troubleshooting electronic logbook programs suitable for preparing and transmitting vessel trip reports
- Equipping vessels with logbook hardware and software
- Design and delivery of an effective training program for fishermen in the use of logbook hardware and software
- Collaborating with third-party software developers and regulators to meet transmission protocols and understand software specifications/security needs
- Assisting industry in understanding the differences between paper and electronic reporting *(Table 1)*.

Project outcomes (to date)

- Outfitted 32 vessels and trained captains in hardware and software use
- Several captains actively transmitting their VTR electronically
- Collaboration with providers of eVTR software to meet project and industry needs

Software providers

Any logbook program approved by NMFS can be used to submit and record an eVTR. To date only the NEFSC-developed program, Fisheries Logbook Data Recording Software (FLDRS), has been approved for use. The Gulf of Maine Research Institute is also assisting with training fishermen in the use of alternative logbook solutions as part of a pilot study.

- **Fishtrax** - developed by the Northeast Seafood Coalition
- **Olrac** (previously Olfish) - developed by a private company

Fundamentally any eVTR program will do the same thing, it's up to the user to decide what works best for them.

Data transmission options

The eVTR files are encrypted for security purposes prior to transmission to NMFS while the vessel is at sea *(Figure 1)*. Key transmission considerations include:

VMS: Available on most boats, long range, speed can be variable and sometimes unreliable, transmission costs comparatively expensive.

WiFi: Short range, generally reliable, infrastructure costs (e.g. modems) and monthly fees can be shared by a sector to reduce cost.

3G Cell Phone Service: Medium range, reliable as long as there is cell phone service. Transmission costs are moderately priced.

USB Drive: Files can also be stored on a thumb drive and then transmitted from a computer on the shore. Data transmission is reliable and inexpensive (since the user would utilize a pre-existing connection), but the additional steps of data transfer to a thumb drive, then taking it to another computer to upload takes time and dedication.

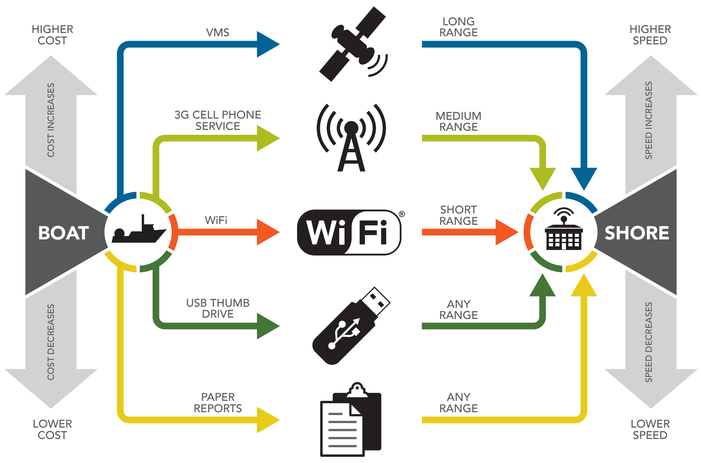


Figure 1: *Transmission options*

	Paper Reporting	Electronic Reporting
Data Entry	• Handwritten onto a paper trip report • Prone to errors and handwriting legibility problems	• Typed into an electronic logbook • Most data fields are pre populated (automatically) • Easy to complete • Programs self check for errors/ outlying data
Data Submission	• Mailed on a weekly basis to NMFS, the dealer, and the sector manager • Data manually entered into computer	• Uploaded to NMFS servers immediately after a fishing trip • Can then be e-mailed or printed as a PDF file to give to the dealer and sector manager
Submission	• Must be mailed weekly	• Must be uploaded weekly
Confirmation of Receipt	• No means of confirming a report was not received by NMFS	• After uploading an eVTR the captain can go online and (after 1 hour) verify that his trip was uploaded and confirmed

Table 1: *Comparison between paper and electronic VTR reporting.*

Benefits

Benefits to Fishermen – Electronic transmission eliminates the need for the paper VTR, expedites data entry, reduces wheelhouse clutter and input errors, and enables faster tracking of catch data. Electronic catch and effort logbook data is available for future reference.

Benefits to Sectors – Simultaneous transmission is available to sector managers, thus facilitating monitoring and management of near real time sector vessel activity, including avoidance of discard hot spots. Manual data entry by sector managers is reduced, enabling greater time to focus on other pressing issues.

Benefits to NMFS – Near real time monitoring of sector vessel activity, more accurate collection and evaluation of catch and discard information.

Future goals

As the project continues GMRI's goal is to continue supporting industry involvement in electronic reporting by generating outreach and support materials, supporting current eVTR users (through either written documentation or hands on training), and assisting in preparing new users. Ideally as eVTR becomes more widespread, further interest will be generated, and more captains will adopt the system.

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Electronic VTRs: A new era in quota tracking

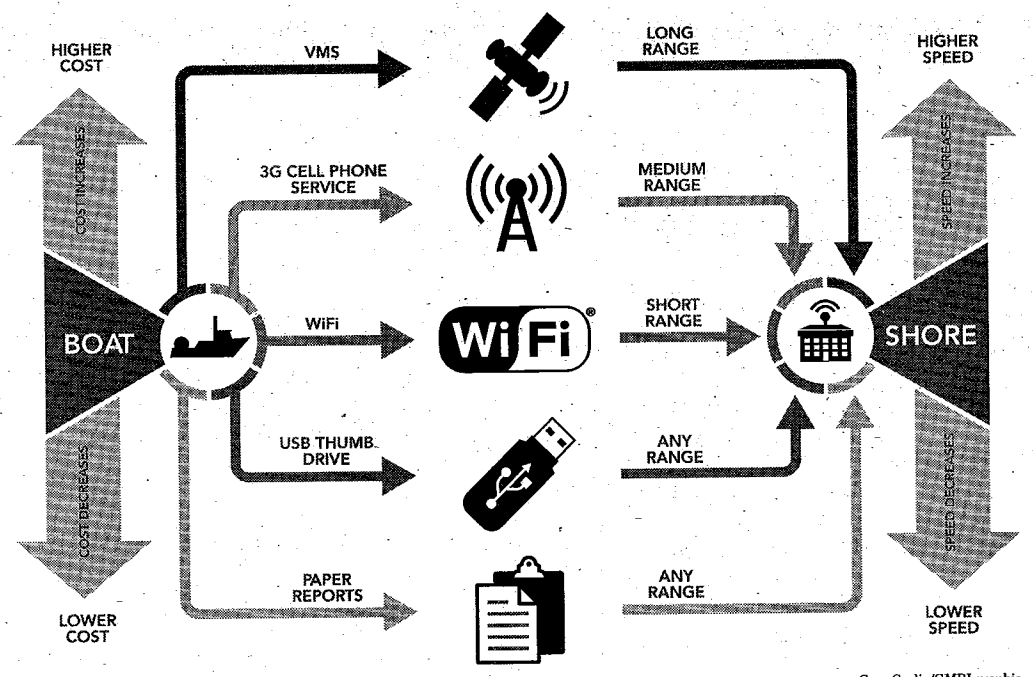
The captain leans out of the wheelhouse, calling to the crew that it's time to haul it in. He just heard from the sector manager. The group had a relatively high catch of yellowtail flounder today and they need to be careful.

But the price for cod is down, so it's not a tough call to wrap it up early to avoid using more yellowtail quota.

The new marketing plan has really paid off. They're getting the best price of anyone now that the retailer can trace the fish back to their boat. The captain is still getting some grief about the poster of the crew at the seafood counter, but for the extra money it puts in their pockets, the supermarket can put up a billboard if it wants.

As they're steaming in, the captain finishes entering the day's catch data into the laptop computer and, once they get closer to port and his computer picks up the Wi-Fi signal from the dock, he sends out a copy of the vessel trip report to the National Marine Fisheries Service (NMFS) and his sector manager.

The crew unloads the catch, and the captain is quickly done with his responsibilities. He's home even before the crew hits the bar.



Croy Carlin/GMRI graphic

The drawing shows methods by which vessel trip reports can be delivered to NMFS, including the range of cost, far left, and speed, far right.

This is how fishing can work. It already does in some parts of the country and the world, and pieces of this process are now becoming a reality here in the Northeast.

With the manifestation of Amendment 16 and the catch share system in the groundfish fishery, accurate reporting of catch and discard weights for each species is paramount.

Late in June, NMFS announced that it would accept electronic versions of the vessel trip report (VTR) from groundfish vessels to provide near real-time monitoring and management of catch and discard data.

Until this point, catch and discard weights have been determined through a combination of observer data, dealer landing reports, and the VTR, the paper report that captains have been filling out and mailing to their sector manager, their dealer, and NMFS.

By transitioning to electronic reporting, captains will be able to send VTRs to all parties practically at once, while at the same time benefiting from an increase in reporting efficiency and access to near real-time quota tracking.

Over the past year, the Gulf of Maine Research Institute (GMRI) in Portland, ME has been working with the groundfish industry and NMFS to help launch electronic reporting in the Northeast.

This work primarily has focused on familiarizing groundfish captains with electronic logbook software and showing them how to complete the logbook and transmit their VTR file to NMFS.

The electronic logbook is essentially a computer program that mimics the paper VTR, but it remembers vessel-specific information and gear preferences.

This greatly simplifies and reduces the time the captain has to spend completing the logbook since the only new data he has to enter relates to the day's fishing – what was caught, where it was caught, etc. Once the logbook is completed, the software program self-checks for errors and then produces a secure encrypted file for transmission to NMFS.

Transmission options

Because the VTR file is encrypted, fishermen can use a variety of transmission options. They can send the file from the vessel via: the VMS; the Internet using a Wi-Fi link if it is available at the dock; a cell phone with a 3G card; or a land-based Internet connection using data saved to a USB memory stick. These options vary in cost, reliability, and range.

Once the file is transmitted, the captain can confirm within one or two hours that NMFS has received the data by logging onto a NMFS VTR website and checking its list of recently completed fishing trips. Doing this also allows the captain to closely monitor his quota.

Many captains who have worked with GMRI to begin submitting their VTRs electronically have good things to say about the process. They say the software is easy to learn and use. They also have adapted to finding ways to transmit the data and are excited to be doing away with the paper logs.

In addition to increased efficiency and organization in the wheelhouse, sector managers also will benefit from being able to manage their members' quotas in near real time. Also, by reducing the amount of time spent manually entering data, the manager will be better able to concentrate on the needs of the sector.

In the near future, the rapid reporting generated from electronic VTRs will be used to warn vessels of bycatch hotspots, further assisting in quota management and increasing profitability.

"As we are looking for ways to reduce the cost of running sectors while requiring quality, timely data, electronic reporting has to be part of that equation," remarked Ben Martens, manager of the Port Clyde Sector.

In summary, electronic reporting allows captains to spend less time reporting their fish and more time catching them. It also allows sector managers to spend less time entering data and more time determining what to do with the data to improve industry profitability.

Croy Carlin

Croy Carlin is a research technician at the Gulf of Maine Research Institute (GMRI). GMRI is currently working with several vessels to begin electronic vessel trip reporting. The institute is available to help other interested fishermen with: installing software and hardware; training captains to use the program; and answering questions regarding the current state of electronic reporting.

For more information on this program, call Carlin at (207) 228-1686 or e-mail him at <ccarlin@gmri.org>.

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NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 50
April 01, 2011-March 31, 2012

Di Jin-Woods Hole Oceanographic Institution

NOAA Program Manager: Chad Demarest-NMFS/NEFSC- Social Science Branch

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme III. Ecosystem Management

PROJECT OVERVIEW

We have made significant progress in three areas: (1) data processing, (2) model estimation, (3) survey design and implementation. We have completed processing the data from the Coast Guard on fishing vessel accidents and the National Data Buoy Center on weather conditions. Two separate statistical models have been developed to examine fishing vessel accident severity in the Northeast region. As detailed below, the first is a model of fishing vessel damage severity, and the second is a model of fishing vessel crew injury severity. The fishing vessel safety survey has been administered once, and relevant data analysis is underway.

ACCOMPLISHMENTS

1. Models of Fishing Vessel Accident Severity

The vessel damage severity (D) incurred by a fishing vessel involved in an accident is expected to vary with the type of vessel accident (**a**), vessel characteristics (**c**), type of vessel propulsion (**p**), type of vessel hull construction (**h**), weather condition (**w**), spatial location (**s**), and time of vessel accident (**t**), i.e.,

$$D = f(\mathbf{a}, \mathbf{c}, \mathbf{p}, \mathbf{h}, \mathbf{w}, \mathbf{s}, \mathbf{t}) \tag{1}$$

Weather condition (**w**) is represented by the daily maximum wind speed (m/s) and daily maximum sea level pressure (hPa). The spatial variable (**s**) measures the distance to shore (km). Time of vessel accident (**t**) includes time of day (nighttime versus daytime) and time of year (seasons).

Equation (1) is estimated utilizing detailed data of individual fishing vessel accidents that were investigated by the U.S. Coast Guard during the 8-year time period 2001-2008 and extracted from the Coast Guard's Marine Information for Safety and Law Enforcement (MISLE) database. Two MISLE data tables were merged to obtain the data set for this study. The two data tables include: the Vessel Event Table (MisleVslEvents) and the Vessel Table (MisleVessel). Only US flagged fishing vessels in the Northeast region were included in the database.
Hourly wind speed and sea level pressure recorded from offshore buoys and nearshore weather stations were obtained from NOAA's National Data Buoy Center. Daily maximum wind speeds

and daily maximum pressure from each recording station, and they were mapped to fishing areas by assigning each area to the nearest weather recording station. The spatial feature of accident probability (distance from shore) is the distance from the center of gravity (the geographic point that minimizes the distance to the perimeter) of each fishing area to the nearest coast. This was calculated using GIS software and the NMFS digital map of fishing areas.

Among the accident cases in the data set, 28.5% are classified as vessel "undamaged" ($D = 0$), 40.3% as vessel "damaged" ($D = 1$), and 31.2% as vessel "total constructive loss" or "actual total loss" ($D = 2$). The mean statistics for the explanatory variables reveal that the average size and age of a fishing vessel involved in an accident are 74 gross tons and 26.2 years, respectively. 66.2% and 30.7% of the accidents occurred at nighttime and in winter, respectively. Most frequent accident types include environmental damage (19.4), material failure (14.9%), sinking (11.4%), and flooding (11.3%). The average daily maximum wind speed and sea level pressure are 10.6 m/s and 1,018.9 hPa.

Results of an ordered-probit model estimation are shown in Table 1 of Appendix I. Fishing vessel damage severity is positively associated with several tapes of accidents (e.g., loss of stability, abandonment, and sinking), daytime wind speed, vessel age, and distance to shore. Severity is negatively associated with daytime sea level pressure and vessel size.

A similar model of fishing vessel accident crew injury was also estimated using the MISLE injury Table (MisleInjury). In the model, $D = 0$ if no injury is involved in the accident (90.8%); $D = 1$ if non-fatal injury is involved (5.6%); and $D = 2$ if fatal injury is involved (3.6%). Our estimation results suggest that crew injury severity is positively associated with loss of stability, sinking, sea level pressure, and distance to shore. The injury severity is negatively related to material failure and summer season. Wind speed has the wrong sign but is not statistically significant (Table 2 in Appendix I).

2. Fishing Vessel Safety Survey

The fourth specific aim of the project was to develop an alternative measure of fishing vessel safety using a survey-based approach. For these purposes, a questionnaire was designed to solicit information on safety characteristics and risk taking behaviors from fishermen participating in a series of safety training courses in Massachusetts (see attached survey in Appendix II). Fifty-one surveys were completed at the initial training course in New Bedford on February 17, 2012, and a second training seminar is scheduled to take place in April. Assuming a similar turnout, approximately 100 surveys will be available to explore a range of safety-related questions and risk behaviors as they relate to demographic characteristics, fisheries, and regulatory changes. The analysis of these data is currently ongoing, and will ultimately serve to complement the model being developed separately for this project.

HIGHLIGHTS

- Statistical models have been developed to understand the determinants of fishing vessel damage severity and crew injury severity in accidents.

SOCIETAL BENEFITS

Commercial fishing is one of the least safe occupations. The property, injury, and other costs of US commercial fishing vessel accidents are considerable. Promoting the safety of human life at sea is a policy objective set out in National Standard 10 (16 USC 1851) of the Magnuson-Stevens Fishery Conservation and Management Act (P.L. 94-265). The study will contribute to the efforts to reduce accidents in the commercial fishing industry.

EDUCATION AND OUTREACH ACTIVITIES

The study involves commercial fishermen in the above mentioned safety survey to understand their safety behavior.

Appendix I: Results of Fishing Vessel Accident Severity Models

Table 1. Fishing vessel accident damage severity equation estimates

Explanatory variable	Coefficient	*t*-value
Type of accident		
Fire	0.9323***	4.70
Flooding	0.9767***	7.43
Material failure	0.4177***	3.71
Sinking	1.6231***	10.69
Abandonment	2.2525***	7.68
Loss of stability	2.4002***	4.21
Weather condition		
Daytime*Wind speed	0.0309**	2.51
Daytime*Sea level pressure	-0.4030***	-2.61
Vessel Characteristics		
Gross ton	-2.4715***	-3.82
Age	0.0086**	2.43
Spatial variable		
Distance to shore	0.0020**	2.06
Constant	0.1553	1.11
Ordered probit parameter, μ	1.3168***	21.51
Number of observations	836	
Chi-square statistic	280.778***	

*, ** and *** denote significance at 10, 5, 1% significance level, respectively.
Gross ton is in 1,000 ton.
Sea level pressure is in hPa/1000.

Table 2. Fishing vessel crew injury severity equation estimates

Explanatory variable	Coefficient	t-value
Type of accident		
Material failure	-0.4263*	-1.81
Sinking	0.5157**	3.24
Loss of stability	1.5274***	4.01
Weather condition		
Wind speed	-0.0253	-1.50
Sea level pressure	16.7065**	2.01
Season		
Summer	-0.2509	-1.57
Spatial variable		
Distance to shore	0.0022*	1.72
Constant	-18.2851**	-2.15
Ordered probit parameter, μ	0.4469***	6.94
Number of observations	966	
Chi-square statistic	43.974***	

*, ** and *** denote significance at 10, 5, 1% significance level, respectively.
Sea level pressure is in hPa/1000.

Appendix II: Fishing Vessel Safety Survey Questionnaire

Fishing Partnership Fishermen Safety and Survival Training Evaluation Survey

Training Location:_____Training Date:_____

F/V ID Number_____Home Port_____

Type F/V (Dragger, Scalloper, Lobster, etc.)_____

Position: Owner _____Captain _____Mate _____Crew_____

Other_____(specify) Age _____ Sex: ____ M/F

How many years have you been fishing? _____

Do you come from a fishing family? _____Yes _____ No. If yes, how many generations? _____

Do you work full-time _____ or part-time _____ as a fisherman?

If you are a captain, do you own your vessel? _____Yes _____ No

Are you involved in multiple fisheries? _____Yes _____ No. If yes, which ones?

Before today, have you ever received formal safety training in any of the following:

First Aid ____Yes (< 5 years ago) _____ (> 5 years ago) _____ No, never

CPR ____Yes (< 5 years ago) _____ (> 5 years ago) _____ No, never

Survival suit ____Yes (< 5 years ago) _____ (> 5 years ago) _____ No, never

Life raft ____Yes (< 5 years ago) _____ (> 5 years ago) _____ No, never

Drill conductor course ____Yes (< 5 years ago) _____ (> 5 years ago) _____ No, never

Cold water training ____Yes (< 5 years ago) _____ (> 5 years ago) _____ No, never

Can you swim? _____Yes _____ No

Do you smoke cigarettes? _____Yes _____ No

Do you wear a seatbelt? _____Yes _____ No _____ Sometimes

How dangerous do you think fishing is on a scale of one to ten (1 being the least dangerous and 10 being the most)):

In general, compared to other jobs _____

Compared to your specific fishing activities _____

Have you or another crewmember on your vessel been involved in a life-threatening accident?

If yes, how long ago? _____

Briefly describe the accident:

Have you or another crewmember on your vessel been injured? If yes, briefly describe the injury(s):

Have you or another crewmember lost workdays due to a fishing related injury or infection? If yes, briefly describe:

Fisheries regulation questions:

If you are a scallop fisherman, have crew size limitations impacted your safety practices?
_____Yes _____ No.
If yes, describe what you do differently as a result of the limits:

If your fishery is subject to quota-based management, have these regulations impacted your safety practices?

_____Yes _____ No.

If yes, what suggestions do you have for ensuring safe fishing practices in fisheries that have a quota-based system? Please give an example, if possible:

As a result of current government regulations on your fishery, have you done any of the following?

Fished in bad weather that you would have otherwise avoided? _____Yes _____ No

Continued fishing when tired at a point when you would have normally stopped? _____Yes _____ No

Extended the length of a typical fishing trip? _____Yes _____ No

Have you recently made a decision not to purchase safety equipment because of the financial cost?

_____Yes _____ No. If yes, which pieces of equipment?

Have you ever failed to maintain existing safety equipment (i.e, life raft or EPIRB)?

_____Yes _____ No. If yes, which pieces of equipment?

Is this different from the past and, if so, how?

Have you or a fellow crewmember had a fishing-related accident that you would attribute to fisheries regulations? ____Yes _____ No. If yes, please describe:

THEME IV. PROTECTION AND RESTORATION OF RESOURCES

CINAR

Cooperative Institute for the North Atlantic Region

High Resolution 3D Mapping using the VPR

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 36
April 01, 2011-March 31, 2012

Cabell S Davis-Woods Hole Oceanographic Institution

NOAA Program Manager: Tony Penn-NOS/ORR/ARD

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme IV. Protection and Restoration of Resources

PROJECT OVERVIEW

The primary objective of this project was to conduct a broad-scale Video Plankton Recorder (VPRII) survey of the Gulf of Mexico during March/April 2011 aboard the R/V *Oceanus.* The cruise objective was to collect high-resolution data on plankton and marine snow together with environmental variables using the VPRII. The plan was to survey of the shelf and slope waters of the northern Gulf of Mexico, with the transect lines running through the standard SEAMAP stations and extending beyond them into the slope sea. Collection of data from VPRII video and environmental sensors enables determination of occurrence, abundance, biomass, and vertical distribution of plankton and marine snow, together with ocean temperature, salinity, chlorophyll fluorescence, PAR, and turbidity. This sampling allows comparison of data from traditional samplers used in the SEAMAP surveys and the current NRDA MOCNESS surveys with optical imaging of the VPRII. The VPRII sampling extends the spatial resolution of the present sampling and allows quantification of fragile plankton and marine snow. It also allows comparison between deeper DAVPR optical-based sampling in the slope region with net-based sampling of shelf and slope regions. The R/V *Oceanus* cruise was part of the over-arching plan to conduct sampling in each season, utilizing several sampling methods (e.g. MOCNESS, bongo net, neuston net, and imaging systems). Because plankton are transported over wide areas, and populations are connected across the northern Gulf of Mexico, the sampling plans were designed to be broad in geographic scope.

ACCOMPLISHMENTS

We successfully completed the VPRII survey of the Gulf of Mexico. We towyoed the VPRII for a record 3,048 nautical miles, from St. Petersburg to Galveston. The VPRII collected over 10 million plankton images together with environmental data on over 3,500 vertical profiles (the equivalent of over 3,500 CTD casts and plankton tows). This sampling is the most intensive large-scale plankton survey ever done (it is 500 miles longer than our previous transatlantic VPRII towyo). The survey encompassed such diverse areas as the loop current waters, Apalachicola and Mobile coastal waters, the near-field of the DWH wellhead, the Mississippi outflow, and the Flower Gardens. The environmental data supplementing the video images included, temperature, salinity, depth, chlorophyll fluorescence, turbidity, photosynthetically

active radiation (PAR), and acoustic backscatter (ABS) from four high-frequency transducers (0.5, 1, 2, 4 MHz). All data were archived and distributed through a chain of custody to NOAA and BP/Entrix. The unexpectedly large number of images acquired requires significant post-processing. The cost of the research vessel (R/V *Oceanus*) was supported by this grant, and the standard WHOI year-end adjustments to the day rate was less than expected. A 1-year no-cost extension was implemented to enable use of the remaining funds for additional data processing.

HIGHLIGHTS

- Conducted a high-resolution 5,644 km (3,048 Nm) Gulf-wide VPRII survey from Tampa, FL to Galveston, TX, covering shelf and slope regions.
- Collected images every 11.7 cm (4.6”) along the track.
- Non-invasive imaging sampled delicate plankton and marine snow
- Collected data from a suite of sensors to relate plankton distributions to environmental variables.

SOCIETAL BENEFITS

Once the data are processed, they will provide important information to be used, together with other optical and traditional plankton sampling, as part of the NRDA environmental impact study of the DWH spill. The VPRII data provides unprecedented

EDUCATION AND OUTREACH ACTIVITIES

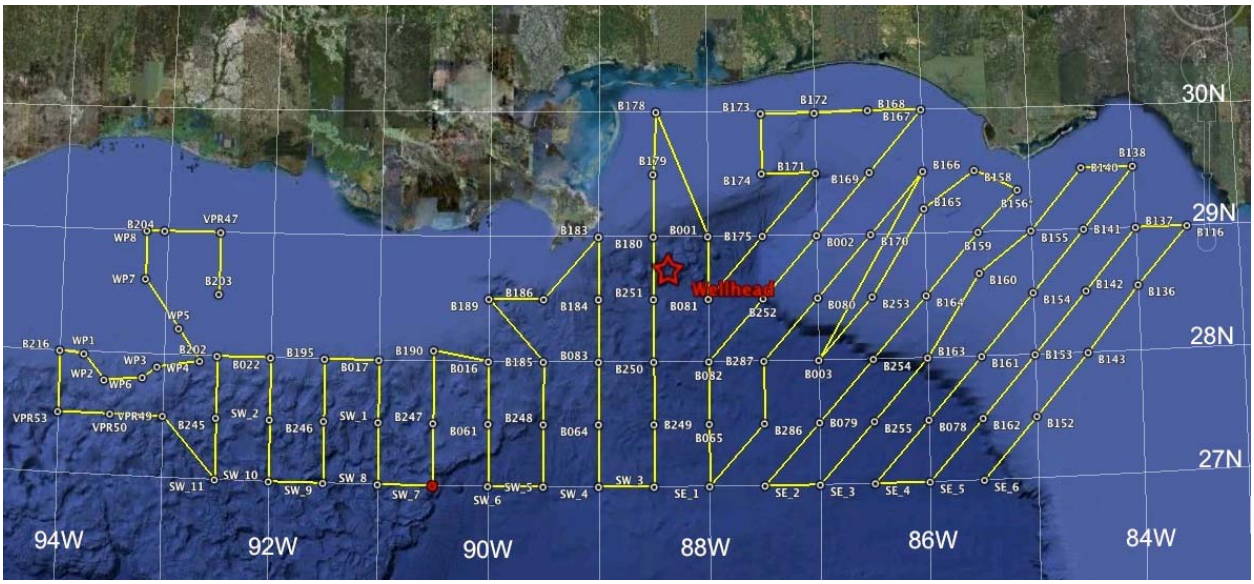
A participant on the cruise has subsequently entered a MSc program in marine science at LSU based in part on his experience during the cruise. We will have a new student working on analysis of data from this cruise.

PUBLICATIONS

No publications yet, as data analysis is currently underway.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

This map shows the VPRII survey track and the locations of SEAMAP stations passed enroute.



Holocam and Video Plankton Recorder

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 42
April 01, 2011-March 31, 2012

Cabell S Davis-Woods Hole Oceanographic Institution

NOAA Program Manager: Tony Penn-NOS/ORR/ARD

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme IV. Protection and Restoration of Resources

PROJECT OVERVIEW

As part of the overall NOAA/NRDA plankton-sampling program to assess the possible impact of the DWH oil spill in the Gulf of Mexico, new optical sampling methods were used to obtain digital images of oil droplets, fragile forms of plankton, and marine snow, none of which are sampled adequately using traditional net and bottle collection methods. In addition, the optical methods allow acquisition of high-resolution along-track survey data. Such information is critical for assessment of the pelagic ecosystem of the gulf. Between June 2010 and April 2011, a series of seven cruises to the Gulf were conducted using digital optical imaging systems including a holographic plankton camera (Holocam), the Digital Autonomous Video Plankton Recorder (DAVPR), and the second generation Video Plankton Recorder (VPRII). This sampling provided a large amount of digital images. These images require post processing to obtain abundance and distributional data for plankton taxa, marine snow, and oil droplets, together with associated environmental data (e.g., CTD, fluorescence). This project involves processing of the images to obtain data on the distribution, abundance, biomass, and sizes of plankton, marine snow and oil droplets.

ACCOMPLISHMENTS

During the first 7 months of this project we have completed and submitted the processing results for Holocamera data from the M/V Jack Fitz 3 cruise, describing the size distributions of oil droplets at 9 stations spaced between 2 and 10 km from the wellhead. A total of 7697 holograms had been previously processed from these 9 dives. The processing method involved reconstruction and processing of 1200 images from each hologram. The method included detection of circular objects in the images and measurement of their diameters and other metrics, creation of a training set of human-labeled objects, construction of a classifier tree, automatic classification and diameter measurement of droplets, and plotting their size distributions for different depth intervals. The work done in this project included careful review of the algorithms and software previously developed, conversion of all units to metric, verifying and correcting environmental data (e.g., CTD) and metadata, re-plotting all the data, and saving all the plotted data into spreadsheets. The processed data and methods have been delivered to NOAA and BP.

In addition to processing the M/V Jack Fitz 3 holograms, we have processed all of the DAVPR samples from 4 cruises (M/V American Diver, M/V HOS DAVIS 2, R/V Walton Smith 2, and M/V Arctic). A total of 80 DAVPR deployments were processed. This processing included extraction of images of plankton from the raw data files, creating a training set of images by manually sorting images into taxonomic categories, building a dual classifier using shape and texture based feature sets, machine classification of the images, and human correction of the machine classification. The classified results are being plotted together with environmental data for each deployment.

HIGHLIGHTS

- The image processing provides vertical distributions of plankton and marine snow from deep DAVPR deployments between the surface and 1000-1200m depth near the DWH wellhead and at upstream and downstream locations.
- The image processing provides data on delicate plankton and marine snow.
- The data include deep towyo sections across the continental slope in locations near and away from the DWH wellhead.

SOCIETAL BENEFITS -

This work provide is part of the overall effort to study the potential impact of the DWH oil spill on the Gulf of Mexico ecosystem.

EDUCATION AND OUTREACH ACTIVITIES

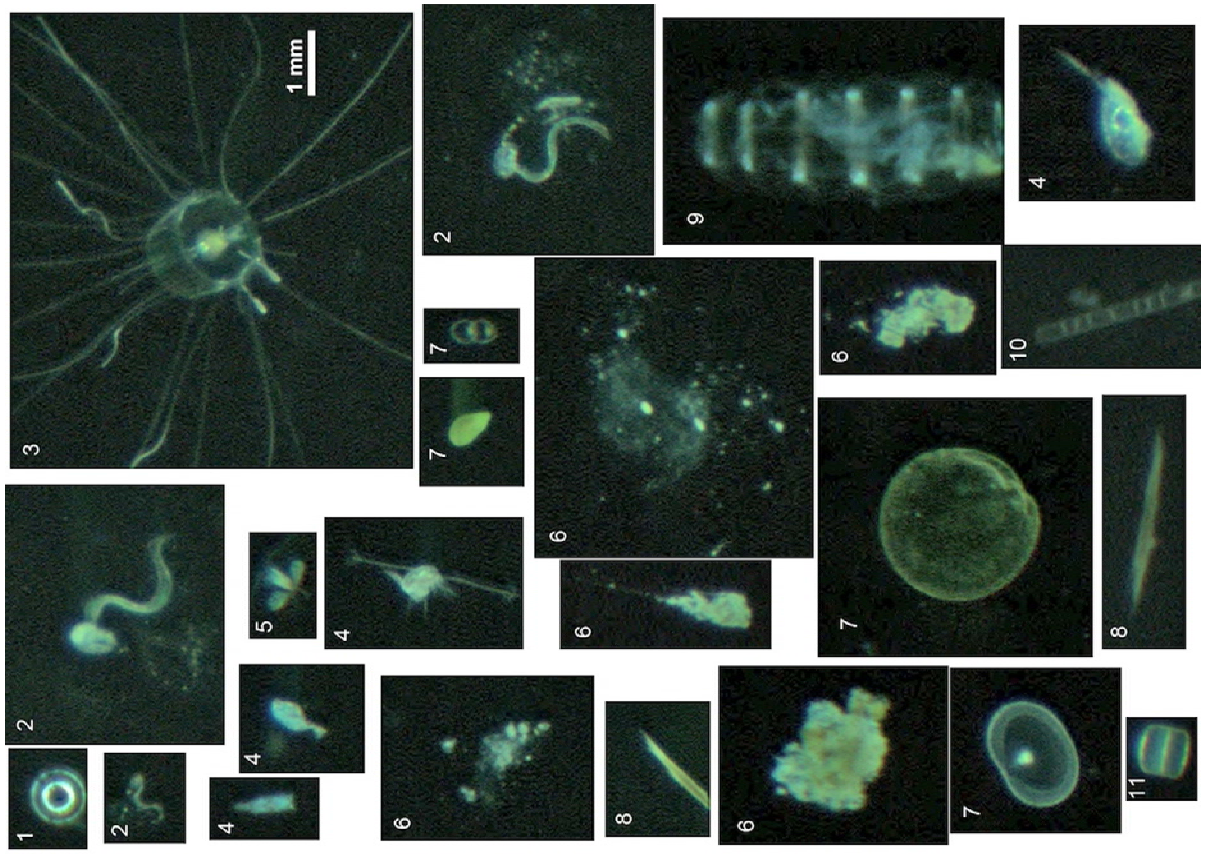
A student at LSU is using these data as part of his MSc degree in Marine Science.

PUBLICATIONS

No publications yet, as data processing is underway.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

Figure 1. Color DAVPR images of plankton and marine snow from the Gulf of Mexico 40 kilometers southwest of the Deepwater Horizon oil spill wellhead. Cruise on the M/V *American Diver* (July 28-August 5, 2010). Scale bar applies to all images. Key: 1=air bubble, 2=larvacean, 3=medusa, 4=copepod, 5=copepod with egg sacs, 6=marine snow, 7=unidentified, 8=Trichodesmium erythraeum, 9=doliolid, 10=diatom (Leptocylindricus),11=diatom (Coscinodiscus) The scale-bar applies to all images.



Estimates of Harbor Seal Numbers in New England

NOAA Cooperative Agreement No. NA09OAR4320129 **UMaine** Subpoint 03
April 01, 2011-March 31, 2012

James R. Gilbert-University of Maine

NOAA Program Manager: Gordon Waring-NMFS/NEFSC- Protected Species Branch

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme IV. Protection and Restoration of Resources

PROJECT OVERVIEW

The goal of this research is to estimate the numbers of harbor seals on coastal islands and ledges and adjacent New England waters. This requires: 1) an estimate of a correction factor to adjust aerial surveys for the fraction not observed, 2) an estimate of the number of seals on land and visible in the area, and 3) an estimate of population size of harbor seals with adjustment for correction factors.

In 2011, 21 seals were captured at Cape Cod in March and near Rockland Maine in April. Aerial counts of harbor seals were not completed in 2011 because of unusual fog conditions during the survey time window. Only one flight was completed, resulting in insufficient samples from which to estimate seal abundance.

A no-cost extension to the research project was requested and granted. The plan is to repeat capture of the harbor seals in late March and late April. Aerial counts are scheduled around mid-day low tides in late May and the first two days of June.

ACCOMPLISHMENTS

Because the aerial counts were not completed, there are no results from this year.

HIGHLIGHTS

- The Twin Otter proved to be an excellent survey platform.
- Photographs from the Twin Otter were of excellent quality, more than sufficient for counting.

SOCIETAL BENEFITS

Harbor seal populations are a significant part of the Gulf of Maine ecosystem. The last population estimate was in 2001; a current estimate of population size is necessary to estimate the impact of fisheries by-catch.

A Third Dimension: Applying Imaging and Visualization Technology to Battle of the Atlantic Shipwrecks

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 41
April 01, 2011-March 31, 2012

William Lange-Woods Hole Oceanographic Institution

NOAA Program Manager: Joseph Hoyt-Monitor National Marine Sanctuary

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme IV. Protection and Restoration of Resources

PROJECT OVERVIEW

In 2008, the *Monitor* National Marine Sanctuary (MNMS) commenced a multiyear project focusing on shipwreck sites associated with the Battle of the Atlantic. During WWII, this was the closest theater of war to the continental United States. Directly off the coast of North Carolina remains a collection of nearly 200 shipwrecks from one of the most significant battles in one of the most historic wars in world history. The *Monitor* National Marine Sanctuary is in the process of considering expanding the current sanctuary to include additional maritime heritage resources off the coast. Expansion requires the identification and characterization of significant vessels, to aid in determining sanctuary boundaries and appropriate management practices. The goal of this project was to catalog site significance and integrity, and identify degrading impacts from both environmental and cultural factors.

An historical and archaeological assessment of the resources was critical to inform management decisions regarding sites under the consideration for expansion. In previous years, MNMS and partners have collected data and completed archaeological surveys of four sites. Additionally, with OER support, the 2009 field season conducted a multi-beam sonar and ROV survey to discover and document previously unknown deep-water shipwrecks. Several targets were identified, which have now benefitted from more detailed characterization using advanced imaging technology. In addition to documenting newly located sites, MNMS needed to acquire baseline data on known sites to aid in evaluating significance and boundary delineation.

A method for expedient and detailed baseline documentation is critical to the management needs of MNMS as expansion is considered. To meet this need, MNMS worked with Woods Hole Oceanographic Institution's' Advanced Imaging and Visualization Laboratory (WHOI-AIVL), which has developed a technique for acquiring underwater HD-3D imagery which can be processed into a variety of outputs from a single dataset. This methodology allowed for the rapid acquisition of quality 3D visualization data, which in the future will allow researchers to generate three-dimensional CAD renderings of the sites, as well high definition 3D visualization, and photo-mosaics. High acquisition rates allow for the documentation of several sites in a short

time period while generating products, which aid in evaluating, characterizing, and potentially managing these resources. The project aligns with OER's emphasis on the early phases of marine archaeology and brings together marine archaeology and advanced visualization. AIVL's breakthroughs in 3D imaging have allowed for several additional sites to be documented in the potential expanded area.

ACCOMPLISHMENTS

The Woods Hole Oceanographic Institution's (WHOI's) Advanced Imaging and Visualization Laboratory (AIVL) provided technical assistance in the acquisition, processing and display of underwater 2D and 3D HDTV imagery for NOAA's *Monitor* National Marine Sanctuary Program "A Third Dimension: Applying Advanced Imaging and Visualization Technology to Battle of the Atlantic Shipwrecks". This effort took place in August of 2011. Using the latest in state of the art high resolution underwater imaging systems AIVL worked with NOAA Marine Sanctuary personnel in conducting optical surveys and close-up documentation of the shipwrecks in the Battle of the Atlantic project area. This work was captured in Stereoscopic 3D HDTV as well as 2D HDTV and with ultra-high resolution still images. The Stereoscopic imagery allows NOAA Marine Archeologists the ability to easily access the condition of each wreck much more efficiently than 2D imagery. Future quantitative modeling and feature extraction such as measurements of key objects will be possible with the 3D data collected. A small penetration ROV with a Stereoscopic 3D imaging system was also utilized to penetrate deep inside shipwrecks of interests for more detailed examinations of the wreck and cultural artifacts. NOAA plans to use this data for detailed archeological maps/plans as well as sharing this rich image content with the public through its various visitor centers.

HIGHLIGHTS

- In August of 2011, the Advanced Imaging and Visualization Laboratory (AIVL), in conjunction with MNMS, imaged and surveyed a series of wrecks near Cape Hatteras, NC. The targets were a combination of wrecks that had been discovered and surveyed over the years by the local dive community and a collection of new targets that were discovered during a NOAA sponsored survey cruise earlier in the summer. The wrecks were imaged by a series of 2D and 3D WHOI- AIVL camera systems that have been developed over the past decade and have been optimized for underwater survey and cinematography work. Both divers and ROV's were used to capture images.
- Aug 2-4 Transit to NC Mobilization and build up of cameras and ROV's.
- Aug 5 – Divers were deployed on the wreck of the Dixie Arrow. The main purpose of this dive was to let non-NOAA divers get their dive gear tested in shallow water and let the camera team get camera in the water. This also gave those on the NOAA, who were not familiar with WHOI-AIVL camera systems and methodologies, a chance to see the operations and develop an operational plan for deploying cameras from the NOAA boat while divers were deployed from an auxiliary dive vessel.

- August 6 – U701. The U701 has been a difficult place for divers to reach due to the high currents and constantly shifting sands, which makes the drops for divers somewhat unpredictable and difficult to judge. The first drop was off target and the entire team

missed the wreck. During the second drop the AIVL dive team made the wreck and continued with a 60-minute 3D video survey of the wreck. This was the first time a 3D camera system was deployed on the wreck and due to the AIVL operations team diving on CCR, much more footage was acquired on the wreck than ever before. Running fiber ops was considerably more difficult then anticipated due to the inability of the NOAA vessel to anchor efficiently in deeper water with high currents.

- August 7-8: No in-water survey work was conducted due to inclement weather. During this time, the ROV was built up and prepared for deployment.

- Aug 9 - *EM Clarke*: The AIVL team deployed 2 3D HDTV camera systems and captured stills during the first dive. During this dive the team surveyed the outer portions of the wreck from bow to stern on the deck level, which due to the orientation of the wreck was perpendicular to the sea floor.

- Aug 10 - Morning, *Dixie Arrow*: This was principally a test dive for the ROV, but we quickly learned that due to the intense currents and difficulty in anchoring, that ROV operations were going to be very difficult with this vessel

- Aug 10 - Afternoon, *EM Clark*: This dive focused on documenting the interior portions on the stern of the wreck in 3D HDTV, principally the torpedo damage and the washout in the stern where the majority of sand tiger sharks congregate.

- Aug 11 - *Monitor*: One dive was conducted on the *Monitor* site. The conditions were the most poor of all sites during the entire trip, and the team attempted a mosaic survey of the site. Due to the conditions, we don't believe there was 100% coverage, although the majority was captured. Some close-up 3D HDTV imagery was also collected.

- Aug 12 – *Lancing*: Due to very poor visibility and a drop away from the wreck, the AIVL divers never located the wreck. The ROV was deployed but due to strong currents, only a glimpse of the wreck was recorded.

- Aug 13-14: No in-water survey work was conducted due to inclement weather.

- Aug 15: *Bluefield's* (ROV): This was an unknown target that was discovered during the earlier NOAA survey cruise and believed to be the *Bluefield's*. The currents were extreme and since the NOAA vessel was unable to anchor and the small ROV was unable to make way against the current, we attempted without success to use the ROV as motorized tow sled. No imagery was acquired.

SOCIETAL BENEFITS

The further development and application of new methods in remote survey and mapping of submerged maritime heritage sites will lead us not only to a better understanding of the maritime heritage resources that exist off our coasts but will also provide marine archeologists and policy makers with the data required in order to better manage, preserve and protect these potentially fragile remains of our nautical heritage.

EDUCATION AND OUTREACH ACTIVITIES

NOAA and WHOI have presented the results of this project at the Society Historical archeology Conference in January 2012. Further outreach is being planned for the sanctuaries visitor center as well as educational television work with the National Geographic Society.

PUBLICATIONS

No publications have been prepared to date as data and imagery are still being analyzed.

Human Interaction Investigations in Marine Mammals

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 08
April 01, 2011-March 31, 2012

Michael J. Moore-Woods Hole Oceanographic Institution

NOAA Program Manager: Teresa Rowles-NMFS Marine Mammal / Health and Stranding Response Program

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme IV. Protection and Restoration of Resources

PROJECT OVERVIEW

Part 1 - Human Interaction Investigations in Marine Mammals
This project comprises a single task with three components. Dr Moore to undertake a review of criteria necessary to diagnose human interaction as the proximate or contributing cause of death in a stranded marine mammal. This review would then be assessed and enhanced by a small workshop of invited specialists. The resulting document will then be submitted for peer-reviewed publication and provided to NMFS.

Part 2 - Large Whale Stranding Response and Human Impact Investigation.
The purpose of this project is to respond to reports of live or dead stranded large whales, especially right whales, by providing stranding response-related investigations, including, but not limited to, planning, euthanasia, carcass retrieval and/or towing, necropsy, sample collection, distribution, and analysis, and necropsy report writing. The investigations shall be consistent with those outlined in the "Right Whale Necropsy Protocol" and NOAA Fisheries Service final response protocols/Standard Operating Procedures. This proposal shall be for a period of one year, with 4 additional option years to be issued at the Government's discretion and subject to the availability of funds.

ACCOMPLISHMENTS

Part 1. Human Interaction Diagnostic Criteria. Dr Moore undertook a review of reports and papers pertinent to the topic of criteria necessary to diagnose human interaction and the proximate or contributing cause of death in a stranded marine mammal. Straw criteria were then discussed and substantially augmented and revised during a two day workshop held at Woods Hole Oceanographic Institution on February 1 and 2, 2012, involving 30 participants from the USA, Canada, Chile and Spain. Plenary presentations were made on each of the focal areas: peracute underwater entrapment; chronic entanglement, blunt and sharp vessel trauma and gunshot. Terms were defined, and a standard template utilized to enable diagnostic criteria to be established. Draft sections for the resultant workshop report are under review, and should be finalized in the coming months.

Part 2. Stranding Response. This project period has been relatively quiet in terms of cases requiring examination by this project. Only one case was worked up.

MJM08MAR2012Eg: Mar 02 2012 First sighted by USCG 1305 local time reported a code 3 right whale carcass 70 nm east of Cape Ann, MA. Weather forecast for the ensuing 5 day period was essentially unworkable. Mar 04 2012 Arrangements were made to be able to land the carcass at Salisbury Beach State Reservation (Mass Dept. Conservation and Recreation), undertake a necropsy, and to truck the waste and skeleton to be composted. Mar 06 2012 USCG Woods Hole undertook a SAR projection, assuming a semi-submerged 40' container. Mar 07 20 2012. A vessel departed Gloucester at 0000 and was on station at 0730. A plane search initiated at that time located the whale and acquired images. The boat then proceeded to the whale and acquired further images and a sample of blubber and epidermis. The whale length exceeded the length of the vessel (45'). Examination of the carcass by the plane and boat crews and later of the images by other whale biologists showed no propeller cuts or line marks evident. The only abnormality possibly not a result of post mortem decomposition or scavenging by birds was a large red patch caudal to the right axilla, the associated irregular delineation above that and the blue streak in the blubber running above this delineation along the right lateral thorax. Given the focal nature of this change it is conceivable that this is the remains of a large bruise from blunt trauma associated with a vessel strike. The carcass condition and sea state precluded any attempt at towing. So the plan to tow and necropsy was abandoned. Cause of death remains undetermined, but there is the faint hint of the possibility of blunt trauma. The sample is being analyzed for possible genetic individual identification.

HIGHLIGHTS

- Criteria for the diagnosis of Human Interaction in dead and seriously injured marine mammals were defined and documented.
- A right whale carcass floating 80 nm offshore was relocated and documented to the extent that weather, sea and carcass conditions permitted.

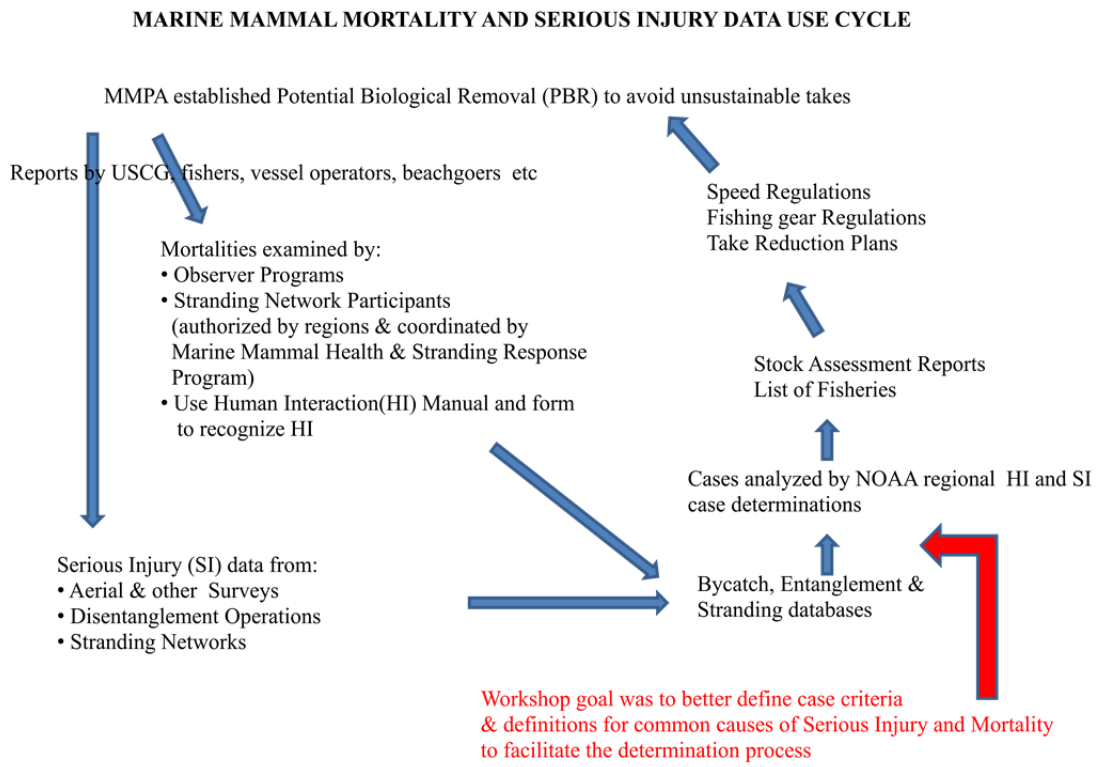
SOCIETAL BENEFITS

Accurate diagnosis of anthropogenic mortality and serious injury of endangered and threatened marine mammals is the first step in adequate mitigation of such factors.

EDUCATION AND OUTREACH ACTIVITIES

Dr Moore provided a Q&A session after screening of a documentary film about the Orca whale 'Luna' at the Martha's Vineyard Film Society on February 25th 2012. This enabled a broad ranging discussion of the various ways humans interact with marine mammals today.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS



A summary chart of how marine mammal serious injury and mortality data are used within NOAA data management to mitigate anthropogenic mortality and serious injury of endangered and threatened marine mammals.

Dead right whale MJM08MAR2012Eg View of rostrum to right and tongue and lips to left with body behind.

THEME V. SUSTAINED OCEAN OBSERVATIONS AND CLIMATE

CINAR

Cooperative Institute for the North Atlantic Region

Bowhead Feeding in the Western Beaufort Sea Oceanographic Conditions Whale Prey Distributions and Whale Feeding and Foraging Behavior

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 07
April 01, 2011-March 31, 2012

Carian Ashjian-Woods Hole Oceanographic Institution

NOAA Program Manager: Kim Shelden -NMFS

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme V. Sustained Ocean Observations and Climate

PROJECT OVERVIEW

The Beaufort Sea Shelf to the north and east of Barrow AK is a critical feeding area for migrating bowhead whales, particularly during the fall migration from their summer grounds in the Canadian Arctic to their over-wintering grounds in the northern Bering Sea (e.g., Lowry et al., 2004). The project is a component of the larger "Bowhead Whale Feeding in the Western Beaufort Sea" project coordinated by the National Marine Mammal Laboratory (2007-2012). The project is complemented by an ongoing NSF funded Arctic Observing Network project that describes interannual variability in biological and physical ocean conditions in the Chukchi and Beaufort Seas near Barrow, AK. The work addresses relationships between the formation and distribution of bowhead whale prey (zooplankton) aggregations, oceanographic conditions, and bowhead whale distributions in the Western Beaufort Sea by conducting oceanographic sampling from a 43' boat, including sampling of whale prey, on both the coarse and fine scales.

ACCOMPLISHMENTS

Fieldwork was conducted from August 17-September 20 using the *R/V Annika Marie*. During this period, the *Annika Marie* worked for 16 days and could not work because of bad weather for 13 days. Surveys concentrated on three sampling lines, with repeated samplings on different days of some lines. The sampling of Line 1 also is a component of the 2011 Distributed Biological Observatory (www.arctic.noaa.gov/dbo). Additional sampling was conducted on the Beaufort Shelf offshore of the Elson Lagoon Barrier Islands on E-W transects at ~5 and ~15 m.

One hundred twenty-seven (127) stations were occupied. Sampling was conducted using a CTD, ring nets, a Tucker Trawl, and Nisken bottles to collect water samples for determination of chlorophyll *a* and nutrient concentrations, to enumerate the abundances of phytoplankton and cocooid cyanobactera, and for microplankton composition and abundance. The acoustic Doppler current profiler (ADCP) was towed between stations on the across-shelf transects. Marine mammal occurrences also were recorded. The Acrobat towed vehicle suffered an unfortunate collision with the seafloor that damaged the tow cable; we were unable to effect repairs and thus could not use the instrument.

Considerable interannual variability in physical and biological oceanography has been observed between the seven years of our observations. Ocean temperatures this year were similar to those observed during 2005 and 2010 (Figure 2), with warmest ocean temperatures at ~8°C. The 2005, 2007, 2009, 2010, and 2011 surveys encountered very warm Pacific Water (>>4 °C), and corresponded to years of low Arctic summer sea ice cover, whereas the 2006 and 2008 surveys encountered much cooler Pacific Water and sea ice meltwater.

The plankton community contained high abundances of chaetognaths, ctenophores, small copepods, and medusae. Furcilia stage krill were observed primarily off of the shelf; very few juveniles and adults were collected at any location. Few bowhead whales were observed near Barrow during the study period. The Beaufort shelf was sampled along the ~5 m and ~15 m isobaths on multiple days throughout late August and early September during which period a decline in zooplankton abundance and an increase in phytoplankton density was qualitatively observed.

The entire BOWFEST project team met on March 12 and 13 in Seattle WA to discuss plans for synthesis of results and the preparation of the final report.

HIGHLIGHTS

- Considerable interannual variability in physical and biological oceanography has been observed between the six years of our observations. To date, 2005, 2007, 2010, and 2011 were years with warm ocean water temperatures and little sea ice while 2006 and 2008 were years with much colder ocean water and considerable sea ice, and 2009 was intermediate in temperature between the two extremes.

- The oceanography and whale prey distribution on the shelf near Barrow are intimately tied to wind forcing.

- A favorable feeding environment for bowhead whales near Barrow is created when krill are upwelled onto the shelf from along the Beaufort Shelf break and subsequently trapped and aggregated there by ocean currents.

- This favorable feeding environment is created predictably each year, despite the considerable interannual variability in ocean conditions.

- Much lower abundances of adult and juvenile krill, key prey for the bowhead whale, were observed on the shelf in 2011 relative to previous years. Krill were predominantly of the furcilia life stage (small).

SOCIETAL BENEFITS

Defining and understanding the interannual variability in ocean conditions and whale prey and how it is associated with larger scale atmospheric and oceanographic conditions is critical to achieving a better understanding of the importance and persistence of the western Beaufort Shelf as a feeding environment for the bowhead whales during their fall migration. This in turn has implications to the success and resilience of Iñupiat subsistence whaling as well as to a better understanding of how to protect and manage the Western Arctic bowhead whale population.

EDUCATION AND OUTREACH ACTIVITIES

Okkonen, S., Jones, D., Ashjian, C., Baumgartner, M., Campbell, R.G., Citta, J., George, C., Goetz, K., Maslowski, W., Mocklin, J., Rugh, D., Quakenbush, L., Stafford, K., Vatt Brattstrom, L. A year in the life of the bowhead whale: an educational outreach product in calendar form. January 16, 2012, Alaska Marine Science Symposium, Anchorage AK. Poster.

PUBLICATIONS

Okkonen, S.R., Ashjian, C.J., Campbell, R.G., Clarke, J., Moore, S.E., Taylor, K.D. 2011. Satellite observations of circulation features associated with the Barrow area bowhead whale feeding hotspot. Remote Sensing of Environment 115: 2168-2174.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

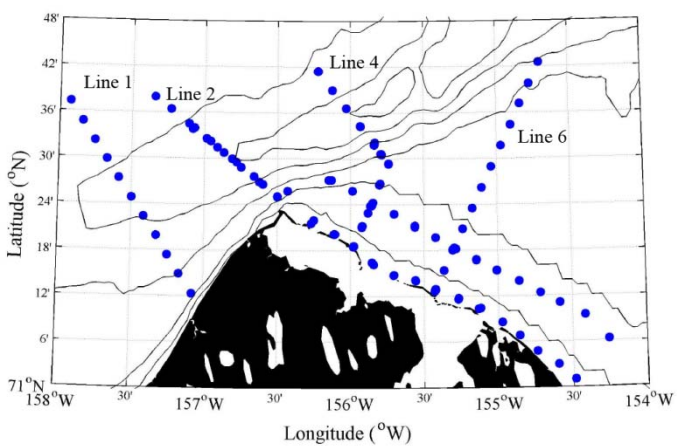


Figure 1. Locations of stations sampled in 2011. Underway sampling using the towed ADCP also was conducted between stations on Lines 2, 4, and 6. Line 1 was included as a component of the international 2011 Distributed Biological Observatories.

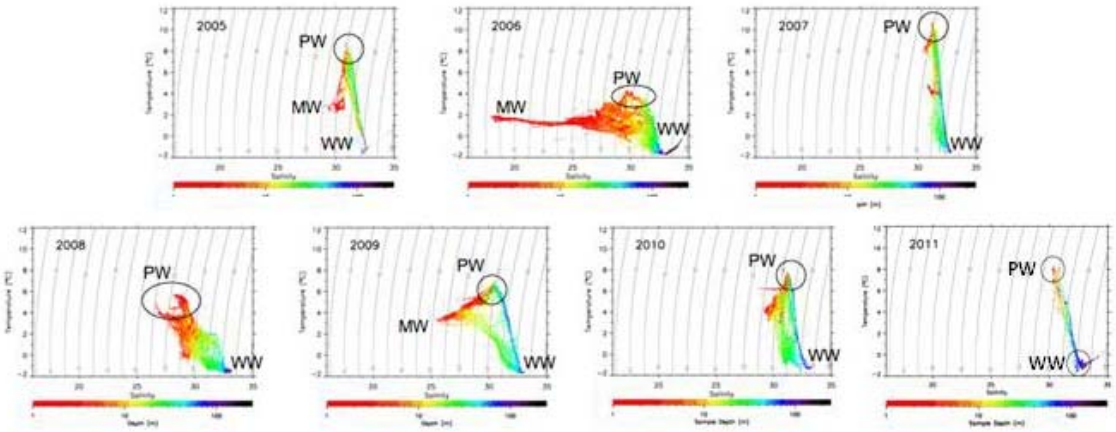


Figure 2. Temperature-Salinity plots of each year's aggregate (Acrobat and individual cast) CTD data. Representative water masses are Pacific Water (PW), Winter Water (WW), and Meltwater (MW). Curved lines are isopycnals (constant sigma-t). Color indicates water depth at each data location.

Bowhead Feeding in the Western Beaufort Sea Oceanographic Conditions Whale Prey Distributions and Whale Feeding and Foraging Behavior

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 12
April 01, 2011-March 31, 2012

Mark F Baumgartner-Woods Hole Oceanographic Institution

NOAA Program Manager: Kim Shelden -NMFS

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme V. Sustained Ocean Observations and Climate

PROJECT OVERVIEW

The Beaufort Sea Shelf to the north and east of Barrow, Alaska is a critical feeding area for migrating bowhead whales, particularly during the fall migration from their summer grounds in the Canadian Arctic to their winter grounds in the northern Bering Sea. The project is a component of the larger "Bowhead Whale Feeding in the Western Beaufort Sea" project coordinated by the National Marine Mammal Laboratory (2007-2011). The project addresses relationships between the formation and distribution of bowhead whale prey (zooplankton) aggregations, oceanographic conditions, and bowhead whale distribution and feeding behavior (e.g., diving patterns relative to prey distribution) in the Western Beaufort Sea by deploying oceanographic moorings, by conducting oceanographic sampling on both the coarse (shore-shelfbreak) and fine (on the shelf, near feeding bowhead whales) scales, and by tagging feeding bowhead whales for periods of hours to describe foraging and feeding behavior relative to prey distributions.

ACCOMPLISHMENTS

Field operations for tagging and fine-scale oceanography took place from August 26 to September 19, 2011. Our objectives for the fieldwork were to (1) attach archival tags to bowhead whales, and (2) intensively sample oceanographic conditions and prey distribution in proximity to the tagged whales. As in 2009 and 2010, we used a dermal attachment short-term tag developed specifically for this project (Figure 1). The new tag was designed to overcome (1) difficulties in approaching bowheads at close enough range for tagging, and (2) irregularities in the skin that made suction-cup tags ineffective. After attachment, the tagged whale is tracked via a high-frequency pinger incorporated in the tag and a hand-held directional hydrophone and receiver used to provide bearing and approximate distance to the pinger from the tagging boat. When the whale surfaces, the position is noted by the tagging boat, radioed to our oceanographic vessel (Launch 1273), and a cast is conducted at that position with a vertical profiling instrument package consisting of a conductivity-temperature-depth instrument, chlorophyll fluorometer, turbidity sensor, and a video plankton recorder.

We had a particularly bad year of weather in 2011. In 2010, we worked a total of 15 days at sea, but in 2011 we were only at sea for 4 days. We missed a single day on the water because of engine problems in the tagging boat, but most other days were lost to fog or high winds. Despite intensive search effort by the several research groups (including ships and an airplane), no bowheads were ever sighted in the Beaufort Sea west of Dease Inlet (our operational area) for the entire time we were in Barrow. Bowheads were located in Barrow Canyon by the airplane around September 5, but the Canyon is a difficult place for small boat work because of typically rough seas there. However, we were able to visit the Canyon on September 13 on a particularly nice day. With the help of a NOAA aircraft, we were able to locate a small group of 5-6 bowheads. Within 20 minutes of arriving on the scene, we were able to attach a short-term tag to one of the whales. The tag remained attached for just over 1.5 hours and we were able to conduct 5 casts with the vertical profiling instrument package in proximity to the tagged whale. The whale traveled 15.0 km during the 96 minutes the tag remained attached at an average speed of 4.2 knots.

HIGHLIGHTS

- Our new dermal attachment tag proved quite successful for tracking and monitoring the diving behavior of bowhead whales during the 2010 and 2011 field season.

SOCIETAL BENEFITS

Studying the movements and foraging behavior of bowhead whales will allow us to better understand why the western Beaufort Sea shelf is such an important area for the whales during their spring and fall migrations. Significant changes are underway in this ecosystem, including climate change and increase industrial activity (e.g., shipping, oil and gas exploration and extraction, and eventually fishing), which will undoubtedly affect both the whales and the Iñupiat communities that depend on the bowhead whale for subsistence. Mitigating impacts to the whales will require a fundamental understanding of the ecology of this important species.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

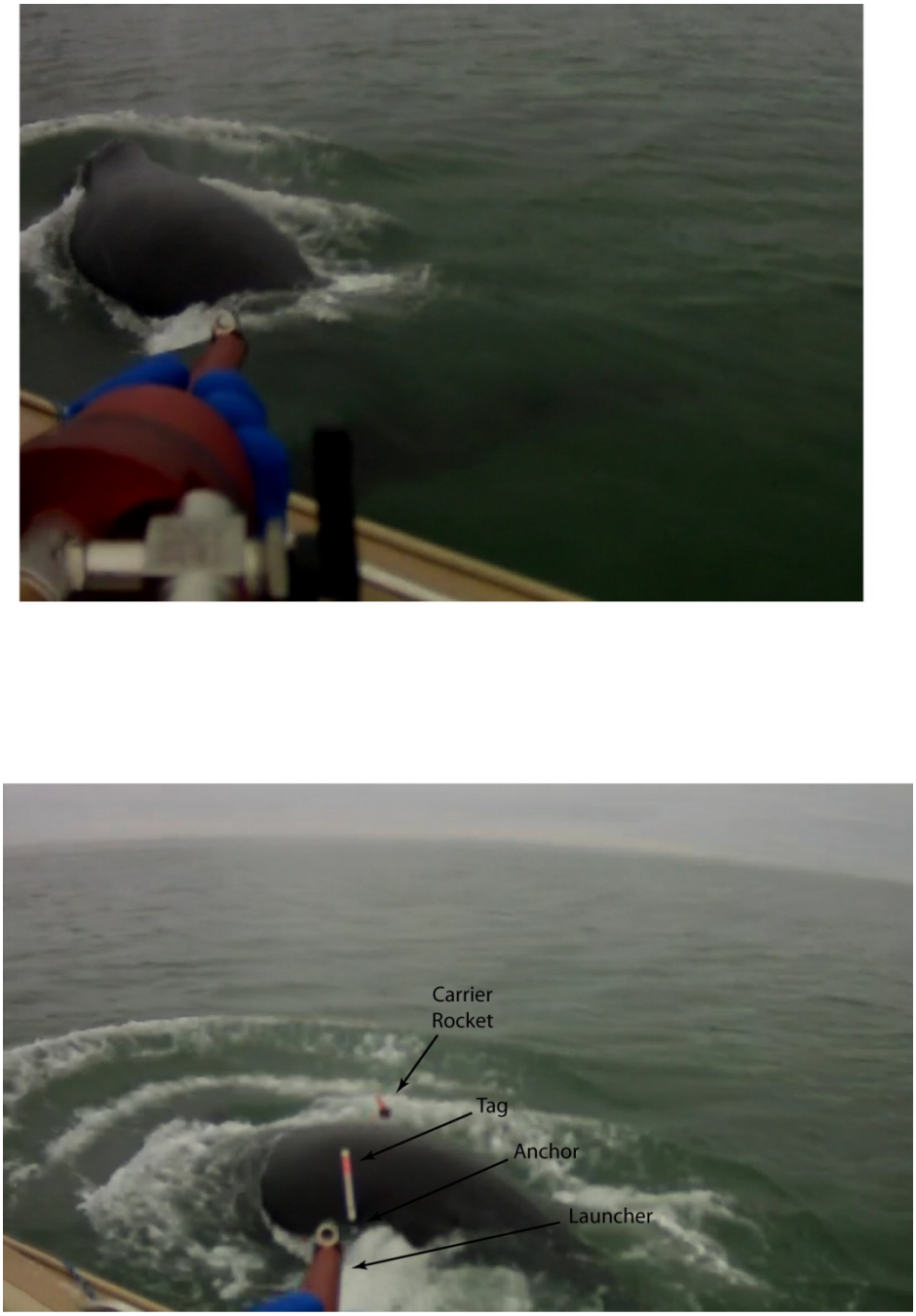


Figure 1. (top) Close approach to bowhead whale immediately prior to tagging with short-term dermal attachment tag. Note launcher in the foreground. (bottom) Successful attachment of projectile dermal attachment tag showing separation of dermal anchor, tag, and carrier rocket after contact with the whale. Images taken from video camera mounted two inches from tagger's right eye.

FY 2011 IOOS Data Registry, Catalog and Viewer Development

NOAA Cooperative Agreement No. NA09OAR4320129 **GMRI** Subpoint 10
April 01, 2011-March 31, 2012

Riley Young Morse-The Gulf of Maine Research Institute

NOAA Program Manager: Zdenka S. Willis - Integrated Ocean Observing System (IOOS) Program Office

Related NOAA Goal Plan: Goal 2. Climate Adaptation and Mitigation: An informed society anticipating and responding to climate and its impacts

CINAR Theme: Theme V. Sustained Ocean Observations and Climate

PROJECT OVERVIEW

The goal of the Data Catalog and Map Viewer project is to provide a single point of access to the standardized data servers that have been and will be established as part of IOOS. Specific objectives include: **Data Catalog -** a spatial database capable of storing metadata, observations and model outputs from IOOS data access services; **Harvester** that obtains metadata from SOS services and populate (a) the Data Catalog and (b) a Web-Accessible Folder (WAF) for indexing by search engines; an **interface to DAP/WCS/WMS harvester**; a map-based, web-accessible **Map Viewer** that provides a visual interface to the Data Catalog; and a **Search Form** providing a textual interface to the data catalog.

Version 1.0 of the Data Catalog and Map Viewer was completed and released in 2010. The 2011 project was focused on enhancing the objectives outlined in Version 1.0 and improving performance and function of the initial product.

ACCOMPLISHMENTS

Version 2.0 of the IOOS Catalog/Map Viewer involved a major redesign of the existing underlying DMAC architecture. Most significantly we moved to Google Fusion Tables and Google Maps Version 3, which solved major performance issues encountered by in Version 1.0 in particular with Internet Explorer while retaining and improving the existing search and filtering functions. This is the new backend spatial database.

Existing services were updated and several new services were added to exploit the new Fusion Table architecture. Registry, Query and Service Testers were developed.

1. **IOOS Data Registry (figure 1):** A single point of capture for all IOOS Web Services was established. A Fusion Table backend and form based front end were created to establish a single point of entry for all IOOS Web Service Registration https://www.google.com/fusiontables/DataSource?snapid=S445388xAYn

2. **SOSTester (figure 2):** Linked to the **Data Registry** an SOS Tester was developed to test the compliance of the registered service and provide instant feedback, Map and Metadata display about the service.

3. **SOS Harvester:** Python scripts were created and are used to sync the SOS Harvester results with the new Fusion Table hosted IOOS Catalog spatial database. Major changes were started in preparation to the new IOOS SOS Profile based on the Sensor Web Enablement 1.0 OGC standard. This work is on going. The Registry Fusion Table is used to drive the SOS and THREDDS Harvesters.

4. **Map Viewer: (figure 3)** A Fusion Table / Google Maps V3 based Map Viewer was created. While retaining current filtering capabilities major performance enhancements across all browser types was accomplished. Additional Regional SOS's and THREDDS servers were added to the Catalog.
   The IOOS Catalog Fusion Table is at:
   https://www.google.com/fusiontables/DataSource?snapid=S445462Ce7o

   Reports, KML outputs, Visualizations and Filters are available via the Fusion Table UI.

5. **Search Form (figure 4):** A simple search form was developed to allow the retrieval from the Fusion Table IOOS Catalog. Results, which consist of SOS Observation URLs, can be displayed on screen, downloaded as a CSV file. The API requests, with a simple SQL like syntax are displayed and can be saved for re-use in the browser or command line. (Figure 4)

HIGHLIGHTS

- Fusion Table architecture yielded major performance improvements. Compatible with IOOS Assets Inventory Fusion Table, both can be viewed side by side in Viewer.
- Major movement toward emerging SWE IOOS Profile but SOS Parsers, utilized in SOS Tester.
- Single source, also in Fusion Tables for all registered IOOS DMAC Services (SOS and TDS)

SOCIETAL BENEFITS

The development of a centralized catalog that provides access to all IOOS assets directly supports Goal 1 of the IOOS Strategic Plan - "Improve access to high-quality, integrated data."

EDUCATION AND OUTREACH ACTIVITIES

Captain Zdenka Willis, Director of the U.S. IOOS Program, circulates informal "Z-Grams" to update partners on the semi-monthly progress of a variety of Program activities. This email newsletter has a large national and international distribution. Capt. Willis reported on the progress of this initiative in several installments of the "Z-Gram" during this reporting period.

November 4, 2011: IOOS Registry, Catalog, Viewer (RCV) Development:

- Micah, US IOOS Program Office continued tracing ESRI Geoportal Server mapping of SOS GetCapabilities response XML and ISO 19115 and 19115-2 metadata to internal Geoportal search indexing properties and associated functionality. Certain elements within ISO metadata and GetCapabilities documents are parsed and then used for either search filtering (i.e. service keywords, abstract text, owner, etc.) via REST and CS-W query, or map preview, or other functionality. In order to determine if Geoportal could serve as a service registry with the IOOS catalog, understanding and evaluating how to extend or adapt these mappings is important.

- Micah also investigated options for mapping the IOOS inventory spreadsheet on a Google Maps site using the private Google Fusion table created previously from the spreadsheet data. He created a proof of concept HTML page showing the inventory as well as a short guide on using Google Fusion tables with Google Maps and the NOAA Enterprise Google Maps license.

January 27, 2012: DMAC PLANNING AND IMPLEMENTATION

<u>IOOS Registry, Catalog, Viewer (RCV) Development - On-going refinements to US IOOS Catalog</u>: We are working on the process to "register" web services that provide access to observations data, emerging data discovery tools and enhancements to the map-based "viewer" that includes lightning-fast presentation of the "dots on the map" showing existing observing assets. The team is also implementing a series of recommendations to better integrate the prototype NGDC Geoportal server as a potential component for a refined US IOOS catalog, particularly as a tool to generate metadata records for the catalog. This includes providing direct links from metadata records in Geoportal search results to pre-filtered IOOS catalog views showing corresponding SOS service platform locations and THREDDS data sets bounding boxes. Linking the publicly available metadata records directly to the IOOS catalog will help to drive traffic to the catalog and will streamline access to IOOS data services for users.

March 9, 2012: IOOS Registry, Catalog, Viewer (RCV) Development:

Presently, teams from Axiom, ASA, NDBC, CO-OPS, NGDC, and GMRI are developing tools for harvesting data and metadata from various web services for the IOOS Data Portal.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS –

Figure 1: IOOS Data Catalog Service Registry

Figure 2: Data Catalog SOS Tester

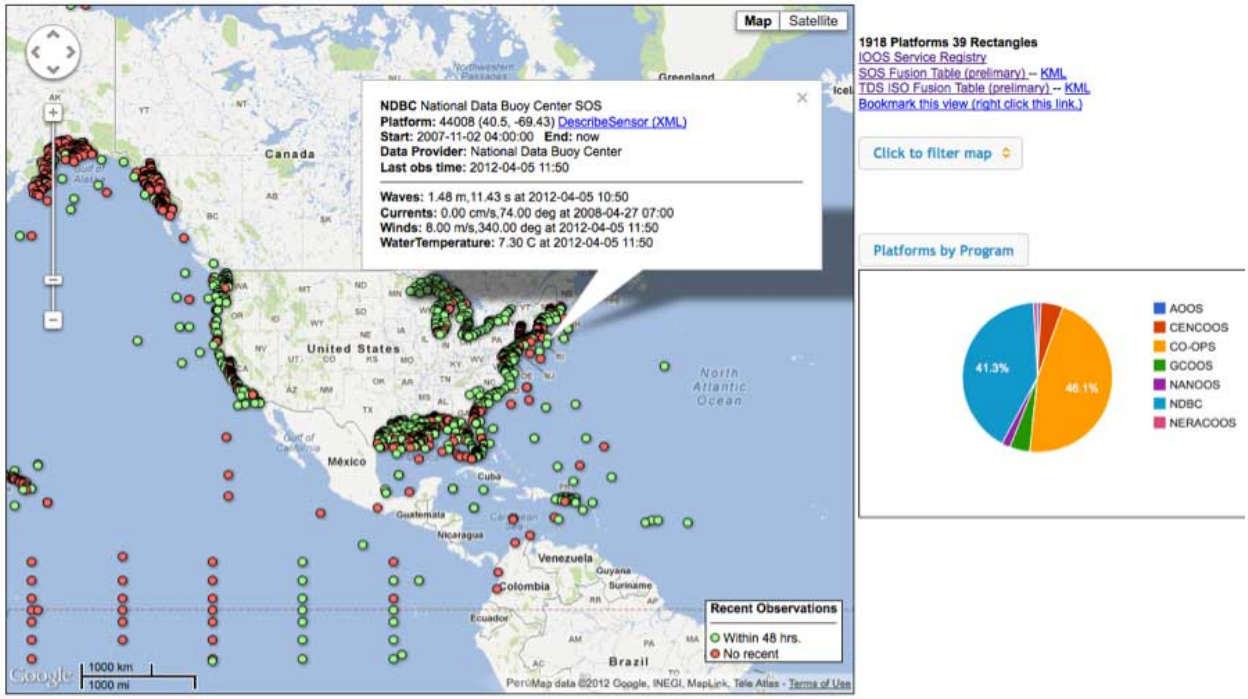


Figure 3: Map Viewer based on Fusion Table / Google Maps v3

Catalog Query API

Programs: NERACOOS Data Providers: All Observed Properties: OceanColor

Add Bounding Box SouthWest Lat: Lon: NorthEast Lat: Lon:

Add Text Search Data Types via free text:

Parse / Display CSV

Download as CSV

https://fusiontables.googleusercontent.com/fusiontables/api/query?sql=SELECT program,platform,observables,obs_url FROM 2796211 WHERE 'program' = 'NERACOOS' and observables = 'OceanColor'

0 Observation Records

program	platform	observables	obs_url
NERACOOS	A01	OceanColor	http://www.neracoos.org/cgi-bin/sos/V1.0/oostethys_sos_dif.cgi?request=GetObservation&service=SOS&version=1.0.0&responseFormat=text%2Fxml%3Bschema%3D%22ioos%2F0.6.1%22&offering=A01&observedProperty=http%3A%2F%2Fwww.csc.noaa.gov%2Fioos%2Fschema%2FIOOS-DIF%2FIOOS%2F0.6.1%2Fdictionaries%2FphenomenaDictionary.xml%23OceanColor
NERACOOS	CO2	OceanColor	http://www.neracoos.org/cgi-bin/sos/V1.0/oostethys_sos_dif.cgi?request=GetObservation&service=SOS&version=1.0.0&responseFormat=text%2Fxml%3Bschema%3D%22ioos%2F0.6.1%22&offering=CO2&observedProperty=http%3A%2F%2Fwww.csc.noaa.gov%2Fioos%2Fschema%2FIOOS-DIF%2FIOOS%2F0.6.1%2Fdictionaries%2FphenomenaDictionary.xml%23OceanColor
NERACOOS	D02	OceanColor	http://www.neracoos.org/cgi-bin/sos/V1.0/oostethys_sos_dif.cgi?request=GetObservation&service=SOS&version=1.0.0&responseFormat=text%2Fxml%3Bschema%3D%22ioos%2F0.6.1%22&offering=D02&observedProperty=http%3A%2F%2Fwww.csc.noaa.gov%2Fioos%2Fschema%2FIOOS-DIF%2FIOOS%2F0.6.1%2Fdictionaries%2FphenomenaDictionary.xml%23OceanColor
NERACOOS	F01	OceanColor	http://www.neracoos.org/cgi-bin/sos/V1.0/oostethys_sos_dif.cgi?request=GetObservation&service=SOS&version=1.0.0&responseFormat=text%2Fxml%3Bschema%3D%22ioos%2F0.6.1%22&offering=F01&observedProperty=http%3A%2F%2Fwww.csc.noaa.gov%2Fioos%2Fschema%2FIOOS-DIF%2FIOOS%2F0.6.1%2Fdictionaries%2FphenomenaDictionary.xml%23OceanColor
NERACOOS	M01	OceanColor	http://www.neracoos.org/cgi-bin/sos/V1.0/oostethys_sos_dif.cgi?request=GetObservation&service=SOS&version=1.0.0&responseFormat=text%2Fxml%3Bschema%3D%22ioos%2F0.6.1%22&offering=M01&observedProperty=http%3A%2F%2Fwww.csc.noaa.gov%2Fioos%2Fschema%2FIOOS-DIF%2FIOOS%2F0.6.1%2Fdictionaries%2FphenomenaDictionary.xml%23OceanColor

Row Count: 5

Figure 4: Search Form to allow retrieval from Fusion Table IOOS Catalog

WHOI Contribution ARGO Float Program (2011-2012)

NOAA Cooperative Agreement No. NA09OAR4320129 WHOI Subpoints 15,16,17,18, and 19
April 01, 2010-March 31, 2011

W. Brechner Owens, Steven R. Jayne and Paul E. Robbins- Woods Hole Oceanographic Institution

NOAA Program Manager: Dr. Steven Piotrowicz-Climate Program Office

Related NOAA Goal Plan: Goal 2. Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond.

CINAR Theme: Theme V. Sustained Ocean Observations and Climate

PROJECT OVERVIEW

The goal of the Argo float program is to have 3000 profiling floats reporting profiles of temperature and salinity on a 10-day cycle covering the global ocean. The program reached this goal in October, 2007. We have been able to maintain this goal due to increased lifetimes of the floats so that we can observe the changing state of the ocean associated with climate change. The US is expected to provide half the array and the WHOI component of the Argo float program represents approximately 15% of the array.

The Argo float program was designed to provide data for a number of different usages. These range from real-time analyses by operational centers to high precision analyses by climate scientists to investigate decadal climate signals. This breadth has placed an extraordinary demand on both the performance of the instruments and on the infrastructure to process the data so that the data is distributed in a timely manner to real-time users and subjected to stringent quality control to provide a high-quality data set that will exponentially increase coverage and quantity of data available to construct ocean climatologies.

ACCOMPLISHMENTS

This project covers WHOI's contribution to the Argo float program. During the period 1 April, 2011 to 31 March, 2012, 97 WHOI floats have been launched. Part of this total represents a backlog of floats die to problems with the Seabird CTDs that have plagued the entire Argo float. We presently have an inventory of approximately 40 SOLO-I floats and will produce another 30 floats in the next two months. We are also begun receiving the 60 SOLO-II floats that have been orders from a commercial vendor. We have been actively working with MRV and our Scripps Institution of Oceanography collaborators to develop the procedures, software, and product description for the SOLO-II float so that it can be used by the broader Argo community. During the past year, 442 WHOI floats have been active and 13,438 profiles have been inserted into the Argo data system.

Of the approximately 90,000 profiles from WHOI floats, more than 96% have been reviewed, quality controlled, and had their salinity adjusted. In addition, a new GUI editor has been developed for carrying out quality control on the float profiles. This new editor, using MATLAB, is a significant improvement over an earlier one used in the Argo community and uses the embedded netcdf function calls that are now available in the latest versions of MATLAB. We, in collaboration with Annie Wong from the University of Washington, have also continued to maintain the software that is used by the Argo community to calibrate the conductivity sensors on the floats.

Over the past year, we have also developed a much improved web page that documents the performance of the floats and presents detailed statistics on the floats, plots of data from the individual floats. This web site can be accessed at the following URL: http://argo.whoi.edu/

In addition, we have now developed a relational data base that allows us to access the details of the engineering data for each float, the specifics of the float manufacture, including serial numbers of parts, etc. We have also constructed a data base for all the Argo fleet that allows us to access subsets of the data easily and make other summaries of the data. This data base is being shared with the international Argo Information Center (AIC).
We have continued to be involved in the management of Argo, including membership in and attendance at meetings of the Argo Science Steering Team, Argo Data Management Team, and the US Argo consortium.

HIGHLIGHTS

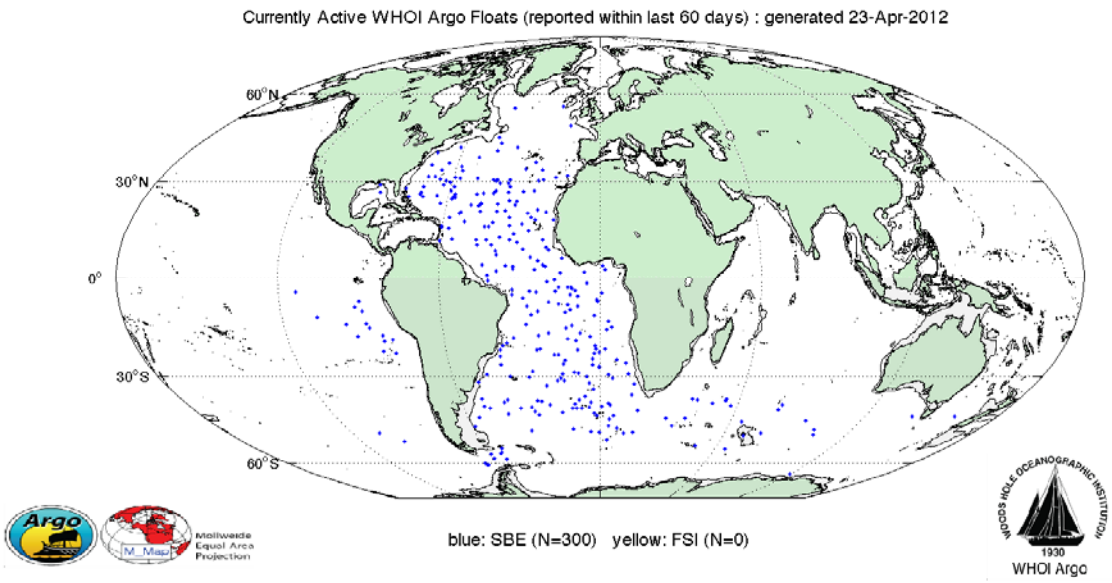
- Continued maintenance of the 3000 Argo array despite level funding for nearly a decade.
- Production of a high quality delayed mode data set usable for detecting the small climate change signals.

SOCIETAL BENEFITS

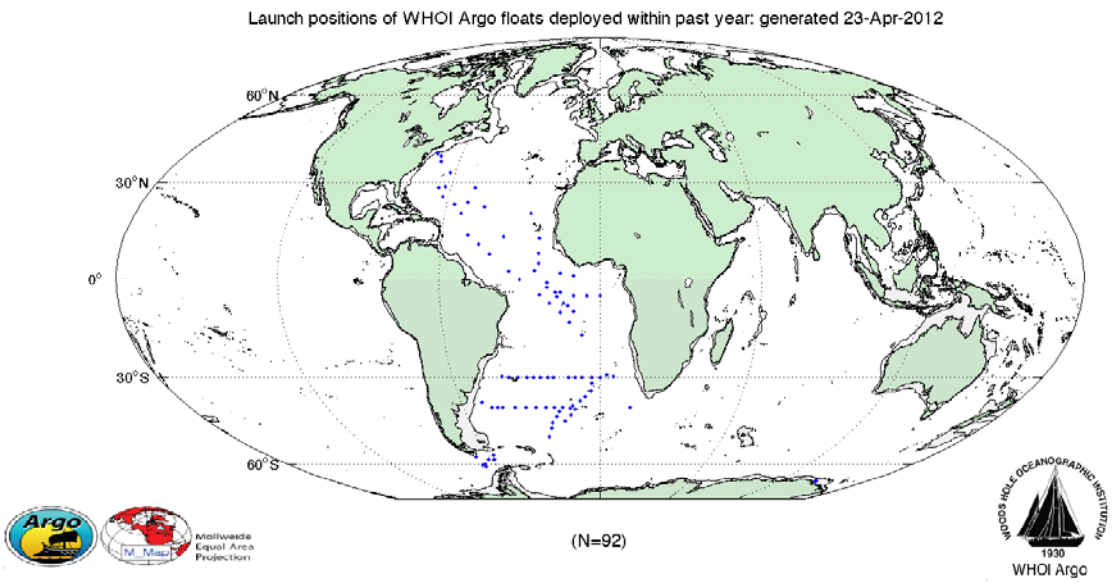
The Argo float program is one of the primary backbones of the Global Ocean Observing System, providing *in situ* measurements of temperature and salinity from the sea surface to 2000 m depth. The Argo data are used for operational forecasts of both inter-seasonal and seasonal to inter-annual predictions, such as El Nino forecasts, and to by the climate science community to estimate changes in the heat and salt content of the global oceans to monitor the changing climate of the global oceans.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

Active WHOI floats



Launch positions of WHOI floats during the past year



NOAA State of the Arctic Report

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 11
April 01, 2011-March 31, 2012

Andrey Proshutinsky-Woods Hole Oceanographic Institution

NOAA Program Manager: John A. Calder-Artic Research Climate Program Office, R/CPO

Related NOAA Goal Plan: Goal 2. Climate Adaptation and Mitigation: An informed society anticipating and responding to climate and its impacts

CINAR Theme: Theme V. Sustained Ocean Observations and Climate

PROJECT OVERVIEW

The major project goal is to provide and effectively document current and unbiased observations on the state of the Arctic Ocean in a way that is accessible to a wide audience. The project's objective is to directly support NOAA's Program Plan for Building a Sustained Ocean Observing System for Climate by expanding current efforts to monitor and document the state of the Arctic Ocean.

ACCOMPLISHMENTS

Changes of the Arctic Ocean physical and biogeochemical parameters in 2011 relative to climatology of the 1970s and 2010-2011 were analyzed and described based on available observations and publications. Among analyzed parameters are: wind-driven circulation of ice and water, water temperature and salinity fields with some integral parameters like heat and fresh water content, rates of sea level change, and biology and geochemistry in the Chukchi and Beaufort Seas. Results of this report will be published in a special issue of the Bulletin of American Meteorological Society. These materials were posted at NOAA's web site and will be reported at the IPY-2012 conference in Montreal, Canada.

HIGHLIGHTS

A large-scale anticyclonic circulation regime (similar to that shown in Fig. OCE-1) has persisted between 1997 and 2011, with only one short-lived reversal to a cyclonic regime in 2009. The anticyclonic regime has dominated for at least 15 years, instead of the typical 5-8 year pattern reported by Proshutinsky and Johnson (1997, 2011a), who analyzed statistics of Arctic circulation regimes between 1948 and 2011. It may be that after the anomalous 2007 conditions (a historical minimum of September sea-ice extent, and maximum upper-ocean warming and freshening), the Arctic climate system shifted towards a new regime characterized by a more persistent anticyclonic regime and with relatively small changes from year to year. On the other hand, a comparison of sea-level pressure (SLP) and Ekman transport shows that the mean fields for 1948-1988 (Fig. OCE-1) and 1948-2011 (not shown) are essentially identical, implying that

the climate (using a conventional definition of 30-year averaged fields) of ocean dynamics is stable, but that strong interannual and decadal variability exists.

SOCIETAL BENEFITS

Information about Arctic climate change will be available to a wide community.

EDUCATION AND OUTREACH ACTIVITIES

Important project results will be presented at IPY-2012 conference (Montreal, Canada). These results are also posted at NOAA's web site "Arctic report card": http://www.arctic.noaa.gov/reportcard/

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

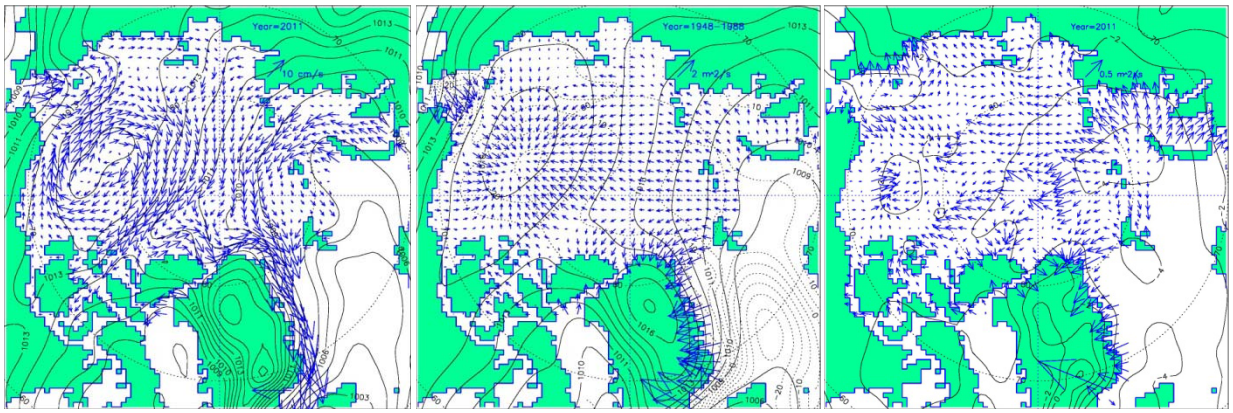


Figure 1. Left: Simulated wind-driven ice motion (arrows) and observed sea level atmospheric pressure (hPa, black lines) for 2011. Results are from a 2-D coupled ice-ocean model (Proshutinsky and Johnson, 1997; 2011a) forced by wind stresses derived from 2011 NCEP/NCAR reanalysis 6-hourly sea level pressure fields. Middle: Ekman transport (vectors, m^2s^{-1}) and sea level pressure (SLP) averaged over 1948-1988 showing typical climatic conditions: relatively fresh waters from the entire Arctic Ocean are accumulated in the BG region via Ekman transport. Right: 2011 Ekman transport and SLP anomalies relative to 1948-1988 climatic conditions. In 2011, SLP over the BG region was somewhat lower than climatology while the accumulation of freshwater increased. The right panel also suggests that the increase of freshwater content in the BG region could originate from local sources.

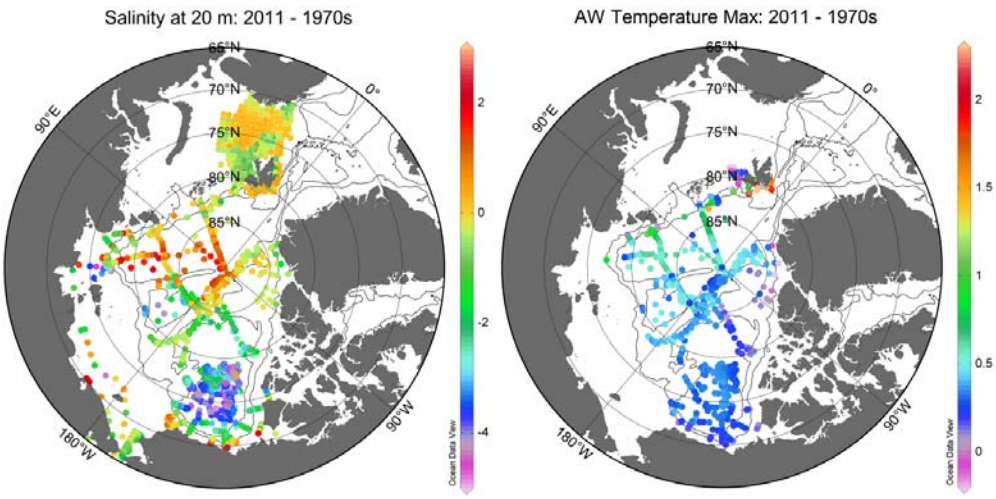


Figure 2. Left: Anomalies of upper ocean salinity at 20 m depth in 2011 relative to the 1970s climatology (cf. Fig. O.3, Proshutinsky et al., 2011b). Right: Atlantic Water Layer (AWL) temperature maximum anomalies in 2011 relative to the 1970s climatology (cf. Fig. O.6, Proshutinsky et al., 2011b). Contour lines show the 500 and 2500 m isobaths.

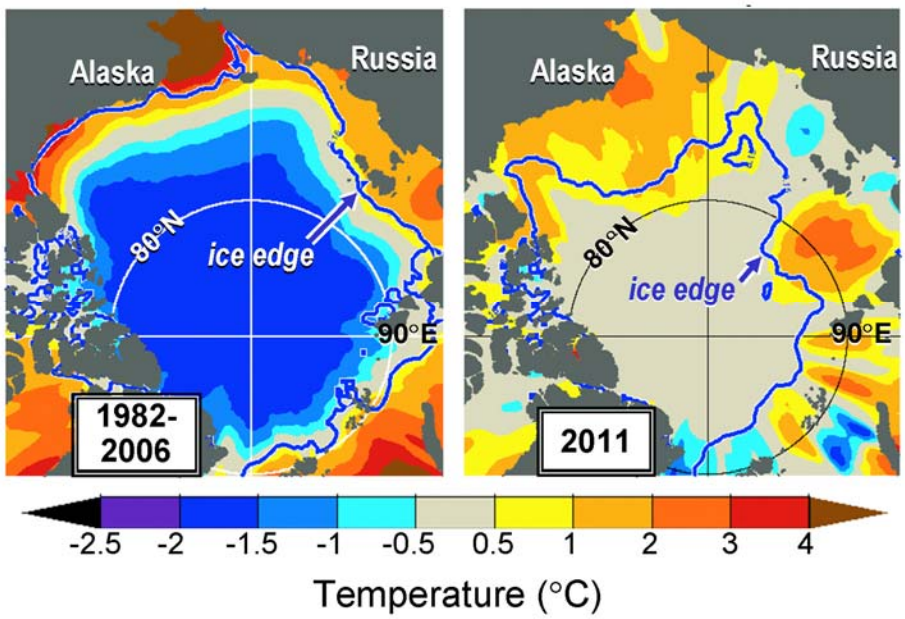


Figure 3. Summer (June-September) SST anomalies in 2011 (right panel) relative to the summer mean during 1982-2006 (left panel). The anomalies are derived from satellite data according to Reynolds et al. (2002). The September mean ice edge (thick blue line) is also shown.

R/V ATLANTIS Use in Support of NOAA/PMEL Vents Research Cruise Embley

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 44
April 01, 2011-March 31, 2012

Albert Suchy-Woods Hole Oceanographic Institution

NOAA Program Manager: Robert Embley-Pacific Marine Environmental Lab, VENTS Program

Related NOAA Goal Plan: Goal 2. Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond.

CINAR Theme: Theme V. Sustained Ocean Observations and Climate

PROJECT OVERVIEW

The Woods Hole Oceanographic Institution provided the R/V Atlantis with a two SSSG Technicians for Robert Embley to carry out research via the JASON Remote Operated Vehicle (ROV) at the Axial Seamount off of the Pacific NW of the USA. Dave Butterfield represented Robert Embley on this voyage, Atlantis AT18-07. There were 5 separately funded projects all piggybacked together at the Endeavour site and Axial Seamount on this cruise and all were successful. Work included instrument deployments and recoveries, fluid and microbial sampling, ROV-based pressure measurements, CTD casts and mooring deployments and recoveries. Dave Butterfield had three days of time for the NOAA Program Manager Robert Embley. Jason dives were conducted during this period at Axial Seamount.

ACCOMPLISHMENTS

The UNOLS vessel Atlantis was deployed during the month of July 2011 out of Astoria, OR for this work. Accomplishments included:
A) Fluid sampling
B) Recovery of RAS (sea floor timed series sampling device) with Jason
C) Sampling ASHES field (east side of Axial) with HFPS and gas-tights (Jason equipment) for time series forchemistry/microbiology.
D) Sampling International District field with HFPS and gas-tights (Jason equipment). These achievements included sampling of the borehole near base of El GuapoE) Sample high-T vents at Vixen/Casper and surrounding diffuse vents.

HIGHLIGHTS

Sampling from all locations especially the ASHES field and the vents, particularly at the borehole near the base of El GuapoE, as well as recovery of the sea floor time series were the real highlights of using Jason on this CINAR Program.

SOCIETAL BENEFITS

This time series study will provide a snapshot for observing the complete forchemistry/microbiology of the Axial Seamount.

EDUCATION AND OUTREACH ACTIVITIES

This research will provide the basis for future studies with the NOAA VENT studies. Many video and still photos from this voyage were distributed worldwide

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

Atlantis in the Pacific NW USA with ROV LARS on aft Port Quarter

Ocean Climate Observations and Analyses (2011-2012)

NOAA Cooperative Agreement No. NA09OAR4320129, WHOI Subpoint(s) 20, 21, 22, 23, 24,and 25

April 01, 2011-March 31, 2012

Robert A. Weller and Albert J. Plueddemann-Woods Hole Oceanographic Institution

NOAA Program Manager: David Legler-Climate Observations Division

Related NOAA Goal Plan: Goal 2. Climate Adaptation and Mitigation: An informed society anticipating and responding to climate and its impacts

CINAR Theme: Theme V. Sustained Ocean Observations and Climate

PROJECT OVERVIEW

The Ocean Reference Station project is carried out to provide critical, sustained observations of a key region of the ocean. As the earth sits in space, sunlight heats the earth in a broad, equatorial region. The ocean and atmosphere both are driven by the thermal gradients between the equator and the poles; the oceans, with their ability to store, transport, and release heat and moisture to the atmosphere, play an important role in weather and climate. Air that is heated rises at the equator and descends in the subtropics, resulting in broad regions of winds flowing from the east to the equator. Around the globe these easterly trade wind regions cover roughly 50% of the ocean surface, in a wide belt spanning the equator. These regions are where the equatorial concentration of solar heating leads to net ocean heating and where in turn large evaporation and accompanying latent heat flux provides energy and moisture to drive the atmosphere over a range of scales, from the general Hadley circulation that is the source of the trade winds down to intense hurricanes intensified by that heat and moisture. They are also where the ocean provides CO_2 to the atmosphere in contrast to the higher latitudes where the ocean gains CO_2 from the atmosphere. Integrated across the expanse of the trade wind regions, errors and uncertainties in the exchange of heat, freshwater, momentum, and compounds such as CO_2, can challenge our ability to understand the way in which the atmosphere and ocean interact and how that interaction should be represented in models used to predict weather and climate variability.

ACCOMPLISHMENTS

To provide sustained, climate-quality observing of the trade wind region, we have developed surface moorings with the capability of making sustained, accurate observations at the sea surface and in the water column and have chosen and occupied three key trade wind sites. These surface moorings are known as Ocean Reference Stations (ORS). The three sites, shown in Figure 1, are the Stratus ORS, the NTAS (Northwest Tropical Atlantic Station) ORS, and the WHOTS (Woods Hole Oceanographic Institution Hawaii Ocean Timeseries Site) ORS.

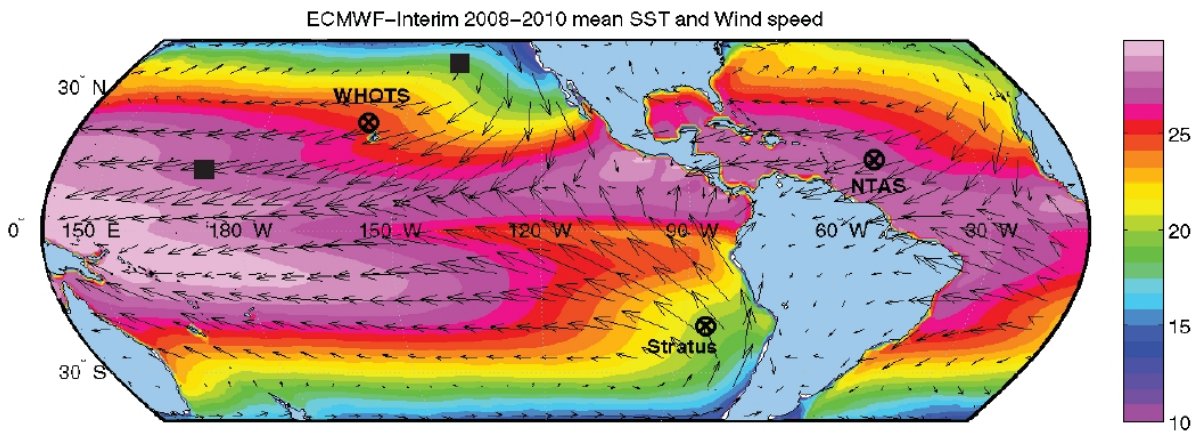


Figure 1. SST (colors) and surface wind vectors from the ECMWF-Interim reanalysis for the period 2008-2010. The positions of the Stratus, NTAS and WHOTS ocean reference station buoys are indicated. The corresponding virtual positions of the Stratus and NTAS buoys, relative to the North Pacific Hadley circulation and SST, are indicated by black squares. From Dr. Roger Lukas, Univ. of Hawaii, partner at WHOTS.

Together, the three sites form a comprehensive array in two ways. First, they sample distinct branches of the trade wind regime. The black squares in Figure 1 are the positions of NTAS and Stratus relative to WHOTS; note that Stratus, at the furthest distance from the region of convergence between the Northeast and Southeast Trades, samples the region of descending atmospheric flow in the Hadley circulation and the origin of the trade winds, while NTAS, samples they trade winds close to the convergence zone which is the ascending branch of the Hadley circulation, and while WHOTS, samples fully developed trade winds in between. Second, the three sites have regional attributes. Stratus is under the persistent marine stratus clouds that characterize the region of northern Chile, in a cool eastern boundary current regime and, due to the proximity of the Andes, away from the tracks of energetic synoptic weather systems; atmospheric, oceanic, and coupled models continue to fail to correctly represent the physics at work there and typically yield sea surface temperatures that are too cool. NTAS lies in the North Atlantic trade wind regions through which the hurricanes that reach eastern North America track, and accurate representation of how the ocean's heat and moisture in this region fuel the growth of those hurricanes is needed. WHOTS, close to the Hawaiian Islands where the Keeling time series documents the increase of atmospheric CO_2, provides not only a critical benchmark time series of oceanic CO_2 but also an emerging record of links between changes in the regional hydrological cycle (rainfall, evaporation) and the variability and dynamics of the upper ocean there due to changes in ocean salinity.

The reasons for our approach, the use of surface moorings for sustained observations, are: 1) the need to obtain high temporal resolution, sampling down to minutes to record high amplitude, short-lived events in the surface meteorology, air-sea fluxes, and upper ocean structure, 2) the need to sample with high vertical resolution in the stratified upper ocean that is in close contact to the atmosphere and links the upper ocean to the interior of the ocean, 3) the need to sample a changing environment in a sustained way, and 4) the need to provide continuous time series at a point for validation, verification, and calibration of models and remote sensing methods. Designing and building a surface mooring, developing and using accurate instruments with low-power consumption that can run unattended, instrumenting the surface buoy with these meteorological and pCO2 sensors and the mooring line with temperature, salinity, velocity, and other ocean sensors, and carrying out on-site verification of the moored instrumentation when the ship services the mooring each year are the best technical approach and the one we use at the three ORS. The resulting meteorological and oceanographic observations provide a set of high quality air-sea fluxes of heat, freshwater and momentum as well as upper ocean heat and salt content. The scientific rationale for the collection of these flux products is manifold: 1) to describe the upper ocean variability and the local response to atmospheric forcing; 2) to motivate and guide improvement to atmospheric, oceanic, and coupled models; 3) to calibrate and guide improvement to remote sensing products and capabilities; and 4) to provide anchor points for the development of new, basin scale fields of the air-sea fluxes. Model, satellite, and climatological fields of surface meteorology and air-sea fluxes have large errors; high quality, in-situ time series are the essential data needed to improve our understanding of atmosphere-ocean coupling and to create more accurate global fields.

HIGHLIGHTS

The ORS results are particularly significant in two areas:

- Benchmarking three trade wind sites – the three ORS now provide accurate local climatologies of surface forcing and upper ocean variability.
    - They form the basis for examining model errors and biases.
    - They also form the basis for tracking anomalies in surface forcing and upper ocean heat content and identifying the spatial representativeness of such anomalies by looking at decorrelation scales in the atmosphere (in model and OA Flux fields) and in the ocean (in Argo float data).
- Quantifying the processes at work to maintain the state of the upper ocean – the combination of accurate local forcing and good time/space resolution in the upper ocean allows us to identify the major contributors to local heat, freshwater, and momentum balances.

SOCIETAL BENEFITS

The Ocean Reference Station project is carried out to provide critical, sustained observations of a key region of the ocean, the trade wind region, that plays an important role in weather and climate. They are also where the ocean provides CO_2 to the atmosphere in contrast to the higher latitudes where the ocean gains CO_2 from the atmosphere. An improved and accurate understanding of the exchange of heat, freshwater, momentum, and compounds such as CO_2, across the trade wind region is required to improve our ability to understand the way in which the atmosphere and ocean interact and how that interaction should be represented in models used to predict weather and climate variability.

EDUCATION AND OUTREACH ACTIVITIES

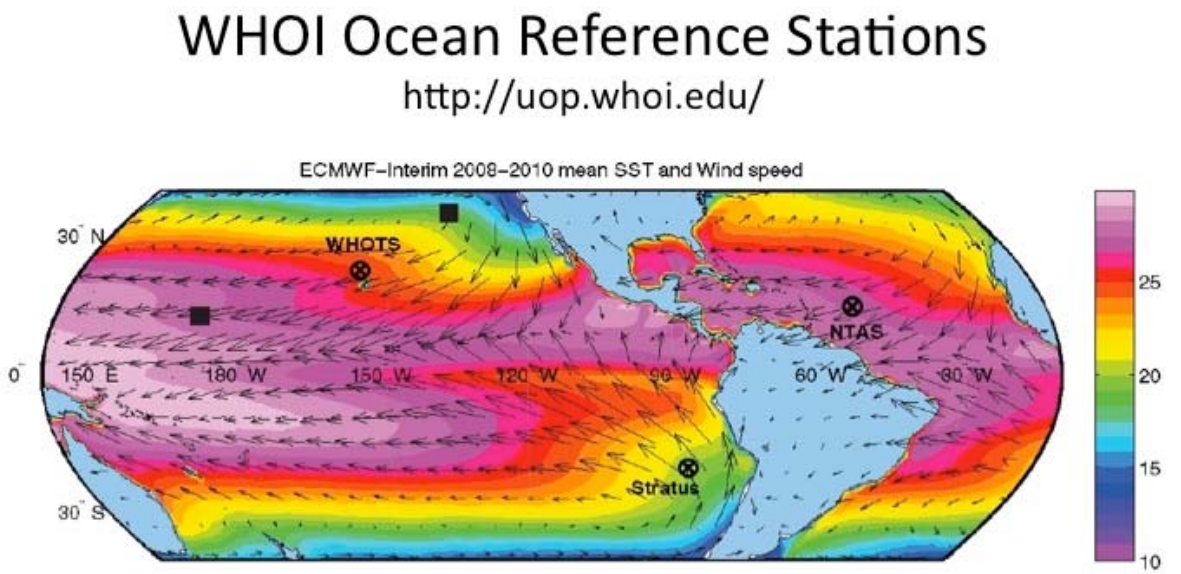
Teacher at Sea: The ORS effort each year makes space available on its cruises to the NOAA Teacher at Sea program. Stratus has hosted six Teachers at Sea, one cruise being subject of one of the children's books on Teacher at Sea published by NOAA. In Arica, Chile past participation by a Chilean Teacher at Sea has been kept alive by hosting visits from her present classes in the port of Arica. WHOTS has hosted four Teachers at Sea; WHOTS also hosted a NOAA Hollings Scholar on a cruise.

Video: ORS Stratus hosted volunteer Diane Suhm on the Stratus cruise on the NOAA Ship Ron Brown in 2010 and funded her to produce a video documenting that cruise. This video was recently provided to the Climate Observation Division. A shorter version has run on cable TV in Massachusetts and will be used at public lectures in Woods Hole. A variety of (non-professional) video footage is also available from NTAS and Stratus cruises.

Student Participation and Training: The Stratus cruises, whenever possible, offer space to undergraduate and graduate students to provide hands on experience at sea. A graduate student from the University of Chile, Santiago made radiosonde observations in the wind jet off the coast of Chile on one cruise. Students from the University of Concepcion, Concepcion, Chile have participated on several Stratus cruises. Graduate students and postdocs from Bigelow Marine Laboratory, George Mason University, Colorado State University, WHOI, the University of Washington, the University of California, Santa Barbara, the University of Hawaii, CICESES (Centro de Investigación Científica y de Educación Superior de Ensenada, Baja California), Southampton Oceanography Centre, UK (now National Oceanography Centre), University of Miami, the University of Buenos Aires, and Texas A&M University have also participated. An excellent example of impact is Dr. Carlos Moffat. He sailed on a Stratus cruise as an undergraduate at Univ. of Concepcion, liked the work, came to WHOI for graduate school, and returned to Univ. of Concepcion as faculty in oceanography. WHOTS and NTAS provide space and research opportunities as available for undergraduate and graduate students from the University of Hawaii (WHOTS) and the Scripps Institution of Oceanography (NTAS).

Regional Outreach: Stratus has used opportunities derived from sailing from different Central and South American ports for regional outreach. Staff from INOCAR (Institute of Naval Oceanography) in Ecuador, the Hydrographic Division of the Peruvian Navy (DHN), the Institute of Marine Sciences of Peru (IMARPE), and the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA) have joined Stratus cruises.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS



The three WHOI ORS, Stratus, NTAS, and WHOTS form an array sampling the critical trade wind region. This figure shows SST (colors) and surface wind vectors from the ECMWF-Interim reanalysis for the period 2008-2010. The positions of the Stratus, NTAS and WHOTS ocean reference station buoys are indicated. The corresponding virtual positions of the Stratus and NTAS buoys, relative to the North Pacific Hadley circulation and SST, are indicated by black squares, showing how the descending, ascending branches are sampled as well in between. From Dr. Roger Lukas, Univ. of Hawaii, partner at WHOTS.

Figure 1. An overview of the locations of the three Ocean Reference Stations (ORS).

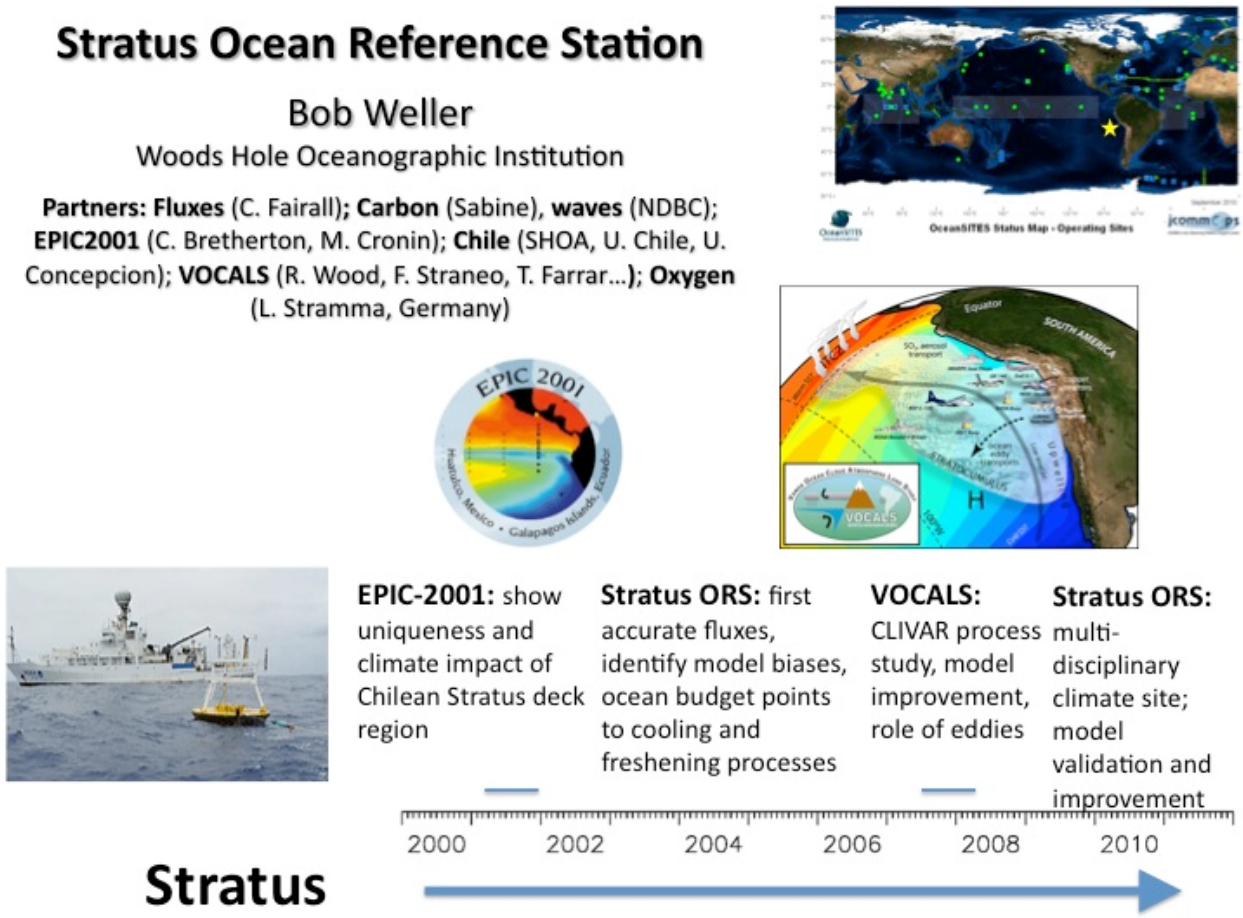


Figure 2. Time-line overview of the Stratus ORS since inception in 2000, with collaborators and key results during different periods of the effort, including anchoring the process studies, EPIC-2001 (Eastern Pacific Investigation of Climate-2001) and VOCALS (VAMOS Ocean Cloud Atmosphere Land Study where VAMOS is Variability of the American Monsoon Systems).

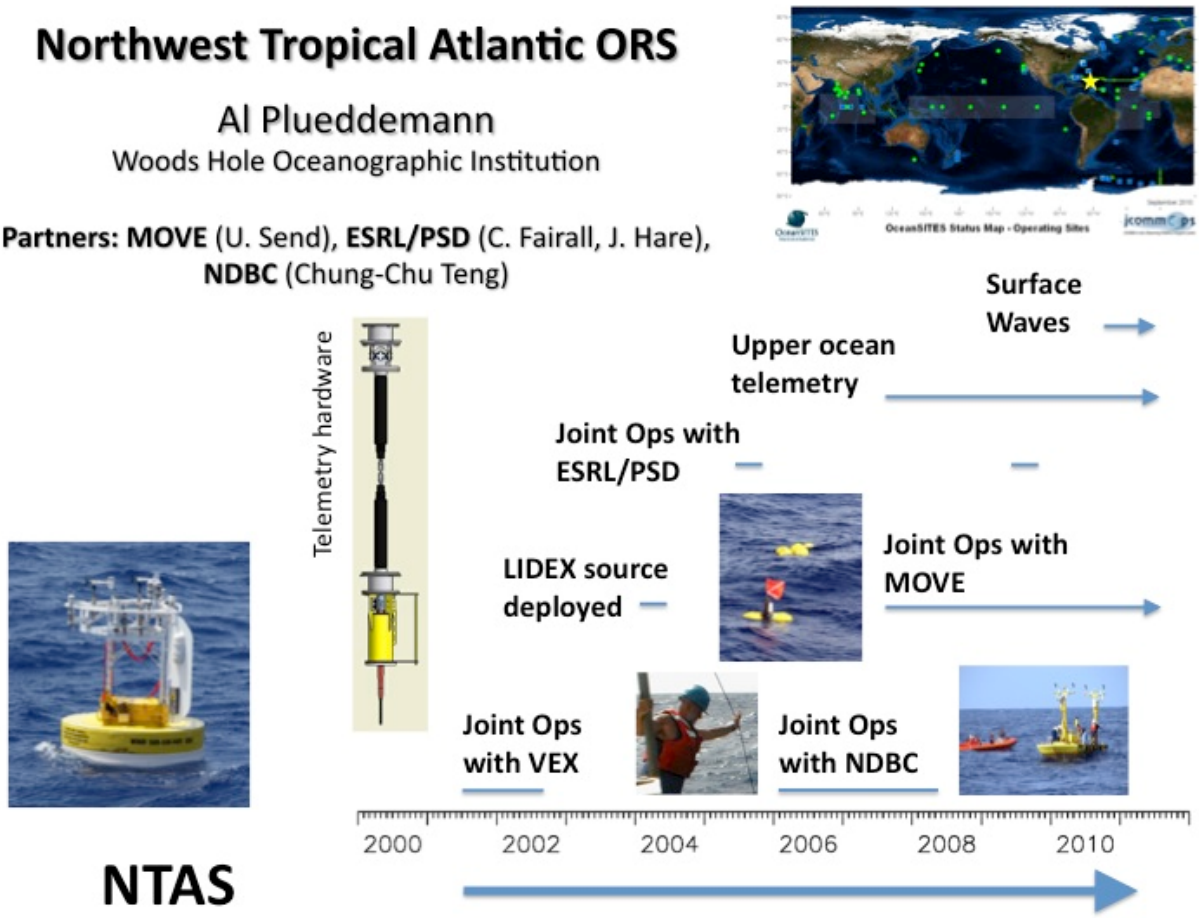


Figure 3. Time-line overview of the NTAS ORS since inception in 2001, with collaborators and key results during different periods of the effort, including cooperation with other NOAA activities such as the National Data Buoy Center (NDBC), the Environmental Sciences Research Laboratory, Physical Sciences Division (ESRL/PSD), the Meridional Overturning Variability Experiment (MOVE), the Western Boundary Time Series (WBTS) project (2010, not shown) and the VENTS project (2011, not shown). The NTAS project also often includes ancillary activities, such as the Vema Channel Exploration (VEX) project in 2001, the Lagrangian Isopycnal Displacement Experiment (LIDEX) in 2004.

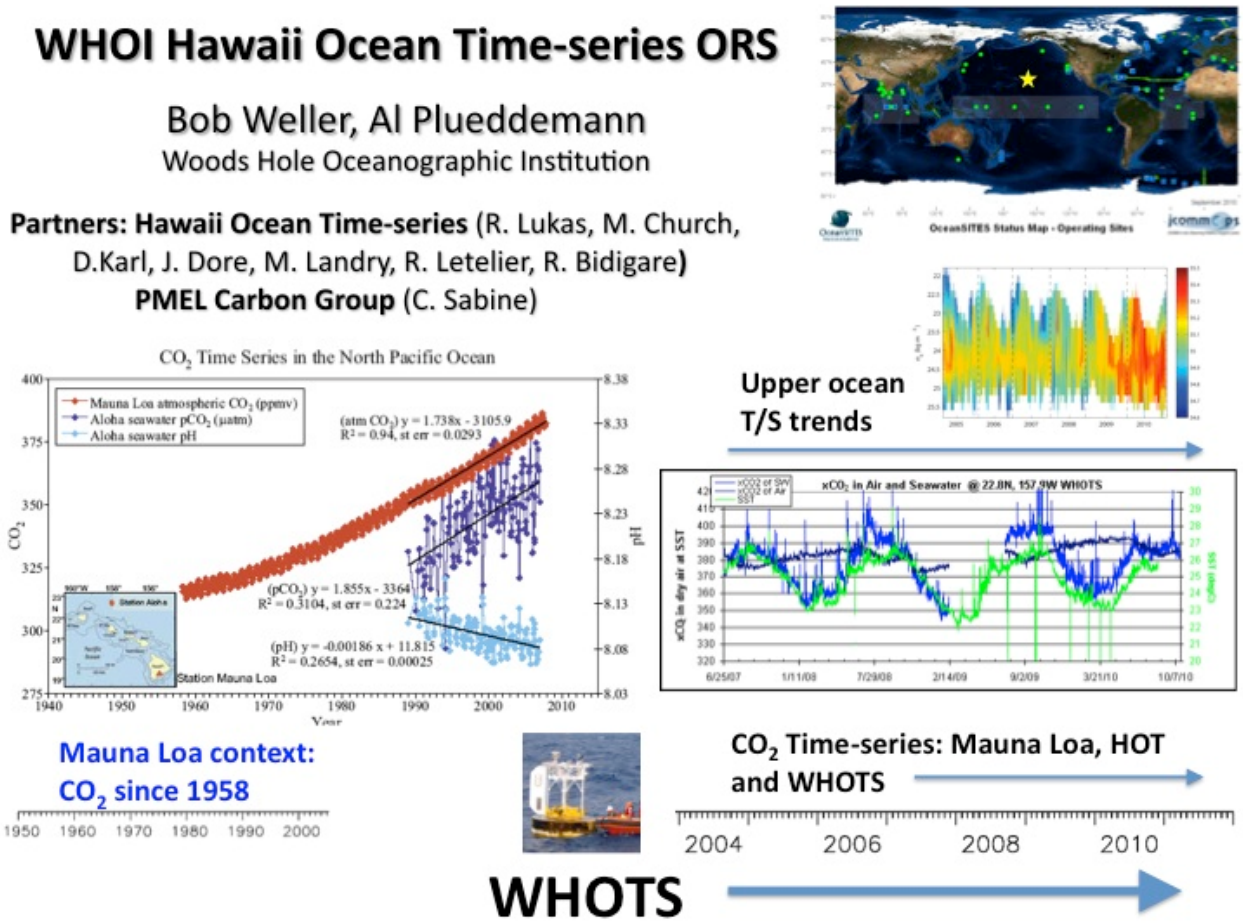


Figure 4. Time-line overview of the WHOTS ORS since inception in 2004, with collaborators and key results. Hawaii, with the context of the Keeling time series of atmospheric carbon dioxide is a key location to track oceanic response to anthropogenic carbon dioxide intake.

Global Ocean Surface Heat Flux Analysis

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoints 14 and 37
April 01, 2011-March 31, 2012

Lisan Yu-Woods Hole Oceanographic Institution

NOAA Program Manager: Joel Levy-Climate Program Office

Related NOAA Goal Plan: Goal 2. Climate Adaptation and Mitigation: An informed society anticipating and responding to climate and its impacts

***C*INAR Theme:** Theme V. Sustained Ocean Observations and Climate

PROJECT OVERVIEW

The Objectively Analyzed air-sea Fluxes (OAFlux) project is a research and development project focusing on global air-sea heat, moisture, and momentum fluxes. The project is committed to develop high-quality, long-term, global ocean surface forcing datasets from the late 1950s to the present to serve the needs of the ocean and climate communities on characterization, attribution, modeling, and understanding of variability and long-term change in the atmosphere, and the ocean. Over the years, concerted efforts have lead to the development of an innovative objective analysis approach to improving the quantification of global air-sea flux fields, and to the use of these flux datasets to stimulate advances in our understanding of the role of the ocean in the global energy budget, the global hydrological cycle, and the change and variability of the Earth's climate.

Global air-sea fluxes are commonly constructed from flux bulk parameterizations that require surface meteorological observables (e.g., wind speed, temperature, humidity, cloud cover, etc.) as inputs. However, no surface meteorological observables are free from errors/biases regardless of whether they are ship-based measurements or space-born satellite retrievals. The OAFlux project was established on the basis that quality global flux fields can be obtained by taking into account data errors while combining and synthesizing the existing data sources. To better represent errors in input data sources, a validation data base was created that consists of 120+ flux buoys over the global oceans, including the tropical moored array network in all three tropical oceans (i.e., the Tropical Atmosphere Ocean/Triangle Trans-Ocean Buoy Network (TAO/TRITON) in the Pacific, the Prediction and Research Moored Array in the Atlantic (PIRATA), and the Research Moored Array for African–Asian–Australian Monsoon Analysis and Prediction (RAMA) in the Indian Ocean), and moored surface buoys deployed by the Upper Ocean Processes Group at the Woods Hole Oceanographic Institution. The in situ validation base provides benchmark time series essential for quantifying uncertainties in input data sources and for evaluating the accuracy of the OAFlux analysis.
At present, the OAFlux project has produced global 1° resolution, daily/monthly analysis (1958-to present) of ocean evaporation, air-sea latent and sensible heat fluxes, and related surface meteorological variables. These products are being maintained online (http://oaflux.whoi.edu/data.html) with twice-per-year updates. The OAFlux new datasets, developed in coordination with other projects, are the global 0.25° and 1° resolution analyses of daily ocean vector wind

fields covering the period of satellite passive/active sensors from 1987 to the present. The current effort of the project is directed toward a global net heat flux dataset with reduced biases/errors. The multi-decadal global flux time series contribute to new insights into the fundamental changes in the global climate system when temperature rises. It shows the intensification of ocean evaporation since the late 1970s, providing observation evidence to the Intergovernmental Panel on Climate Change (ICPP) 5th assessment report (AR5) on the acceleration of the global hydrological cycle in the past warm decades. It illustrates the important role of the strengthening ocean surface wind speed in increasing ocean evaporation. It suggests a non-negligible contribution of high-latitude sensible heat flux (i.e. the thermal exchange at the air-sea interface due to air-sea temperature differences) to global energy balance. Steady progress has been made and the project is on track toward achieving its objectives.

The quality and accuracy of the OAFlux time series have gained increasing recognition and appreciation in the community and the OAFlux data user base is growing rapidly. Users of the OAFlux products include but are not limited to: 1) climate modeling groups and centers, including National Centers for Environmental Prediction (NCEP), Global Ocean Data Assimilation System (GODAS), the National Aeronautics and Space Administration (NASA), Modern Era Retrospective Analysis for Research and Applications (MERRA), and Coupled Model Intercomparison Project (CMIP), using the global OAFlux fields as base reference for validating the performance of the models; 2) investigators and researchers working under the NASA Aquarius mission and the European Space Agency's (ESA) Soil Moisture and Ocean Salinity (SMOS) mission, and the NASA field experiment of the Salinity Processes in the Upper Ocean Regional Study (SPURS), using OAFlux evaporation time series together with the precipitation time series from the NASA Global Precipitation Climatology Project (GPCP) as freshwater flux forcing to study the cause of the change of ocean salinity; 3) researchers and investigators working to understand the global hydrological change under climate warming, using OAFlux time series to study the intensification of the global ocean cycle in the past three decades; 4) investigators under targeted field programs, including CLIVAR (Climate Variability research program), Mode Water Dynamic Experiment (CLIMODE), and Dynamics of the Madden-Julian Oscillation (DYNAMO), using OAFlux products to identify key air-sea interaction processes and feedback mechanisms; 5) researchers working on the ocean carbon cycle, using OAFlux products to identify global "hot spots" where the ocean releases heat to the atmosphere and absorbs carbon dioxide from the atmosphere to understand the air-sea heat flux as a driver of the air-sea carbon flux; 6) those working to quantify the role of the ocean in climate variability and change, using the OAFlux time series to evaluate the ocean’s role as a source or sink of heat and freshwater; 7) those working with ocean models, who use the OAFlux product as the forcing fields for model runs; 8) those developing alternate air-sea flux fields from remote sensing and/or in situ data, who compare their products to the OAFlux fields; 9) those researching new and renewable energy sources, using OAFlux wind and near-surface meteorological parameters to estimate global offshore wind power potential; and 10) educators involved in the Education and Outreach programs, e.g., the education program of the NASA Aquarius mission, the NOAA National Weather Service (NWS) online weather school - JetStream, and the Cooperative Program for Operational Meteorology, Education and Training (COMET) established by the University Corporation for Atmospheric Research (UCAR) and NWS, who use OAFlux climatology as course materials.

ACCOMPLISHMENTS

Four tasks were proposed in the Work Statement for FY11: (1) Maintaining and updating the online OAFlux long-term time series to support near-real time delivery of reliable OAFlux data records, (2) Continuing the development of high-resolution heat flux products in coordination with the development of high-resolution vector wind time series supported by NASA, (3) Improving the net heat flux dataset by reducing biases/errors in satellite-based surface radiation estimates toward an eventual globally balanced surface energy budget, and (4) Applying the OAFlux products to climate studies on the global water cycle and ocean salinity. The deliverables and accomplishments for each task are summarized as follows.

(1) Maintenance and update of OAFlux online products
Deliverables: The deliverables from this task are: i) timely online update of the OAFlux products delivered according to the proposed timeframe, ii) the 50-plus year time series of OAFlux fields made available from January 1958 to July 2011, iii) the OAFlux time series as a base data set for NOAA's annual assessment report on the State of Climate 2011, iv) 14 scientific publications in 2011 by the PIs, with 9 in referred journals, and iv) the consistent, long-term OAFlux products as a fundamental data set in approximately 60 papers that were published in refereed journals in 2011 by international researchers.

OAFlux daily analysis of global ocean evaporation, latent heat flux, sensible heat flux, and related surface meteorology currently operates on a regular production mode and is available from the project website at http://oaflux.whoi.edu. In FY11, online dissemination of the OAFlux products was timely delivered according to the proposed timeframe, with one in October 2010 and the other in May 2011. The most recent update was carried out in October 2011 and all time series are available up to July 2011. The next update is scheduled for May 2012.

OAFlux is developed not from a single source, but from an objective synthesis of multi-platform, multi-sensor satellite observations with atmospheric reanalysis outputs to fill in the information that is not observed by satellites. The accuracy of input datasets changes year to year because of changes in the satellite platforms, aging/degrading of some sensors, the changing error characteristics of atmospheric reanalysis products, etc. To ensure the quality of input datasets and to provide the uncertainty estimates to the OAFlux analysis, a validation database was created that consists of moored buoy measurements from more than 120 locations (Figure 1a), including the tropical moored array network in all three tropical oceans (i.e., the TAO/TRITON in the Pacific, the PIRATA in the Atlantic, and the RAMA in the Indian Ocean), and flux reference sites from Stratus, NTAS, WHOTS, KEO, PAPA, etc. During each scheduled update, the validation database is amended to include the most recent buoy time series.

Long-term time series are essential for characterizing the long-term tendency in surface forcing functions. The OAFlux analysis provides a base data set for the NOAA's State of Climate annual assessment report on the changing global surface forcing functions (Figure 1b; Yu et al., 2011 BAMS). The 50-plus year time series suggests a dominance of decadal oscillation on the long-term change of global ocean latent (evaporation) and sensible heat fluxes. There were 14 publications by the PIs in 2011 (see Section 3.1), with 9 in refereed journals and 5 in proceedings from conferences.

The OAFlux analysis is being increasingly used by international researchers in a wide range of applications, including process-oriented studies on atmosphere-ocean interactions, validation reference for model simulations, forcing functions for oceanic models, climate analysis and

assessments, etc. It serves as a fundamental data set for approximately 60 papers that were published (by researchers not affiliated with the PIs) in referred journals in 2011 alone (see Section 3.2).

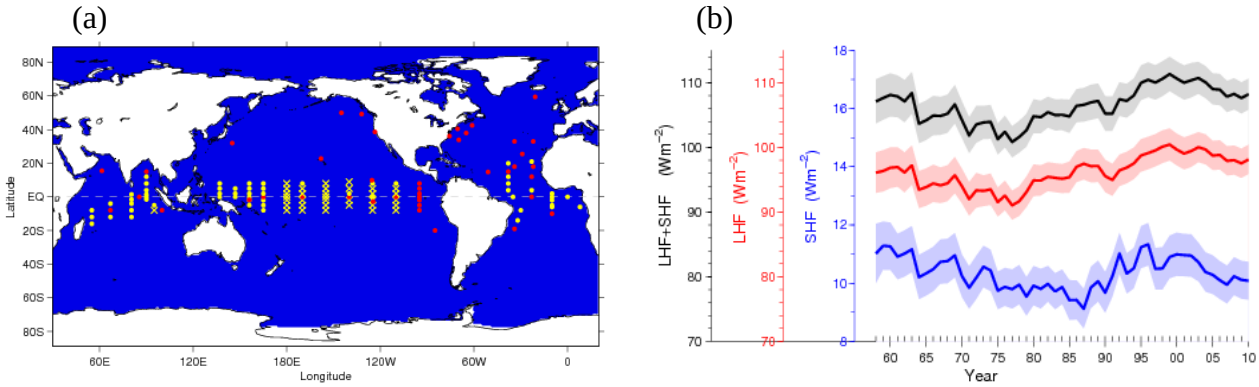


Figure 1. a. The moored-buoy based validate database used in OAFlux analysis. b. Annual-mean time series of latent heat flux (red), sensible heat flux (blue), and the sum of the two heat flux components (black) from the OAFlux analysis. Adapted from Yu et al., 2011.

(2) Continuing the development of high-resolution heat flux products

Deliverables: The basic deliverable from this task is the development of a 0.25-degree gridded global analysis of heat fluxes from 1999 to the present. The high-resolution (HR) dataset has undergone extensive validation using buoy measurements and cross-evaluation with recent atmospheric reanalyses. The dataset has been examined in the Gulf Stream region to examine the benefits of the HR analysis in studying mid-latitude atmosphere-ocean coupled interactions.

Accomplishments and discussion:

The development of a high-resolution (0.25-degree) analysis of global heat flux products takes advantage of three new satellite-derived products. The first is our newly developed vector wind analysis on 0.25-degree from 1987 to the present under the auspices of NASA vector wind science team activities (Yu and Jin 2012). The second product is the SST measurements from microwave (MW) radiometers from 1997 to the present. In contrast to AVHRR, MW is transparent to clouds so that SST can be retrieved in nearly all weather conditions except for rains. Merging AVHRR SST with MW SST remains a technical challenge for the SST community, and so only one type SST can be chosen to ensure the consistency of the OAFlux analysis. The SST product used for the current 1-degree product is the AVHRR SST from NOAA Optimum Interpolated SST (OISST) analysis, which is known for its poor representation in ocean frontal regions on a daily basis. The third product is the near-surface air temperature and humidity produced by Jackson and Wick at the NOAA Environmental System Research Laboratory. The products were derived from satellite SSMI sensors and AMSU sounding profiles with in situ observations as a training background. These three datasets improve the representation of spatial variability of air-sea variables, especially in the ocean frontal regions such as the western boundary currents.

In FY2011, efforts were made to fix technical issues (data gaps, mean bias in humidity and air temperature), to validate the accuracy of the HR OAFlux analysis, and to gain in-depth understanding of the benefits of the HR analysis through applications to mid-latitude air-sea

interaction. We collaborated with the CLIMODE project in the Gulf Stream and cross-evaluated the HR analysis with the recent atmospheric reanalysis from ECMWF reanalysis (ERA) interim, NASA Modern Era Retrospective-analysis for Research and Applications (MERRA), and NOAA coupled forecasting system reanalysis (CFSR) (Figure 2). The benefits of the OAFlux HR wind stress and heat fluxes are clearly displayed. A high degree of covariability between the HR fluxes and MW SST retrievals suggests a strong ocean thermal modulation on the air-sea heat and momentum fluxes when cold air mass passed by. Figure 2 also shows that CFSR fluxes are better than ERA-interim and MERRA in that CFSR is a coupled system and can do better than the atmosphere-only models in case of strong air-sea coupling. Presentation of the analysis was given at several meetings, including the CLIMODE PI meeting, the WCRP open science conference, and the NASA SST science team meetings.

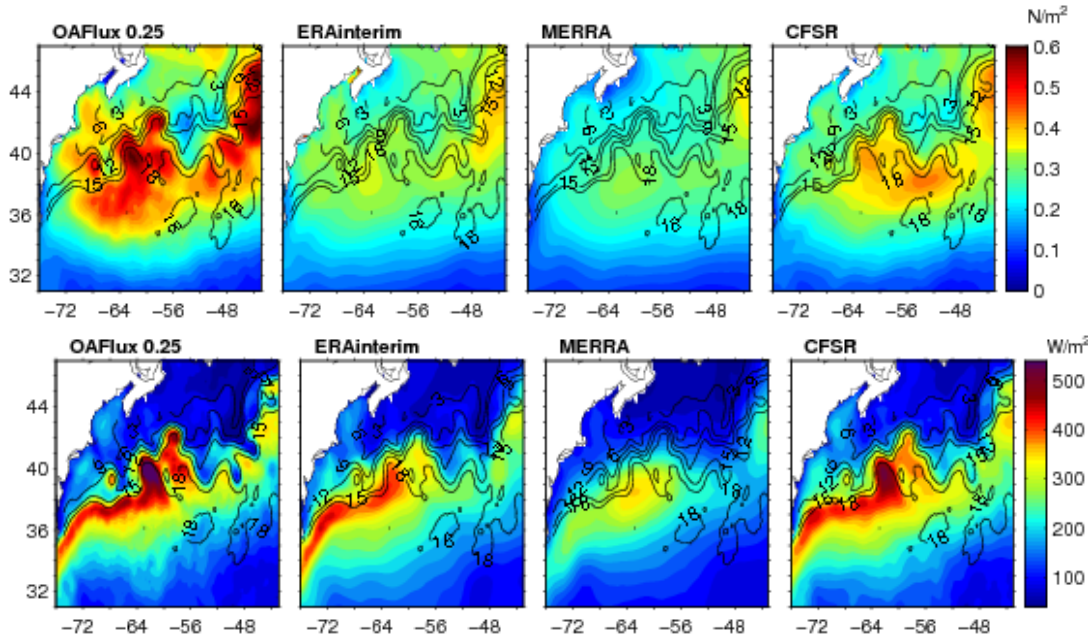


Figure 2. Comparison of OAFlux HR (0.25-degree) analysis of wind stress (top panel) and latent-plus-sensible heat fluxes) with three recent atmospheric reanalyses (ERA interim, MERRA, and CFSR) during a cold air outbreak event in February 2007. OAFlux HR fluxes show a high-degree of covariability with SST.

(3) Improving surface radiation and the net heat flux estimates

Deliverables: The deliverables from this task include i) quantifying the uncertainties in current satellite surface radiation products through buoy validation, and ii) providing guidance on improving global net heat flux estimates.

Accomplishments and discussion:

Achieving a globally balanced net heat budget remains a leading issue for all flux products despite many significant progresses made in the past 20 years. The OAFlux analysis faces the same challenge. When combining the OAFlux global latent and sensible heat fluxes with the state-of-art satellite derived surface radiation products (such as ISCCP (International Satellite Cloud Climatology Project, Zhang et al. 2004) and SRB (Surface Radiation Budget, Stackhouse et al. 2004), the global heat budget is not balanced and the residual is as large as 29-33 W/m^2.

Having a globally balanced heat budget is of paramount importance for climate studies, because it is the forcing term in the long-term change of global ocean temperatures.

Efforts in YR2011 were made to evaluate ISCCP and SRB products using all available buoys. We also introduced three recent reanalyses, three older reanalyses (NCEP1, NCEP2, ERA40), and the ship-based climatology from the National Oceanographic Centre at Southampton (NOCS) in the analysis. The mean and standard deviations between the 9 products for shortwave (SW) and longwave (LW) components are shown in Figure 3, suggesting that errors in SW products are confined mostly in the tropical oceans and that errors in LW are comparable to the errors in SW, though the magnitude of LW is about one-fifth of that of SW. The time series at the STRATUS site further indicates the biases in LW, particularly ISCCP LW.

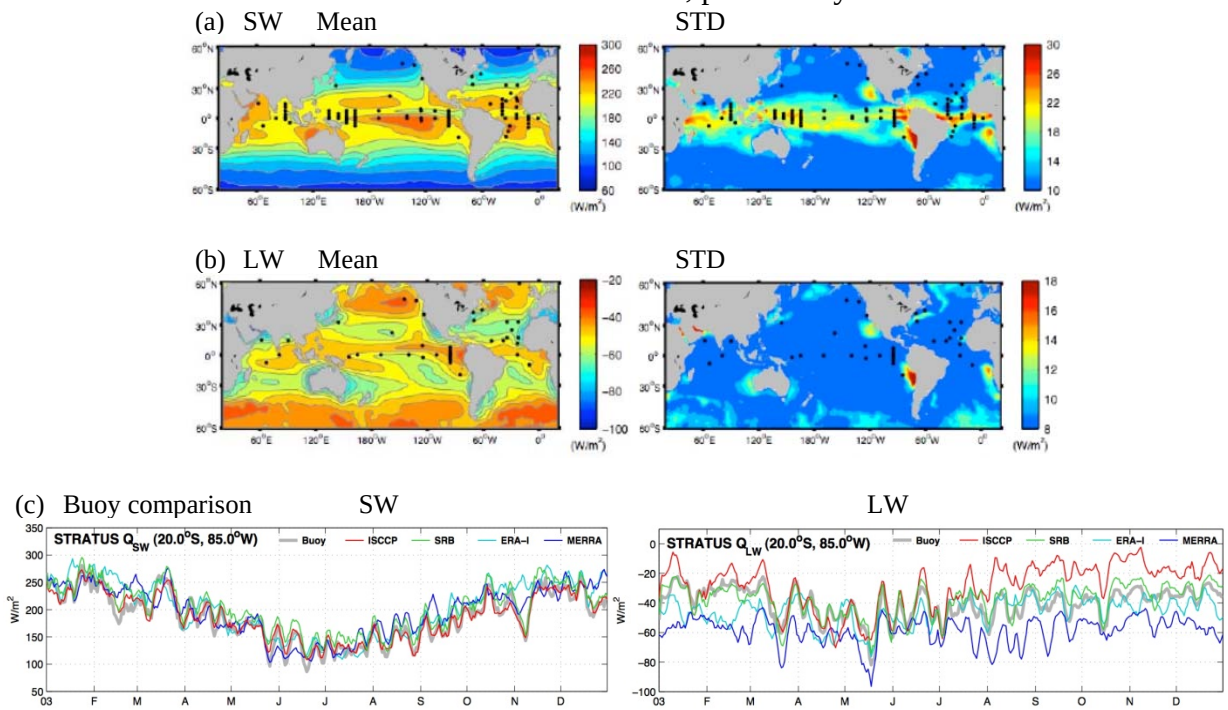


Figure 3. Mean and standard deviation (STD) of (a) 9 annual-mean SW products, and (b) 9 annual-mean LW products. The dots denote available SW and LW buoy locations in the respective plots. (c) Evaluation of SW and LW from 4 products at the STRATUS location.

(4) Climate Applications of OAFlux long-term time series

<u>Deliverables:</u> The deliverables from this task are: i) quantification of the physical representation of OAFlux evaporation and GPCP precipitation time series in ascribing the observed change in salinity, ii) identification of the high-latitude contribution to global sensible flux variability, and iii) publications and presentations based on findings of the study.

<u>Accomplishments and discussion:</u>

In YR2011, the OAFlux time series were applied to address two specific questions. One is the relationship between the ocean water cycle and salinity (Yu 2011) and the other is the cause of decadal variability of sensible heat flux since the 1980s (Song and Yu 2011).

The underlying issue in studying the relationship between the ocean water cycle and salinity is whether and where the oceans can be a rain gauge. Ocean salinity is consequential to the change

of the water cycle because evaporation-minus-precipitation (E-P) is the freshwater flux forcing for the open oceans. The concept of using the oceans as a rain gauge has long been proposed, but implementing this concept is complicated owing to the fact that the two variables are related through complex upper ocean dynamics. As a first step toward an advanced understanding, we derived a global map of the leading forcing for seasonal variability of the mixed-layer salinity (MLS), using a lower-order MLS dynamics that allows key balance terms (e.g. *E-P*, the Ekman and geostrophic advection, vertical entrainment, and horizontal diffusion) to be computed from satellite-derived datasets and MLS climatology. The covariance contribution of each process to MLS is ranked according to the magnitude, leading to the construction of the leading dominance over the global domain (Figure 4). This study was also conducted in coordination with support from NASA remote sensing and climate program.

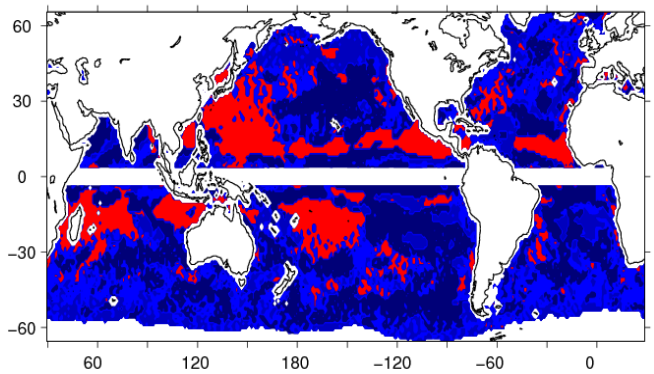


Figure 4. A rain-gauge regime (red colored area) determined from a covariance analysis of seasonal mixed-layer salinity and E-P. The blue (red) colored area denotes the leading process for the change of salinity is governed by ocean dynamics (E-P).

Decadal variability of sensible heat flux (SHF; Figure 1b) was examined using the OAFlux analysis in coordination with funding from the WHOI Arctic Ocean Initiative program. We found that global SHF anomalies are strongly modulated by SHF at high latitudes (poleward of 45°) during winter seasons. Decadal variability of global wintertime SHF can be reasonably represented by the sum of two leading EOF modes, namely, the boreal wintertime SHF in the northern oceans and the austral wintertime SHF in the southern oceans. The increase of global SHF in the 1990s is attributable to the strengthening of the Southern Annular Mode index, while the decrease of global SHF after 2000 is due primarily to the downward trend of the Arctic Oscillation index. This study identified the important effects of wind direction and speed on SHF variability. This finding is in tune with the study of Yu (2007) that shows the important role of winds in enhancing global evaporation in the past 50 years. Taken together, winds are a critical player in the observed global variability of air-sea turbulent latent and sensible heat exchange.

2.1. Outreach and Education

Lisan Yu

Dr. Lisan routinely presents research results at national and international scientific meetings. She serves on the NOAA Ocean Observing System Team of Experts and has led the analysis of global ocean surface flux for the NOAA State of Climate annual assessment report since 2005. She is a contributing author to the IPCC Fifth Assessment report. She serves on the CLIVAR Global Synthesis and Observations Panel. She is a member of NASA Sea Surface Temperature Science Team, NASA Ocean Surface Salinity Science Team, and NASA Ocean Vector Wind Science Team. She routinely reviews research papers and proposals. She presents science talks at the WHOI summer student program. She has advised or co-advised 3 postdoctoral investigators, 1 Ph.D. WHOI-MIT joint program student, 3 guest Ph.D. students, and 2 Summer Student Fellows.

Robert A. Weller

Dr. Weller's outreach and education on air-sea fluxes is closely linked to these same activities on the Ocean Reference Station project that provides some of the high quality validation of the OAFlux. The cruises to the moorings invite participation by the NOAA Teacher at Sea program, and an important teaching topic is air-sea flux. Ten Teachers at Sea have been hosted. A video of one of these cruises and the work to collect air-sea fluxes from surface moorings was produced by volunteer Diane Suhm. This video was recently provided to the Climate Observation Division. A shorter version has run on cable TV in Massachusetts and will be used at public lectures in Woods Hole. These cruises, whenever possible, offer space to undergraduate and graduate students to provide hands on experience at sea and about air-sea fluxes. Weller has used opportunities derived from sailing from different Central and South American ports for regional outreach. Staff from INOCAR (Institute of Naval Oceanography) in Ecuador, the Hydrographic Division of the Peruvian Navy (DHN), the Institute of Marine Sciences of Peru (IMARPE), and the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA) have joined Stratus cruises. Weller now advises 2 postdoctoral investigators.

THEME VI. EDUCATION.AND.OUTREACH

CINAR

Cooperative Institute for the North Atlantic Region

US National Office for Harmful Algal Blooms

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 13
April 01, 2011-March 31, 2012

Donald M. Anderson -Woods Hole Oceanographic Institution

NOAA Program Manager: Quay Dortch-NOS

Related NOAA Goal Plan: Goal 1. Protect, Restore and Manage the Use of Coastal and Ocean Resources through Ecosystem-based Management

CINAR Theme: Theme VI. Education and Outreach

PROJECT OVERVIEW

The U.S. National Office for Harmful Algal Blooms serves as a "clearinghouse" for information related to national and international activities on HAB issues. One of its primary roles is to assist in the development of an integrated, national HAB research agenda based on technical evaluations of current research efforts, workshop activities, and ongoing Federal and state agency efforts to prevent, control and mitigate HABs. Further, the National Office serves as a focal point for HAB research and information by organizing and providing for scientific community access to the latest research developments, workshop reports, research strategies, and related data and information. **The primary objective of the Office is to facilitate an open exchange of scientific information and advance the state of knowledge and research efforts.** The National Office coordinates the interests of, and fosters collaboration among, the many stakeholders in HAB research and mitigation: Federal agencies with responsibilities to address HAB issues, the academic research community, and regional and local resource managers. The National Office also facilitates coordination and information exchange between the U.S. and international HAB research and mitigation efforts, and when requested, with the U.S. Congress.

ACCOMPLISHMENTS

Communication and Outreach:

National HAB Web Site: The *Harmful Algae* Web Site (www.whoi.edu/redtide) serves as a critical resource for the U.S. HAB community. The site is among the top 5 WHOI sites visited each month, typically with over 6,000 visits per month. In addition to maintaining the Web Site, conference announcements, funding opportunities, reports, etc. of interest to the HAB community are routinely posted and circulated through our numerous listservers. We are continuing to expand our state and regional resource section with the help of a subcommittee of the National HAB Committee on education and outreach. This year we established a Facebook account for the National Office and post approximately 2-3 announcements per week – typically these are links to harmful bloom events in the US. We have received positive response from the community about this effort with 150 "likes" at present.

Information requests: The National Office deals with many direct requests for information that are elicited by the site. These include frequent requests for photographs or other media products, referrals to experts in particular regions or disciplines, inquiries from students doing reports, and

journalist inquiries. Another important type of interaction is with victims of HAB poisonings who are seeking help in the form of information and referrals to appropriate physicians. In many of these cases, direct personal interactions via e-mail and telephone are needed, requiring considerable time commitments, but also providing a necessary and valuable level of service to the public.

ICES Working Group on HAB Dynamics:
Each year we collect information on HAB events in the U.S. as the ICES *National Coordinating Center for Exchange of Information on Harmful Algal Blooms.* This involves interacting with colleagues around the U.S. to compile reports of all national HAB events each year. We are responsible for the entry of these data into the Harmful Algal Event Database (HAEDAT) maintained by the ICES Science and Communications Center in Vigo, Spain. Presentations on these bloom reports are also given at annual working group meetings of the ICES Working Group on Harmful Algal Bloom Dynamics (WGHABD). National and international bloom reports are provided to all U.S. network participants, as well as to other interested parties. This is the only compilation of U.S. HAB incidents. Decadal maps for all U.S. HAB events are updated annually for ICES as well as posting on the Harmful Algae Web Site (see www.whoi.edu/redtide/page.do?pid=14898&tid=542&cid=47899&c=3 for an example). During the past year, this database was opened to the public and we communicated that information to our US HAB community listserve. This has elicited some inquiries and increased the list of coastal managers and researchers who can contribute to this valuable set of data.
Another activity has been to lead the organization of a special workshop on Automated Harmful Algal Blooms in situ Observing Systems. PI Anderson is working with several members of the ICES WGHABD to plan this meeting, which is tentatively scheduled for spring 2013.

Event Response Program
The National Office administers a Rapid Response Program for HAB Events in the U.S. in cooperation with CSCOR administrators. This involves advertising availability of funds to the HAB community as well as accepting requests for funds and administering their dispersal. The National Office works with NOAA Program Managers who decide who receives funds and how much will be needed in each case. Additionally, we make arrangements and process travel, vessel charters, analyses and other expenses associated with these rapid response activities. During the past year we arranged funding for the following events: *Cochlodinium* event, Long Island; seal deaths, New England; a *Karenia brevis* event in Florida, North Carolina; and an abalone die off in Sonoma County, California.

Scientific Meetings/Workshops:
The National Office often assists with the formulation of scientific agendas, arranging for financial and administrative support, and providing expert representation for national and international HAB workshops, symposia, and conferences. The National Office also assists in selection and disbursement of funds for student travel to national and international conferences, workshops, and training courses. During the project year, meetings we were involved with include: the 15th International HAB Conference, Korea, Gordon Research Conference, and the Sixth US HAB symposium.

US HAB symposia. Kleindinst served on the Steering Committees for the *Sixth Symposium on Harmful Algae in the U.S.,* which was held in November 2011 in Austin, TX. She provided significant administrative support for this meeting, working closely with the organizers

throughout the planning process. We handled travel awards for 33 graduate students and 3 managers.

International HAB Conferences. Anderson serves on the Steering Committee for the *15th International Conference on Harmful Algal Blooms* which will be held in Korea in November 2012. The National Office is also assisting by handling applications for US student travel awards and the subsequent processing of reimbursements.

IOC Intergovernmental Panel on HABS (IPHAB):
PI Anderson serves as one of the US national representatives to this panel and attended the Tenth Session held in Paris, April 2011. One of the resolutions from this meeting was to organize a meeting on "*Impacts and management of toxic and harmful algal blooms at desalination plants and related seawater facilities*". Anderson was selected as Chair of the Organizing Committee and has been devoting time to establishing the Steering Committee, seeking funding for the meeting, and establishing a network of individuals and stakeholders to participate. In support of these activities, he attended the *Expert Workshop on Red Tides and HABs: Impact on Desalination Plants*, sponsored by the Middle East Desalination Research Centre, Muscat, Oman, where he presented three invited talks. He is also the lead author of a report being prepared from that workshop. Considerable time will be devoted in the coming year to organizing and convening the IPHAB conference on this topic.

National HAB Committee (NHC):
The National HAB Committee was formed in 2005 and is charged with overseeing coordination and implementation of the revised US National Plan. The National Office provides support to the NHC. Each year we request nominations for election of new members from the community and handle the subsequent election and notifications, and, as appropriate, nominations and voting for Committee Chair(s). We initiated and continue to maintain and update the NHC Web Site and listserver, set up for quick communication by this group. Anderson has served as Co-Chair for the past six years and Kleindinst provides administrative support and serves as an ex officio member. She also serves on the subcommittee on Education and Outreach. The National Office arranges and leads conference calls for the group as well as in-person meetings. A significant amount of time was devoted to this activity this year due to the upcoming change in co-Chairs, requiring a review and update of our structure and policies.

HIGHLIGHTS

- A Facebook page was created for the US National Office for Harmful Algal Events. Currently we have 150 “likes” and are receiving positive feedback on this endeavor.
- PI Anderson provided testimony at the Subcommittee on Energy and Environment Hearing, “The Harmful Algal Blooms and Hypoxia Research and Control Amendments Act of 2011”, Washington, DC, June 1, 2011.
- A major contribution on HABs was published in the Annual Reviews in Marine Science - *Anderson, D.M., A.D. Cembella, and G.M. Hallegraeff. 2012. Progress in understanding harmful algal blooms: Paradigm shifts and new technologies for research, monitoring and management. Annu. Rev. Mar. Sci. 4: 143-76.*

SOCIETAL BENEFITS

All of the activity under this project relates to HABs, a serious and growing threat to the nation’s fisheries, coastal ecosystem and human coastal communities.

EDUCATION AND OUTREACH ACTIVITIES

Anderson, D.M., Invited talk, “Direct HAB control or suppression: a status report”, Expert Workshop on Red Tides and HABs: Impact on Desalination Plants, Middle East Desalination Research Centre, Muscat, Oman (February 2012)

Anderson, D.M., Invited talk, “The global problem of red tides and harmful algal blooms (HABs)”, Expert Workshop on Red Tides and HABs: Impact on Desalination Plants, Middle East Desalination Research Centre, Muscat, Oman (February 2012)

Anderson, D.M. “US Summary of Harmful Algal Events - 2011". ICES Working Group on HAB Dynamics annual meeting, Oban, Scotland (April 2012)

Harmful algae website –www.whoi.edu/redtide

National HAB Committee Web Site: www.whoi.edu/nationalhab/

Northeast PSP website - www.whoi.edu/northeastpsp/

Research and Identify Options that can Assist the Evolution of Groundfish Sectors as Viable Business Organizations

NOAA Cooperative Agreement No. NA09OAR4320129 **GMRI** Subpoint 11
April 01, 2011-March 31, 2012

Kate Burns-The Gulf of Maine Research Institute

NOAA Program Manager: Drew Kitts and Matt McPherson-NMFS

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme VI. Education and Outreach

PROJECT OVERVIEW

The project goal is to devise a sector business model or simulator which will allow sectors to forecast probable operational costs and income levels and work out strategies to deal with shortfalls or declining income.

The project has the following objectives:

- Analyze current Sector management income and operational costs.
- Analyze and model landings value, by sector, including trading and the amount and probable monetary value of lost income through not catching their allocation or landing at less than optimum times in terms of market value/market flooding.
- Use the outcomes of these two stages to devise a number of 'models' or 'sector business simulators' (probably 3) which provide a fair representation of any given sector's operational costs.
- Introduce variables into the sector business simulators such as reducing Federal operational assistance to sectors, adapting landings value to reflect probable reductions in revenue from Gulf of Maine and Georges Bank cod, identifying vulnerability to particular species, dependence on particular vessel operators, the impact of at-sea monitoring costs as well as:

    - Opportunities to develop added value 'market focused' business activities
    - Bonded contract selling
    - Community Supported Fisheries (CSF) marketing opportunities
    - Risks of alternative marketing efforts including anti-trust and loss of existing markets
    - Permit holding
    - Lease/allocation trading etc.
    - Cost cutting options such as sharing staff, office and contractual solutions

- Potential income sources to cover monitoring costs, including sharing of the burden by supply chain operators.

- Present the findings to each sector Board, individually, and have a discussion on what strategies they may want to employ to ensure viability. We can then give them 'their' model simulator.

Progress to date

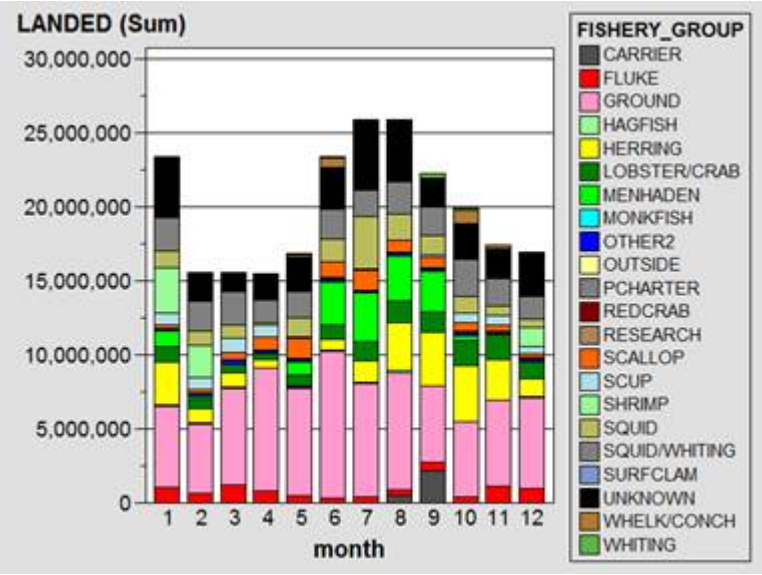
Task	Progress	Comments	Date for completion
Analyze current sector operational costs	Completed by Jonathan Peros using 2010 figures.	Jessica Joyce is checking the figures with more recent costs to make sure they are current. She is also 'ground truthing' the costs with NESSN	30th May
Analyze and model sector landings value	All landings data for 2010-2011 year has been provided by NMFS and Jenny Sun has started work on the analysis.	Jenny has secured an intern, William Bowman, for the summer to do the hard graft on the data. From first look at the data, it may be possible to actually devise a mean for at least 3 similar sectors to create the model. We are hoping the analysis would demonstrate we could do that for two of the models, if not we will have to come up with something more generic.	July 31st
Develop sector 'models'/simulators	Kate Burns will create spreadsheets using sector operational costs and import landings value when that work is complete.		June 30th
Introduce variables	Kate Burns will describe suggested variables to the working group and introduce agreed variables to the models	It will be important to ground truth suggested variables with sector representatives at this stage. Libby Etrie, the Executive Director at NESSN will play an important role as advisor. We also have several other industry advisors we will consult at various stages throughout the project.	14th August
Present to Sector Boards	JP, Jessica Joyce and Libby Etrie will undertake the dissemination work.	There are still some NOAA funds for sector operational costs – probably lasting half way through FY2012. The real pinch will hit in FY2013, probably at the same time as at-sea monitoring costs and reduction in income because of the cod assessments. Sectors will need to plan for restructuring/adapt changes by Spring 2013. It is suggested these meetings are held without the managers, as in some cases the future management of a sector may need to be discussed.	Fall 2012

ACCOMPLISHMENTS

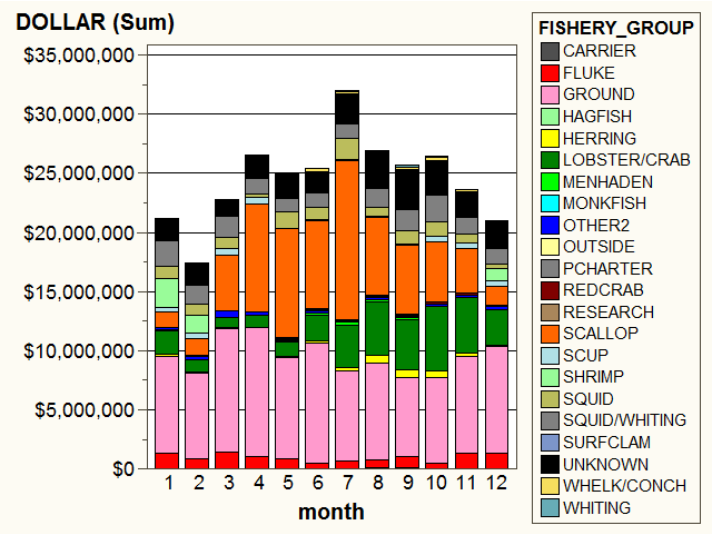
Gaining project support from the Northeast Sector Services Network (NESSN) has been an important accomplishment. This organization is the key to accessing the sectors and helping think through future solutions on sector viability.

Completing analysis of sector operational costs has been accomplished. This involved conversations with some sector managers and Boards as well as accessing their operational costs and details of income.

An important accomplishment was securing the landings data from 2010 from NMFS and starting to analyze these data. Securing the landings data was a huge advantage, one we didn't expect when we set out with the project. It will add considerable depth to the analysis, as we will be able to look at variables like how bringing in other species to the sector management process, or how increasing landings of allocation of less targeted species could assist viability. In addition, the analysis will also explore how landing volume and time of year affect price, and will provide insights on optimum timing for fishing effort to maximize income.
Below are two charts demonstrating the pounds landed and value of fish landed from analysis of the data thus far.



Source: Jenny Sun



Source: Jenny Sun

HIGHLIGHTS

- It is too early in the project to suggest any highlights.

SOCIETAL BENEFITS

This project is all about finding mechanisms for sectors to become viable and smart operations, identifying ways they can maximize the value of their groundfish allocations, cut costs, and secure greater market value.

If the project assists Sectors to move to more optimum business models, there will be a return to both sector members and the local communities. Sectors with good business plans will provide confidence for the members and a road map for managing their fishing operations to maximize returns.

EDUCATION AND OUTREACH ACTIVITIES

The education and outreach work for this project will begin in the Fall 2012, in the meantime we do have an industry round table scheduled for the 10th April to act as a sounding board and begin the process of informing and engaging the industry in the project.

Improve the Fishery – Independent Acoustic and Larval Indices for use in the upcoming Benchmark Atlantic Herring Assessment

NOAA Cooperative Agreement No. NA09OAR4320129 WHOI Subpoint 47
April 01, 2011-March 31, 2012

James H. Churchill-Woods Hole Oceanographic Institution

NOAA Program Manager: Jonathan Hare -NMFS/NEFSC

Related NOAA Goal Plan:
Goal 1. Healthy Oceans: Marine fisheries, habitats, and biodiversity sustained within healthy and productive ecosystems

CINAR Theme:
Theme VI. Education and Outreach

PROJECT OVERVIEW
The principal goal of this project is to evaluate factors identified as potential biases for abundance indices derived from the acoustic and larval surveys of Atlantic herring, principally: 1) changes in larval growth rate, which could affect the larval index calculation; 2) changes in the location of spawning, which could influence the proportion of the adult stock detected by the acoustic survey, and 3) changes in the timing of spawning, which could also influence the proportion of the adult stock available to the acoustic survey. Our specific objectives are to: 1) develop a temperature and prey-dependent growth equation for larval herring, which will be used to include a year varying growth function in the larval index and to develop a time varying age-length key for estimating the age of all larvae captured in the NEFSC larval surveys; 2) estimate the spatial distribution of spawning using numerical circulation modeling to backtrack each larva collected to a hatch location and to test whether spawning distributions have changed through time; and 3) calculate a yearly standardization, s_y, using the annual spawning time and distribution results coupled with the spatial and temporal sampling effort of annual acoustic survey. Our work will lead to an improved larval index through the inclusion of a temperature-prey specific growth function and an assessment of changes in spawning season, and will lead to an improved acoustic index through an examination of potential biases and the estimation of an annual standardization index (s_y).

ACCOMPLISHMENTS

Using output from the FVCOM Georges Bank/Gulf of Maine hydrodynamic model (generated by C. Chen group at U. Mass. Dartmouth), we have simulated of larval herring transport, from possible spawning locations distributed over Georges Bank and the Gulf of Maine, over a ten year period. Considerable effort was devoted to improving the efficiency of the larval tracking, so that large ensemble of larval tracks could be generated for multiple years. Through hardware upgrade and code modification, the time require to simulate a given number of larval tracks was reduced by a factor of 10. The larval track simulations have been used to assess the probable

locations of egg hatching for those Atlantic herring larvae sampled by the acoustic and net survey on Georges Bank, and to evaluate the possibility that changes in the timing and distribution hatching may have biased the NEFSC acoustic larval surveys. The preliminary indication, pending further analysis to be carried out as part of our study, is that the acoustic survey results are not biased by a shift in hatching time or spatial distribution.

HIGHLIGHTS

- Carried out simulations of larval Atlantic herring transport from possible spawning locations over Georges Bank and the Gulf of Maine over 10 years
- Used the results in a preliminary evaluation of the possible bias in the acoustic survey of herring larvae carried out by the NEFSC
- Presented the findings at the Atlantic Herring Stock Assessment Meeting at NEFSC, Wood Hole, MA on Jan 31, 2012.

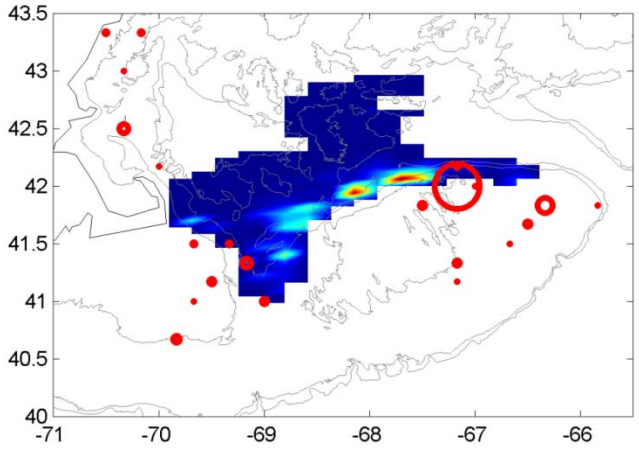
SOCIETAL BENEFITS

Proper interpretation of larval survey data is critical for the effective management of commercially important fish stock, such as the Atlantic herring stock over Georges Bank and the Gulf of Maine. Our work will allow for better design of acoustic larval surveys and improved interpretation of the survey results.

EDUCATION AND OUTREACH ACTIVITIES

Co-PI Dave Richardson presented the analysis of the study at the Atlantic Herring Stock Assessment Meeting at NEFSC, Wood Hole, MA on Jan 31, 2012.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS



An example of the prediction of Atlantic herring hatching locations (circles) derived from simulated larval tracks and the observed abundances (colored field) and ages of larval Atlantic herring sampled over Georges Bank. Taken from a presentation given by co-PI Dave Richardson at Atlantic Herring Stock Assessment Meeting at NEFSC, Wood Hole, MA on Jan 31, 2012.

Marine Resource Education Program

NOAA Cooperative Agreement No. NA09OAR4320129 **GMRI** Subpoint 12
April 01, 2011-March 31, 2012

Alexa Dayton-The Gulf of Maine Research Institute

NOAA Program Manager: Jon Hoey -NMFS

Related NOAA Goal Plan: Goal 1. Healthy Oceans: Marine fisheries, habitats, and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme VI. Education and Outreach

PROJECT OVERVIEW

The Gulf of Maine Research Institute (GMRI), in collaboration with fishing industry partners, John Williamson and Mary Beth Tooley, delivered 2 advanced science sessions of the Marine Resource Education Program, MREP 200, in Woods Hole, MA.

In addition to the two workshops delivered, we engaged in a startup process in the Mid-Atlantic. We formed an MREP-MA Advisory Team and began the process of building regional capacity to develop and implement an introductory MREP program for the region. We originally proposed to deliver the introductory series of MREP 100 Science and Management modules in late 2011, early 2012.

The start-up committee of regional industry members and agency partners was convened in December 2011 to identify a curriculum suitable to the region and its stakeholders. An adapted MREP 100 set of modules was originally envisioned, but after further reflection and discussion with partners in the Mid Atlantic region, the committee has recommended further program development work, and identified a new timeframe of Winter 2012 for the program implementation. This committee meets again in late May 2012, and several Mid-Atlantic industry members took part in the MREP 200 program in Woods Hole as a basis for program development activities.

ACCOMPLISHMENTS

The MREP 200 module offered only once prior to 2011 underwent some revisions. We retooled the curriculum slightly to clarify and distinguish between Fishery Dependent data and Fishery Independent Data, with these topics covered on separate days. Dr. Paul Rago of the NEFSC was able to provide a 'road map' for participants to continuously refer back to during the two days and allow everyone to piece together the interactive stops and how they relate to the stock assessment process. This road map was incorporated into all presentations to help orient attendees throughout the two days.

We did not have a moderator at either of the first two MREP 200 sessions in 2010 and 2011. We did add this role in the November 2011 session, and found that it was useful to add this voice to the discussion. It is a slightly modified role from the more intense MREP 100 moderator role, where most of the program takes place in small group settings and distributed settings. A few large group discussions benefitted from the support such as the initial introductions, and the extended conversation with Paul Rago on stock assessment methods.

HIGHLIGHTS

- MREP 200 Science March 17– 18, 2011 Coonamessett Inn, Falmouth MA
- MREP 200 Science November 16 - 17, 2011 Coonamessett Inn, Falmouth MA

SOCIETAL BENEFITS

We delivered MREP 200 as a foundation for improved trust in the stock assessment process and NMFS trawl surveys.

MREP has prepared industry members for meaningful engagement in the fisheries management process.

Alumni continue to ask for further educational opportunities beyond the initial MREP 100 workshop setting itself. The MREP 200 program meets this need. Other suggestions include continued educational workshops programs on a variety of topics, as well as access to additional information as they seek to engage with the Fishery management processes. A number of initiatives outside of the MREP scope and funding have been developed by GMRI, a number of other non-profit organizations, NOAA and the council itself, and we continue to look for ways to introduce MREP alumni to these resources, as a way to continue to foster community and leadership within the fishing community.

EDUCATION AND OUTREACH ACTIVITIES

For this year's recruiting efforts, we supplemented the standard paper based application with an online application, and updated the web site with new photos and content to make it easier to navigate, and more visually interesting.

For the early 2011 programs, we performed a 2,000-piece postcard mailing to a selected group from the Ground Fish permit holders list in early January 2011. We also circulated postcards at NEFMC meetings, provided a stack of postcards for distribution with a personalized letter to each of the Sector Managers, and mailed all prior MREP graduates so they could refer others to the program. The postcard campaign was followed up with e-mails to sector managers, and MREP alumni to ensure they noticed the piece. We also have been advertising in Commercial Fisheries News and Board members and MREP alumni made outbound phone calls to specific individuals. We further solicited participation at other convening events hosted by GMRI and organizations such as NH Sea Grant, and Maine DMR. The broader efforts were good at building program awareness, but the most successful recruiting elements continue to be word of mouth referrals by MREP alumni, and Board members.

For the late 2011 MREP 200 program, we reached out to our NEFSC partners who circulated an email to the Cooperative Research partners email list. This email unexpectedly went far and wide, and made it on Saving Seafood. The results were very positive however, attendance for the program came in very strong at the end, and we generated a waiting list for the upcoming March 2012 program. This tactic should be considered in the future and reinforces the connection between the MREP program and Cooperative Research.

Fishermen learn about R/V Bigelow survey sampling methods from scientists in a setting aboard the research vessel during the MREP 200 program November 2011.

GC × GC Capacity Building in South Korea in the Wake of the Hebei Spirit Oil Spill

NOAA Cooperative Agreement No. NA09OAR4320129 **WHOI** Subpoint 51
April 01, 2011-March 31, 2012

Robert K. Nelson-Woods Hole Oceanographic Institution

NOAA Program Manager: Brendan Bray-Office of Response and Restoration

Related NOAA Goal Plan: Healthy Oceans: Marine fisheries, habitats , and biodiversity sustained within healthy and productive ecosystems

CINAR Theme: Theme VI. Education and Outreach (Capacity building in Korea)

PROJECT OVERVIEW

This is a continuation of a technical exchange/capacity building partnership that began in 2009 with Dr. Un Hyuk Yim's visit to Woods Hole to analyze Hebei Spirit oil spill samples using comprehensive two-dimensional gas chromatography (GC×GC).

ACCOMPLISHMENTS

November 2011, hosted Dr. Un Hyuk Yim and Sung Yong Ha from the Korean Ocean Research and Development Institue (KORDI) for a week and analyzed 20 Hebei Spirit Oil Spill samples using GC×GC at our lab in the Fye building at WHOI.

March 2012, Robert K. Nelson traveled to (a) KORDI: Geoje Island, South Korea and (b) Korean Coast Guard Research Institute (KCGRI) Oil Spill Laboratory, Incheon, South Korea. While in Korea, RKN gave an oral presentation at KORDI on March 26, 2012 an oral presentation at the KCGRI Oil Spill Lab on March 28, 2012 and a GC×GC workshop at the KCGRI Oil Spill Lab on March 28 and 29, 2012.

HIGHLIGHTS

- Since 2009, researchers from KORDI have traveled to WHOI on two occasions. During these collaborative visits, the KORDI researchers have developed proficiency analyzing samples using GC×GC and ChromaTOF software. The KORDI researchers have developed a working relationship with colleagues at KCGRI. KCGRI has had a GC×GC instrument for approximately 3 years but have not had trained personnel capable of operating their instrument. During RKN's visit to KCGRI the GC×GC instrument was brought to operational status and now both KORDI and KCGRI have access to this very high resolution technology.

SOCIETAL BENEFITS

Technology capacity building is an essential element for assessing the impacts of spilled hydrocarbon pollutants world-wide. GC×GC is a very high resolution analytical technique that has gained acceptance as for the analysis of very complex mixtures such as crude oil. Korean researchers and the Korean Coast Guard can now utilize this technology to evaluate oil spill impacts such as the Hebei Spirit oil spill to their considerable oyster aquaculture industry and coastal fisheries.

EDUCATION AND OUTREACH ACTIVITIES

The primary goal of this project was education, outreach and technology transfer. RKN developed contacts at KORDI, the KCGRI and at Leco-Korea during his visit to Geoje Island and Incheon. At KORDI, research colleagues and contacts include Dr. Un Hyuk Yim, Dr. Woon Joon Shim, Dr. Jee-Hyun Jung, Dr. J. R. Oh and Sung Yong Ha. While at KCGRI RKN met with the Director General of the Korean Coast Guard's Marine Pollution Response Bureau, Dr. Sang-woon Kim, the KCG Research Institute Head of the Oil Spill Lab, Dr. Hong-Gi Chae, and Kyoung-Eun Jung and Sun Jong Lee from the KCGRI Pollutant Analysis Team. In addition, RKN met and worked with Byeong Ho Kim of Leco-Korea in order to make the GC×GC at the KCGRI operational.

PUBLICATIONS

Manuscript using GC×GC analysis on the three crude oils (United Arab Emirates Export Crude, Kuwait Export Crude, and Iranian Heavy Crude) released into the environment during the Hebei Spirit oil spill in preparation.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS –

Images from talks at KORDI, the Korean Coast Guard Research Institute, workshop at the KCGRI Oil Spill Lab and meeting with the KCG Research Institute Head of the Oil Spill Lab, Dr. Hong-Gi Chae.

APPENDIX 1: CINAR PERSONNEL SUMMARY:

April 1, 2011 – March 31, 2012

Task 1 Support

Employees	**Appt. Dates**
Don Anderson, CINAR Director	7/01/09 - present
Judy Kleindinst, CINAR Administrator	7/01/09 - present
Ann Stone, CINAR Administrative Professional	9/26/09-present

Postdoc	**CINAR Theme**	**Appt. Dates**	**Advisors**
Dr. Joel Llopiz University of Miami Rosensteil School of Marine and Atmospheric Science	Ecosystem Monitoring	Fall 2010 (18 month appt.)	Carin Ashjian Cabell Davis Simon Thorrold
Dr. Robert Todd University of California, San Diego	Sustained Ocean Observations and Climate	Fall 2011 (18 month appt.)	Fiammetta Straneo Glen Gawarkiewicz Steven Lentz Albert Plueddemann
Dr. Ke (Kevin) Chen North Carolina State University	TBA	Fall 2012 (18 Month appt.)	TBA

APPENDIX 2 : CINAR PERSONNEL SUMMARY CHART :

April 1, 2011 – March 31, 2012

Category	Number	B.S	M.S.	Ph. D.
Employees that	receive ≥ 50 %	NOAA Funding	(not including	Students)
Research Scientist	2	1	1	0
Visiting Scientist	0	0	0	0
Post Doctoral Fellow	2	0	0	2
Research Support Staff	11	5	6	0
Administrative	0	0	0	0
TOTAL	15	6	7	2
Employees that	receive < 50 %	NOAA Funding	(not including	Students)
Research Scientist	40	4	10	26
Visiting Scientist	1	0	0	1
Post Doctoral Fellow	1	0	0	1
Research Support Staff	48	26	17	5
Administrative	16	7	1	1
TOTAL	106	37	28	34

Students	0	0	0	0
Undergraduate Students	4	0	2	2
Graduate Students	0	0	0	0
TOTAL	4	0	2	2

Obtained NOAA employment within the last year	0	0	0	0

APPENDIX 3: CINAR PUBLICATIONS FOR REPORTING PERIOD

CI Name	PI Name / Author Names	Status of Publication (In Review , In Press, Published)	Publication Date	Publication Title	Published In (Journal Name, volume and page number)	Type of Publication	Citation No. (Digital Object Identifier)	CI Lead Author	NOAA Lead Author	Other Lead Author	Peer Reviewed	Non Peer Reviewed
CINAR	Okkonen, S.R., Ashjian, C.J., Campbell, R.G., Clarke, J., Moore, S.E., Taylor, K.D. *Note: Other CI (CIFAR) lead author	Published	2011	Satellite observations of circulation features associated with the Barrow area bowhead whale feeding hotspot.	Remote Sensing of Environment 115: 2168-2174.	Journal Article	doi:10.1016/j.rse.2011.04.024			x	x	
CINAR	Anderson, D.M, A.D. Cembella, and G.M. Hallegraeff	Published	2012	Progress in understanding harmful algal blooms(HABs): Paradigm shifts and new Technologies for research and Management	Annual Reviews in Marine Science, 4,143-176	Journal Article	10.1146/annurev-marine-120308-081121	x			x	
CINAR	Baumgartner, M.F. and S.E. Mussoline	Published	2011	A generalized baleen whale call detection and classification system	Journal of the Acoustical Society of America	Journal Article	DOI: 10.1121/1.3562166	X			X	
CINAR	A. Proshutinsky, M-L. Timmermans, I. Ashik, A. Beszczynska-Moeller, E. Carmack, I. Frolov, R. Ingvaldsen, M. Itoh, T. Kikuchi, R. Krishfield, F. McLaughlin, H. Loeng, S. Nishino, R. Pickart, B. Rabe, B. Rudels, I. Semiletov, U. Schauer, N. Shakhova, K. Shimada, V. Sokolov, M. Steele, J. Toole, T. Weingartner, W. Williams, R. Woodgate, M. Yamamoto-Kawai, and S. Zimmermann , submitted	Submitted	2011	Ocean, [in "State of the Climate in 2010"]	Bull. Amer. Meteor. Soc.	Journal Article					x	
CINAR	Todd, RE, DL Rudnick, MR Mazloff, BD Cornuelle, RE Davis	Published	2011	Thermohaline structure in the California Current System: Observations and modeling of spice variance	J. Geophys. Res., 117, C02008	Journal Article	10.1029/2011JC007589	X			X	
CINAR	Llopiz, J.K.	In Press	2012	Latitudinal and taxonomic patterns in the feeding ecologies of fish larvae: a literature synthesis	Journal of Marine Systems	Journal Article		X			X	
CINAR	Peck, M.A., K.B. Huebert, J.K. Llopiz	In Press	2012	Marine fish larvae and their prey: extrinsic and intrinsic factors driving match-mismatch dynamics	Advances in Ecological Research	Journal Article				X	X	
CINAR	D'Alessandro, E.K., S. Sponaugle, J.K. Llopi	Published	2011	Larval ecology of the great barracuda, Sphyraena barracuda, and other sphyraenids in the Straits of Florida	Marine Biology	Journal Article	10.1007/s00227-011-1770-z			X	X	
CINAR	Rebuck, N.D., D.W. Townsend and M.A. Thomas.	Published	2010	Gulf of Maine Region Nutrient and Hydrographic Database.	http://grampus.umeoce.maine.edu/nutrients/	Publication List				X		X
CINAR	McGillicuddy, D.J., Jr., D.W. Townsend, R. He, B.A. Keafer, J.L. Kleindinst, Y. Li, J.P. Manning, D.G. Mountain, M.A. Thomas and D.M. Anderson	Published	2011	Suppression of the 2010 Alexandrium fundyense bloom by changes in physical, biological, and chemical properties of the Gulf of Maine	Limnology and Oceanography 56: 2411–2426.	Journal Article				X	X	
CINAR	Townsend, D.W., N.D. Rebuck, M.A. Thomas, L. Karp-Boss, and R. M. Gettings	Published	2010	A changing nutrient regime in the Gulf of Maine.	Continental Shelf Research 30: 820–832	Journal Article		X			X	
CINAR	Manderson, J., L. Palamara, J. Kohut, and M	Published	2011	Ocean observatory data are useful for regional habitat modeling of species with different vertical habitat preferences	Marine Ecology Progress Series Vol. 438: 1–	Journal Article	doi: 10.3354/meps09308		X		X	
CINAR	Palamara, L., J. Manderson, J. Kohut, M. Oliver, S. Gray and J. Goff	Published	2011	Improving habitat models by incorporating pelagic measurements from coastal ocean observatories	Marine Ecology Progress Series Vol. 447: 15	Journal Article	doi: 10.3354/meps09496	X			X	
CINAR	Wood, R., C.S. Bretherton, C. R. Mechoso, R. A. Weller et al.,	Published	2011	The VAMOS Ocean-Cloud-Atmosphere-Land Study Regional Experiment (VOCALS-Rex): goals, platforms, and field operations	Atmos. Chem. Phys. Discuss., 10, 1-53	Journal Article				x	x	

CI Name	PI Name / Author Names	Status of Publication (In Review , In Press, Published)	Publication Date	Publication Title	Published In (Journal Name, volume and page number)	Type of Publication	Citation No. (Digital Object Identifier)	CI Lead Author	NOAA Lead Author	Other Lead Author	Peer Reviewed	Non Peer Reviewed
CINAR	Cowles, T., J. Delaney, J. Orcutt, R.Weller	Published	2011	The Ocean Observatories Initiative: Sustained Ocean Observations Across a Range of	Mar. Tech. Soc. Jrnl., 44(6), pp.54-64.	Journal Article				x		x
CINAR	Cronin, M. F., R.A. Weller, R.S. Lampitt , and Uwe Send,	Published	2011	Ocean Reference Stations	In Earth Observation, R.B. Rustamov and S.E. Salahova (eds.), InTech, ISBN: 978-953-307-973-8	Journal Article			x		x	
CINAR	Duennebier, F. K., R. Lukas, E.-M. Nosal, J. Aucan, and R. A. Weller	Published	2011	Wind, waves, and acoustic background levels at Station Aloha	J. Geophys. Res.	Journal Article	10.1029			x	x	
CINAR	Song*, X., and L. Yu, 2011: * Visiting student	In press.	2011	High latitude contribution to global variability of sensible heat flux at the air-sea interface	Journal of Climate, special collection on "CLIVAR/SeaFlux High Latitude Surface Fluxes". http://dx.doi.org/10.1175/JCLI-D-11-00028.1	Journal Article			x			
CINAR	Yu, L., .,	Published	2011	A global relationship between the ocean water cycle and near-surface salinity	Journal of Geophysical Research – Oceans. 116, C10025, 17pp	Journal Article	doi:10.1029/2010JC006937.	x			x	
CINAR	Yu, L., X. Jin, and R. A. Weller,	In press	2011	Global ocean heat fluxes [in "State of the Climate in 2010"].	Bull. Amer. Meteor. Soc., 92(6), S1-S266.	Journal Article		x			x	
CINAR	Zhang, L-P., L-X. Wu, and L. Yu,,	Published	2011	Oceanic origin of recent La-Niña like warming.	Advances in Atmospheric Sciences	Journal Article	doi: 10.1007/s00376-010-0129-6.		x		x	
CINAR	Yu, L., and M. J. McPhaden.	Published	2011	Ocean pre-conditioning of Cyclone Nargis in the Bay of Bengal: Interaction between Rossby waves, surface fresh waters, and sea surface temperatures	Journal of Physical Oceanography, 41(9), 1741-1755.	Journal Article	doi:10.1175/2011JPO4437.1.	x			x	
CINAR	Nof, D., S. Gorder, and L. Yu,	Published	2011	Thoughts on a variable meridional overturning cell and a variable heat-flux to the atmosphere.	Geophysical & Astrophysical Fluid Dynamics, 105, 1-22	Journal Article	doi:10.1080/03091929.2010.481383.		x		x	
CINAR	Yu, L.,	In press	2011	Sea surface exchanges of momentum, heat, and freshwater determined by satellite remote sensing. Climate and Oceans: A Derivative of the Encyclopedia of Ocean Sciences. J. Steele, S. A. Thorpe, K. K. Turekian, (Eds). 119.	Academic Press, London, UK. 636pp. 110-119	book		x			x	