CINAR

Cooperative Institute for the North Atlantic Region

Annual Progress Report

April 01, 2014 - March 31, 2015

Donald M. Anderson, Director

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

Gulf of Maine Research Institute

RUTGERS THE STATE UNIVERSITY OF NEW JERSEY

University of Maryland CENTER FOR ENVIRONMENTAL SCIENCE

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CINAR
Annual Progress Report

Reporting Period: April 01, 2014 - March 31, 2015

Submitted by:

Donald M. Anderson, Director

Submitted to NOAA on 06/30/2015

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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 from OAR, $3 million from NMFS, and $1.7 million from NOS.
- In year four, funding was lower this year, with $5.6 million from OAR, $2.8 million from NMFS, and $.04 million from NOS.
- In year five, funding was nearly $10 million with $6.6 million from OAR, $3.1 million from NMFS, and $0.03 million from NOS. (Note that this total does not include Hurricane Sandy supplemental funds (nearly $6 million, with $5.6 million from OAR and 0.4 M from NOS) as those were funded through separate grant agreements.
- In year six (that is, the period between April 1, 2014 and June 30, 2014 not reported in year 5), funding was $.076 from OAR and $.048 from NMFS. The CINAR renewal grant began July 1, 2015 (NOAA Cooperative Agreement No. NA14OAR4320158) and therefore most of "year six" funds were submitted via that agreement.

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 Scholars Sara Bender and Andrew Jones as part of this year's CINAR progress report.

Education and Outreach

CINAR continued its program in summer Minority Traineeships, providing one minority student to each partner. These students received training through one or more CINAR investigators. Details about the summer 2014 program are provided under Task I activities.

Following up on the successful informal workshop we held in 2014 called "CINAR 101" to explain the process of preparing CINAR proposals, submission, and the award process for our partners, CINAR staff visited UMaine and GMRI. At each location, tailored presentations were given and meetings were held with both researchers and administrative staff to answer individual questions and clear up some misconceptions.

Last year, we began a new program, "*WHOI-NEFSC Special Seminar Series on Fisheries and Ecosystems Acoustics*". That successful seminar series has been well received and will continue for the foreseeable future. More details are provided under the Task I activities section.

Scott Gallager - Woods Hole Oceanographic Institution
Operational support for HabCam V4 on Legs 1 and 2 of the 2014 annual scallop survey

The objective of this project was to set up the HabCamV4 and to participate in the 2014 scallop survey, Legs 1 and 2. The stereo HabCam system is being transitioned to NOAA to conduct annual scallop and groundfish stock assessments. Manual and automated analysis of the stereo image pairs from the stereo NOAA HabCam is essential to utilization of the full potential capabilities of the imaging system.

- Scallop and substrate classification software were run in parallel with data acquisition and transferred result to database while at sea.

- Upon transfer of imagery from the ship to the NOAA RAID drives allowed scallop annotations and data to be processed and plotted for presentation to the scallop Stock Assessment Review Committee (SARC).

Jessica Joyce – Gulf of Maine Research Institute
Improving fishery-dependent data collection and integration into NMFS data systems

The objective of this project is to work with industry stakeholders to articulate a vision of fishery dependent data collection and systems that contributes to NOAA Fisheries' internal review of fishery dependent data in the Greater Atlantic Region. The overall goal is to gather industry input and support for a significant Federal initiative to overhaul the current Fishery Dependent Data systems.

- A workshop brought together over 60 fisheries stakeholders from the Greater Atlantic Region, including harvesters, seafood dealers, representatives from fishing and seafood businesses, industry associations, state agencies, academic and research institutions, environmental organizations, as well as groundfish sector managers, New England and Mid-Atlantic Fishery Management Council staff, and NMFS staff.

- Input offered during the workshop was merged with input derived from stakeholder interviews and surveys conducted before the workshop. Together, these contributions will be directly incorporated into a data systems requirements document to be developed by NMFS staff.

Daphne Munroe – Rutgers University
Evaluation of larval sources and population connectivity in the Atlantic sea scallop

This project is examining the linkage between increased broodstock abundance of the Atlantic seas scallop (*Placopecten magellanicus*) and potential for increased recruitment downstream. Investigators aim to provide a greater understanding of population connectivity in an economically and ecologically important fishery along the Atlantic coast. Results of larval dispersal simulations will aid in the understanding of how rotating stock closures and fishery

management of the Mid-Atlantic Bight Sea scallop stock is interacting with recent increases in stock biomass.

- A bio-physical larval scallop model was developed that calculates larval dispersal and connectivity for Atlantic Sea scallops in the Mid Atlantic Bight.

- Connectivity patterns in the federal sea scallop stock have been calculated for multiple years (2006 to 2012) and used to assess connectivity among rotating closed areas.

- Preliminary results demonstrate strong connectivity among rotating closed areas and recruitment elsewhere in the stock.

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.

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 to 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;

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

10) To develop, carry out, and sustain key observational components of NOAA ocean observing missions.

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.

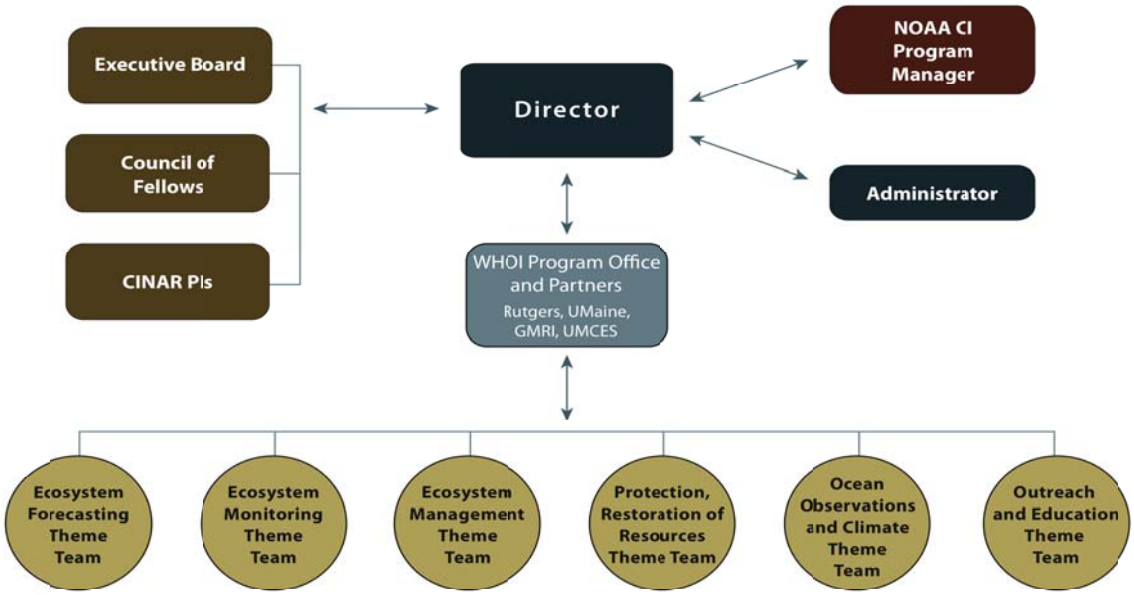


Figure 1. Organizational structure of CINAR.

CINAR PIs

The CINAR PIs include Donald M. Anderson, *CINAR Director, Woods Hole Oceanographic Institution*; Mark Miller, *Professor, Environmental Science, Rutgers University*; Michael Roman, *Director, Horn Point Laboratory, University of Maryland Center for Environmental Science*; Fei Chai, *Director, School of Marine Sciences, University of Maine*; and Andrew Pershing, *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
Ned Cyr	NMFS/OST
Donald Anderson	CINAR Director
Fei Chai	CINAR PI, University of Maine
Peyton Robertson	North Atlantic Regional Team Representative
Laurence Madin	WHOI Leadership
Cynthia Decker	Interim 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 Director serves as a special advisor to the Council in an *ex officio* status.

The CINAR Council of Fellows members are:

Donald Anderson, Chair	CINAR Director
Mark Miller	CINAR PI, Rutgers
Michael Roman	CINAR PI, UMCES
Fei Chai	CINAR PI, University of Maine
Andrew Pershing	CINAR PI, Gulf of Maine Research Institute
Paulinus Chigbu	MSI Representative / UMCES
Position to be filled	NMFS/NEFSC
Position to be filled	OAR/Climate Program Office
Ellen Mecray	NESDIS/NCDC
Cynthia Decker, *ex officio*	Interim 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).

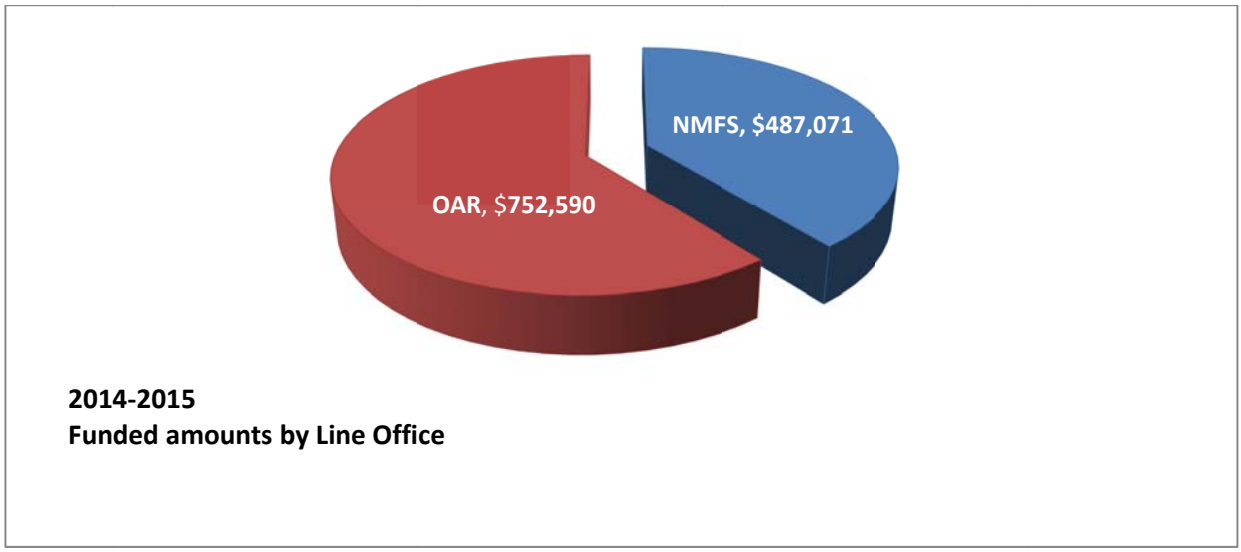
CINAR Research and Administrative staff

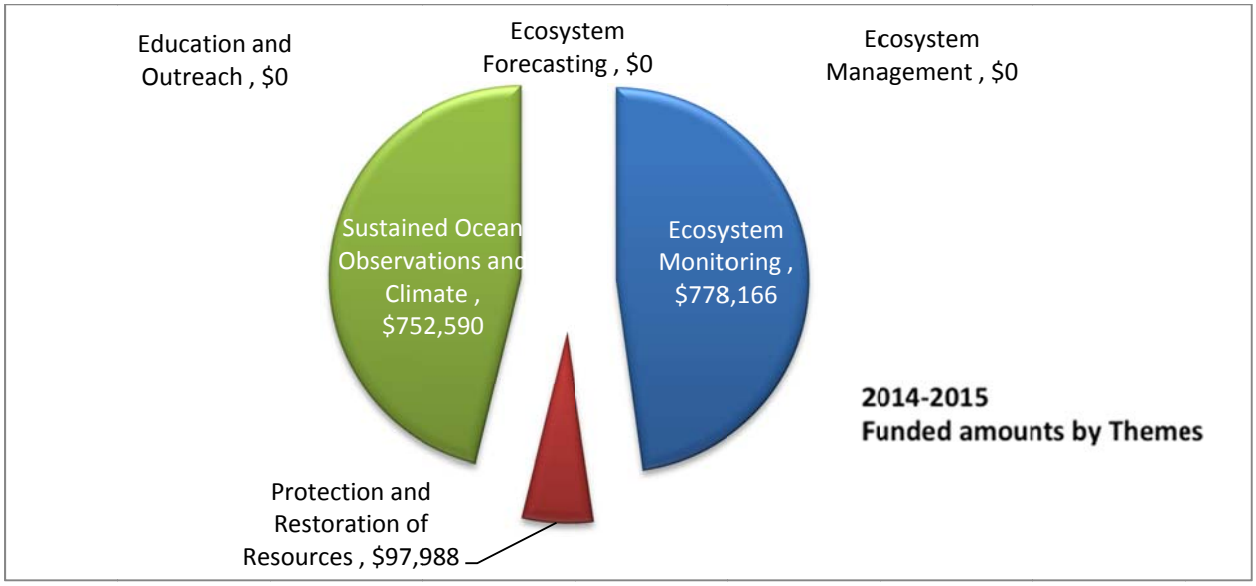
WHOI and the partner institutions provide the administrative staff for grants and contracts management, human resource management, systems administration, procurement, and all necessary support staff roles for CINAR activities. CINAR uses the services of researchers through an appropriate combination 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.

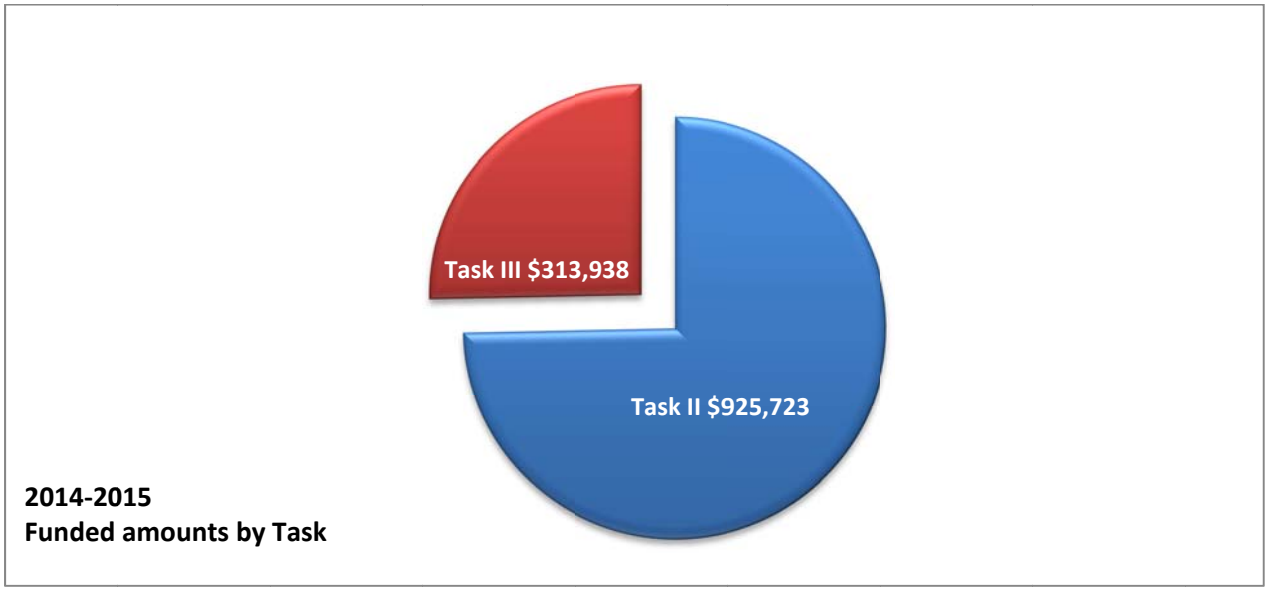
CINAR Program Office

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

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







Task I Activities with Distribution of Funding

No new Task I funds were received during this period. We are providing information on activites here as well as in the report for NA14OAR4320158 as the two agreements overlap in time.

Data Management

The NSF funded Biological and Chemical Oceanography Data Management Office (BCO-DMO) 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

Education and Outreach

Postdoctoral Scholar program. Through WHOI cost-sharing support for CINAR, each year we appoint an 18-month Postdoctoral Scholar. 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 - Sara Bender and Andrew Jones. Their reports begin on page 19.

Undergraduate student training: CINAR instituted a Minority Traineeship in 2013 funding one undergraduate minority traineeship at each partner institution each summer:

Partner Inst.	Student Name	CINAR Investigator	Study Focus
GMRI	Christina Hernandez	Andrew Pershing	Species distribution changes from the 1980s to the present
WHOI	Alexis Wood	Lauren Mullineaux	Dynamics of phytoplankton blooms and their biogeochemical implications
UMaine	Darnell Dinwiddie	Gayle Zydlewski	Various aspects of sturgeon of the Gulf of Maine from scutes to habitat
UMCES	Sarah Black	Nick Nidzieko	Algorithms to adaptively track salinity gradients with an autonomous underwater vehicle

It is of note that Minority Trainee Christina Hernandez has now been accepted into the MIT/WHOI Joint Program in Oceanography.

Outreach.

WHOI-NEFSC Special Seminar Series on Fisheries and Ecosystems Acoustics.

A new seminar series was started in June of 2014, sponsored jointly by NEFSC, CINAR, and the WHOI Biology and Applied Ocean Physics and Engineering Departments and co-convened by CINAR Fellow Gareth Lawson, Andone Lavery, and Tim Stanton of WHOI, together with Michael Jech of NEFSC. The series focuses on bio-acoustics, both passive and active, emphasizing applications and technological developments relevant to fisheries and ecosystem research and management as well as protected species conservation. The intent is to promote interactions between WHOI and NEFSC personnel on these topics and in general. In order to maximize attendance from both institutions, the seminars take place in the NEFSC Clark Conference Room and occur as a special seminar during the regular AOPE time slot. The talks are also distributed live as a webinar, via the OneNOAA Science Seminar series.

The seminar series has convened approximately every two months and has been very well received. The presentations have covered a variety of topics, ranging from new developments in broadband acoustic technologies (Andone Lavery, WHOI), passive acoustic monitoring of vocalizing marine mammals (Danielle Cholewiak, NEFSC), autonomous platforms for such monitoring of cetaceans (Mark Baumgartner, WHOI), active acoustic assessments of reef fish in untrawlable habitats (Christopher Taylor, NOAA NOS), to passive acoustic monitoring and tagging of spawning cod (Micah Dean, MA DMF). Attendance at these seminars has been very high, and the question/discussion periods following the presentations have been insightful. Remote attendance via the webinar has equally been high, with participants joining in from as far

away as the PIFSC in Hawaii (despite the time change). The webinar system has successfully allowed these participants to engage fully in the seminars by asking questions and making comments, and the large number of remote attendees indicates a strong interest in this topic. In the coming year the seminar series will continue with talks from WHOI and NEFSC scientists, and increasingly with speakers drawn from the greater region.

2013 CINAR Postdoctoral Scholar Progress Report

NOAA Cooperative Agreement No.- NA14OAR4320158
April 01, 2014-March 31, 2015

Postdoctoral Scholar: Sara Bender, WHOI

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: II. Ecosystem Monitoring

PROJECT OVERVIEW:

The CINAR Postdoctoral Research funding (as part of the Woods Hole Oceanographic Institution Postdoctoral Scholar program) provides a fellowship for Dr. Sara Bender from December 2, 2013 – May 2, 2015. This research is being conducted in the lab of Dr. Mak Saito.

The project focus continues to be centered on the nuisance algae *Phaeocystis sp*. and was designed to apply molecular-based approaches (transcriptomics and proteomics) to study this unicellular algal species in laboratory cultures, field samples collected in the Ross Sea, Antarctica, and as part of a field campaign in Cape Cod Bay, Massachusetts. The overarching goal of the project is to interrogate the metabolism of *Phaeocystis sp*. using global and targeted proteomics to better understand its metabolic response to changes in macro- and micro- nutrients. Over the past year, the project has focused extensively on developing data analysis methods to properly deal with the data deluge that comes from proteomic samples. The objectives, outlined below, have also changed slightly to take better advantage of existing proteomic datasets (in particular, see Objective 3).

ACCOMPLISHMENTS:

The postdoctoral position began on December 2, 2013 and continues through May 2015. The updated objectives for this research are as follows: (1) To use *in silico* approaches to analyze existing transcriptomic and proteomic datasets of *Phaeocystis antarctica* grown under controlled laboratory conditions; (2) To incorporate field metaproteome samples collected from *Phaeocystis* blooms in the Ross Sea into the objective 1 manuscript to give ecological context to the laboratory findings; (3) To investigate the interactions between *P. antarctica* and bacterial assemblages associated with its colonies in field metaproteomes collected from the Ross Sea; (4) To continue to collect samples and to extract proteins from an ongoing field campaign in Cape Cod Bay, where *Phaeocystis pouchetii* blooms annually.

Objectives 1 and 2 are complete and a manuscript of this research is in preparation (estimated submission date is May 2015). Results from this study were presented at the international ASLO meeting in Granada, Spain in early February. Comparisons between the transcriptomes and proteomes for *P. antarctica* cultures have, for the first time, captured the molecular response of *P. antarctica* as it transitions from its single-cell life stage to the colonial stage. Proteins that are likely integral in colony formation have been identified in laboratory cultures, as well as in field

samples, and may, in the future, serve as useful biomarkers for understanding the physiological state of *P. antarctica* blooms off of Antarctica.

For Objective 3, proteins have been successfully extracted from the Ross Sea field samples and the metaproteome has been run through the mass spectrometer and through an updated *in silico* database that includes both prokaryotic and eukaryotic organisms. This work will continue over the next few months. At present, this analysis is entirely computer-based.

The second field season for Objective 4 is underway. Due to the long winter, it is expected that this year's bloom will be delayed (few *P. pouchetii* cells were collected during the March 2015 sampling trip). Last year, Sara Bender participated in three research cruises on the R/V Shearwater in collaboration with the Provincetown Center for Coastal Studies (PCCS; Dr. Amy Costa). Field samples of *P. pouchetii* were collected, and the protein extraction protocol from the 2014 samples is underway. One set of samples has been run on the mass spectrometer and is now in the queue for computer-analysis. Samples for 2015 have been collected from a March 2015 sampling trip, and two upcoming day-cruises on Cape Cod Bay are planned for April and May 2015.

Finally, additional funding for the *P. pouchetii* fieldwork was secured through an internal Woods Hole Oceanographic Institution proposal with the Coastal Ocean Institute. This funding will be used to continue the Cape Cod Bay fieldwork.

HIGHLIGHTS

- Finalized analysis of *P. antarctica* lab and field (meta) proteome samples; manuscript preparation is underway (estimated submission, May 2015)
- Created a database to annotate Ross Sea metaproteomes for the prokaryotic and eukaryotic size fractions; sample analysis is underway
- Participated in 2014 field campaign in Cape Cod Bay with the PCCS group; 2015 field campaign is underway
- Processed *P. pouchetii* field samples: some samples have been run on the mass spectrometer, protein extractions are underway on the remaining samples
- Participated in two conferences (Joint Aquatic Science meeting, 2014; The Association for the Sciences of Limnology and Oceanography conference, 2015)
    - Presented proteomic analysis for *P. antarctica* during "ASLO" conference
- Guided a high school student at Falmouth Academy for a science fair project; science fair judge at the Falmouth Academy (2015) and Massachusetts State (20214) science fairs
- Conducted professional service as an ad-hoc reviewer for NSF and multiple peer-reviewed journals
- Volunteered in a national professional development organization (C-MORE), as a committee member for the WHOI Postdoctoral Association, and as a science fellow for an NSF-funded climate interpretation group (NNOCCI)

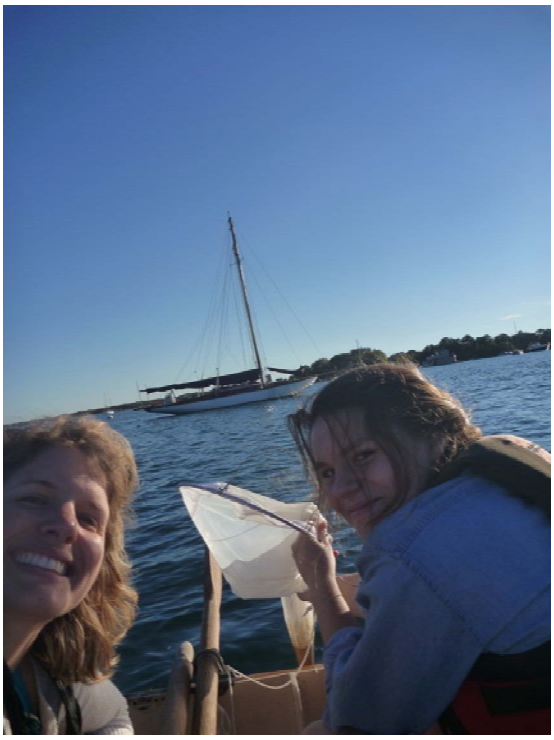
SOCIETAL BENEFITS

Phaeocystis sp. is a eukaryotic, bloom-forming alga that is considered a nuisance species to higher trophic levels. To date, a solid understanding of the bottom-up factors that trigger bloom

formation in *Phaeocystis antarctica* in the Ross Sea and *Phaeocystis pouchetii* in Cape Cod Bay are unknown. The application of molecular approaches (such as proteomics) offers a high-resolution tool for understanding some of the mysteries that surround bloom formation. The successful development and application of these "*Phaeocystis* bloom biomarkers" will provide greater insight into the physiological state of these organisms in present and future oceans.

EDUCATION AND OUTREACH ACTIVITIES

- *Oral presentation* at the Joint Aquatic Sciences Meeting (Portland, Oregon): February 18-23, 2014
    - "Nitrogen transporters in laboratory transcriptomes and field metatranscriptomes reveal species-specific metabolic responses of marine diatoms to nitrogen availability"
- *Elected Representative* on the Woods Hole Oceanographic Institution Postdoctoral Association committee: 2014 – 2015
- *Communications Officer*, Professional Development Organizing Committee, Center for Microbial Oceanography: Research and Education (C-MORE): 2014 – 2015
- *Science Advisor & Climate Fellow*, Woods Hole Oceanographic Institution, National Network for Ocean and Climate Change Interpretation (NNOCCI): 2014
- *Judge* in two High School Science Fair Competitions
    - Massachusetts State Science Fair: May 19, 2014
    - Falmouth Academy, MA: February 20, 2015
- *Mentor* for Falmouth Academy (FA) High School student
    - Student received 2nd place in the FA Science Fair; advanced to regional and state science fair in 2015
- *Oral presentation* at the Association for the Sciences of Limnology and Oceanography (Granada, Spain): February 22-27, 2015
    - "Unfolding Colony Formation Mechanisms in *Phaeocystis antarctica*"
- *Ad-hoc reviewer* for the National Science Foundation, Marine Ecology Progress Series (MEPS), Environmental Science & Technology, French National Research Agency, C-MORE EDventures Proposal Review Committee (Center for Microbial Oceanography: Research and Education- C-MORE)



FIGURES:

Figure 1 Sample collection in Great Harbor, Woods Hole, MA as part of student's high school science fair project. Pictured, left to right: Sara Bender (mentor) and Celia Patterson (high school sophomore).

2014 CINAR Postdoctoral Scholar Progress Report

NOAA Cooperative Agreement No.- NA14OAR4320158
April 01, 2014-March 31, 2015

Postdoctoral Scholar: Andrew Jones, WHOI

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: IV. Protection and Restoration of Resources

Andy Jones began his CINAR Postdoctoral Scholar position at Woods Hole Oceanographic Institution (WHOI) in December 2014. Prior to beginning his appointment, he received his Ph.D. under the supervision of Dr. David Post at Yale University. To date, his research has generally focused on trophic ecology of and the conservation of diadromous species fishes. The subject of his work has ranged from more basic ecological topics such as exploring the general mechanisms that enhance variation within populations, to more applied topics like the patterns of migration in anadromous fishes and interaction between these fishes and their predators.

Since arriving in Woods Hole, Andy has been busy splitting his time between getting previous work published, establishing collaborations, and planning fieldwork associated with the research he will be conducting during his appointment as a scholar. His future work will be related to two main themes: (1) continuing his work on the conservation, management, and basic biology of diadromous fishes, and (2) exploring the trophic ecology of marine fishes from the northeast U.S. continental shelf.

A significant portion of his work on diadromous fishes will focus on alewife and blueback herring (two species known collectively as river herring). River herring are, ecologically and culturally, species whose recent precipitous decline has led to coast-wide moratoria on their harvest. Much debate surrounds the causes of their decline and potential paths toward restoration. One subject that is particularly poorly understood are the factors that affect growth and survival of larvae and juveniles in freshwater habitats. As a scholar he will work collaboratively with Joel Llopiz (one of his advisors) on a project funded by WHOI Sea Grant to investigate the factors controlling the growth and survival of river herring larvae. Such information should make a strong contribution to our understanding of how environmental heterogeneity can affect these key species and will have implications for our understanding of things like their carrying capacity and recruitment variability.

Andy's work on river herring will include a number of smaller projects as well. This includes working in collaboration with scientists from the Massachusetts Division of Marine Fisheries (DMF) and the National Marine Fisheries Service (NMFS) to explore the efficacy of using natural tags (scale freshwater marks) as a cost effective way to estimate the size at ocean entry for river herring. This project utilizes DMF's extensive scale archives and will likely form the basis of future proposals to explore at sea mortality in river herring species. Additionally, pairing with researchers from the Marine Biological Laboratory and local volunteer groups, Andy will investigate the movement patterns of two species of river herring in the local Coonamessett River watershed. Information on the timing and duration of migration will be used to improve

monitoring and can be used to assess passage issues and the degree to which specific water bodies are used as spawning habitat.

The second and distinct part of Andy's research program will involve collaboration with researchers from NMFS to explore dietary patterns in marine fishes from the northeast U.S. continental shelf. This vein of research specific projects will include assessing dietary variation below the species level in marine fishes, and exploring the relationship between phylogenetic relatedness and dietary similarity in these species. Despite historically being largely overlooked, there is growing evidence that variation below the species level can have a large effect on the ecological interactions of a species, thus warranting investigation in this valuable ecosystem. Currently many workers consider phylogenetic niche conservatism to be common, however this has not been empirically examined in this ecosystem or many large marine ecosystems. Both of these projects will have significant implications for our basic understanding of marine food web structure, and have the potential to shape our understanding of topics relevant to managers, such as natural mortality resulting from predation in this ecosystem.

Additional activities Andy has been undertaking in the first quarter of his appointment include presenting new work on diadromous fishes at the winter meeting of the American Fisheries Society's Southern New England Chapter; serving on the board of a local water quality group; and submitting a grant to fund future research on diadromous species.

CINAR Research Summaries

The following pages provide research summaries of the 13 CINAR projects funded during the period April 1, 2014 through June 30, 2014, and those projects still ongoing from funding received during the previous year. The projects are organized by theme. Note that not all themes are represented in this report as most projects funded during the time period are included in the report for the CINAR renewal award.

Theme II. Ecosystem Monitoring

Scott Gallager, WHOI - *Operational Support for HABCAM V4 on Legs 1&2 of the 2014 Annual Scallop Survey*

Theme III. Ecosystem Management

Donald Anderson & Porter Hoagland, WHOI; Bonnie McCay, Rutgers – *Integrated approaches to ecosystem-based fisheries management: Combining social and ecological perspectie sthroug pilot fishery ecosystem plans*

Steven Eayrs, GMRI – *Commercial fishing vessel electronic trip reportig pilot study*

Jessica Joyce, GMRI - *Improving Fishery-Dependent Data Collection and Integration into NMFS Data Systems*

Theme IV. Protection and Restoration of Resources

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

Cabell Davis, WHOI - *Processing and interpretation of Video Plankton Recorder and other optical data collected in the Gulf of Mexico*

Daphne Munroe, Rutgers - *Evaluation of larval Sources and Population Connectivity in Atlantic Sea Scallop*

Jonathan Labaree, GMRI - *Funding Sector Operations and Dockside Monitoring in Fishing Year 2011*

Theme V. Sustained Ocean Observations and Climate

Carin Ashjian, WHOI – *An Eye in the Ocean: Exploration of high-resolution vertical distributions of plankton and particles and coincident hydrography in the Western Chuckchi sea – data synthesis*

Albert Suchy, WHOI - *R/V Knorr use in support of NOAA/PMEL WACS II research cruise*
Robert Weller and Albert Plueddemann, WHOI – *Ocean Reference Stations*

Theme VI. Education and Outreach

Donald Anderson, WHOI – *U.S. National Office for Harmful Algal Blooms*

Alexa Dayton – GMRI - *Marine Resources Education Program: Northeast Region*

THEME II. ECOSYSTEM MONITORING

CINAR

Cooperative Institute for the North Atlantic Region

Operational support for HABCAM V4 on Legs 1&2 of the 2014 annual scallop survey

NOAA Cooperative Agreement No.- NA09OAR4320129
April 01, 2014-March 31, 2015

CINAR Investigator - Scott Gallager - WHOI

NOAA Sponsor - Robert Johnston - NMFS / NEFSC

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: II. Ecosystem Monitoring

PROJECT OVERVIEW

The objective of this project was to set up the HabcamV4 system in pre-cruise mode, establish upgrades to the seagoing networking system to 10 gig Ethernet, and to participate in the 2014 Scallop Survey on Legs 1 and 2.

ACCOMPLISHMENTS

Gallager and York participated in the 2014 Scallop Survey on Legs 1 and 2. We believe it is critical that two HabCam personnel go to sea on both Legs 1 and 2 of the scallop survey to ensure operations are performed smoothly and the equipment functions normally. Gallager and York participated in Leg 1 to establish at sea processing while also contributing to dredging operations. Gallager and a WHOI Summer Student Fellow (no cost to NOAA) participated in Leg 2.

We also worked with NOAA personnel to set up the system in Gallager's calibration tank and to ensure that all systems are operational before breaking it down for shipment to Delaware.

The stereo HabCam system is being transitioned to NOAA to conduct annual scallop and groundfish stock assessments. Manual and automated analysis of the stereo image pairs from the stereo NOAA HabCam is essential to utilization of the full potential capabilities of the imaging system.

HIGHLIGHTS

- Operated image acquisition, light-field correction, and color correction in real-time at sea.
- Ran an at-sea database for metadata associated with imagery so manual annotations could be performed by NOAA and WHOI personnel as time permitted.
- Ran scallop and substrate classification software in parallel with data acquisition and transferred result to database while at sea.

- Upon transfer of imagery from the ship to the NOAA RAID drives in Gallager's lab by the end of the cruises around July 15, we were able to get all assignments completed for scallop annotations and data processed and plotted for the August 15, 2014 deadline for presentation to the scallop Stock Assessment Review Committee (SARC).

SOCIETAL BENEFITS

This research is providing a direct transition from inefficient and potentially damaging bottom trawling for surveying of scallop populations to a non-invasive high efficiency and cost-effective optical approach to assessing scallops and their patchy distribution.

EDUCATION AND OUTREACH ACTIVITIES

Data collected on the survey cruises were presented by Gallager at the NOAA habitat assessment workshop run by R. Langton. Two WHOI summer students and one NOAA student participated in the cruises and the processing of images from the surveys.

PUBLICATIONS

Honig, P., A.D. York, and S.M. Gallager. Automated Optical Identification of Marine Substrate. Submitted J. Oceanography

FIGURES

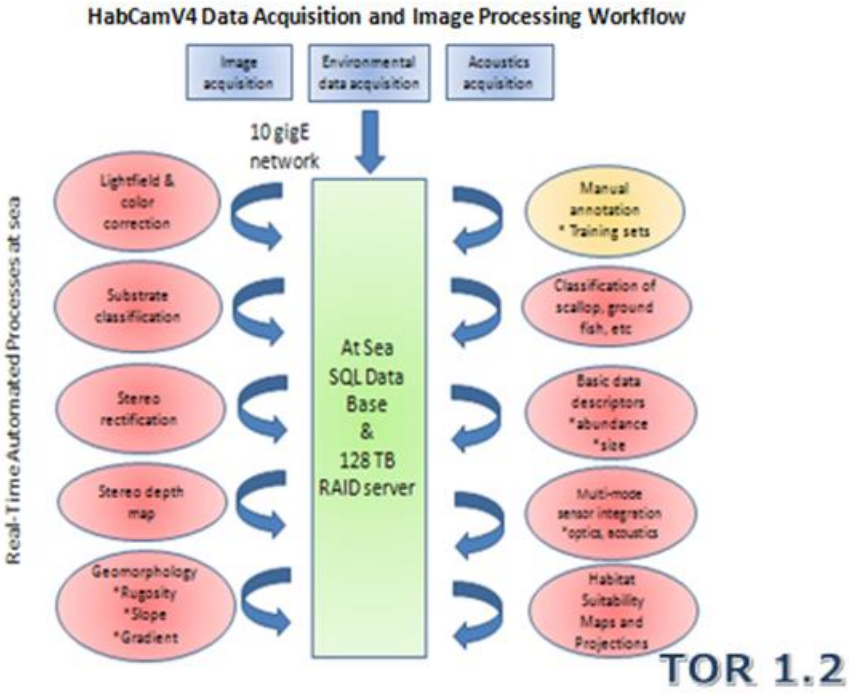


Figure 1. Hardware and database as set up on the R/V Sharp for the annual scallop survey

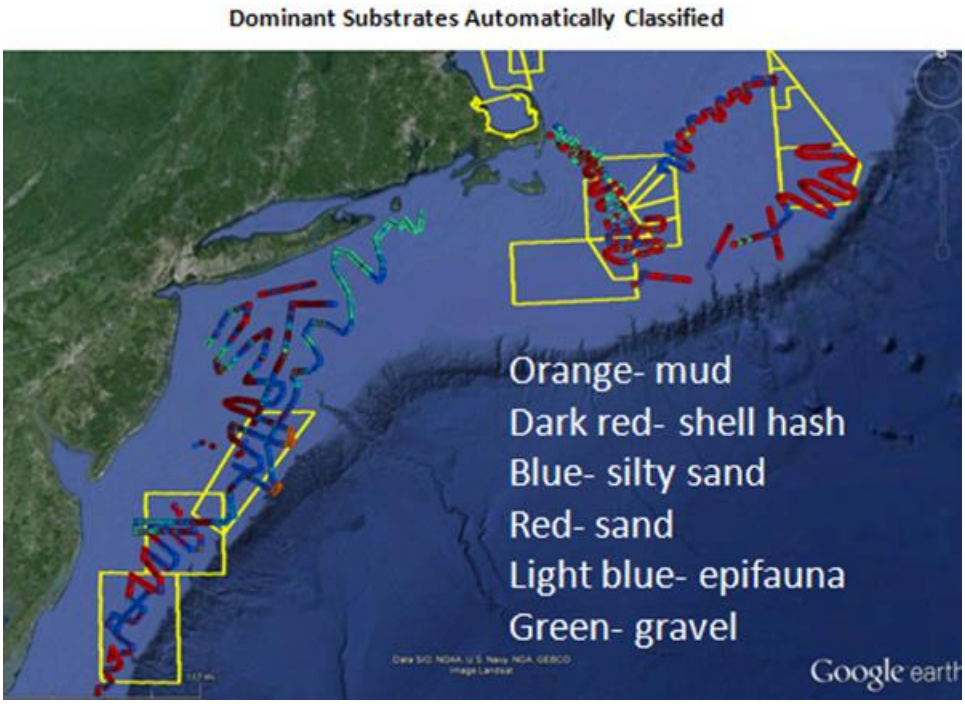


Figure 2. Legs 1-3 2014 scallop survey. Dots are color codes by substrate as measured automatically using machine vision software (Honig, York and Gallager, submitted)

THEME III. ECOSYSTEM MANAGEMENT

CINAR

Cooperative Institute for the North Atlantic Region

Development of a conceptual framework for the contribution of the social sciences (CSS) to Ecosystem-Based Fishery Management (EBFM)

NOAA Cooperative Agreement No. NA09OAR4320129

April 01, 2014-March 31, 2015

CINAR Investigators – Donald Anderson & Porter Hoagland – WHOI; Bonnie McCay - Rutgers

NOAA Sponsor – Barbara Roundtree - NMFS

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: III. Ecosystem Management

PROJECT OVERVIEW

This project comprises four pilot studies focusing on the ways in which the social sciences could contribute to the realization of EBFM. The funding covers travel expenses for CINAR investigators to collaborate, to report on progress at international meetings, and to aid it the organization and support of a symposium on multispecies fishery modeling. The PIs and collaborating investigators recognize the progress on the pilot studies must of necessity rely upon complementarities among ongoing research efforts funded through other sponsors. Some of these complementarities were discussed during a Human Dimensions Session at a NEFSC EcoAP Research Retreat. (December 2012).

ACCOMPLISHMENTS:

The pilot studies have been reported on, discussed, and improved at international meetings and symposia. The PIs have decided to postpone the convening of a workshop envisioned for the spring of 2013 to continue progress on the four pilot studies. Early results of the research have been reported on at a special symposium on multispecies modeling at the 2015 American Fisheries Society meeting in Portland, OR. The pilot studies and their current status are as follows:

1. Spatial mapping to characterize the extent of overlap between EPUs (or other finer resolution ecological units) and human communities, especially those associated with individual ports or MARFIN-type regions. One hypothesis is that a greater degree of coherence between EPUs and such "communities at sea" might imply more successful management of the EPUs as common property resources. A second is that linking EPUs to specific communities (and local economies) might foster a greater sense of stewardship as well as opportunities for direct participation in environmental assessment or governance. Finally, the ability of qualitative assessments of fishing communities (e.g., port profiles and other extant data) to inform EBFM might be enhanced by linking them to specific habitats and territories within or continuous with specific EPUs. Kevin St. Martin (Rutgers) and Julia Olson (NEFSC) are continuing to work closely with Mike Fogarty and his colleagues at the NEFSC Ecosystems Assessment Program on

understanding the relationships between EPUs and communities-at-sea and spatial resource dependencies.

2. Linking ecological food web models to regional economic impact models to understand both overall welfare and some of the distributional effects of alternative conservation and management measures, institutional arrangements, ecological relationships, or environmental changes. Current efforts in the northeast region involve both the use of input-output (IO) models to characterize the economic impacts of management measures and the development of more complex computable general equilibrium (CGE) models that are capable of providing estimates of welfare effects. Work to date includes the publication of a paper on the viability of economic fisheries data for use in coastal and marine spatial planning in the Northeast Region, the welfare and inequality effects of the displacement of commercial fisheries by renewable energy facilities and presentation of the CGE approach to the modeling of EBFM at the International Institute for Fisheries Economics and Trade in Dar es Salaam, Tanzania and Brisbane, QLD. This work also was recently presented at an MIT Sea Grant Stakeholder Forum on "Adapting to Change in Marine Systems" (April 2013). Di Jin (WHOI), Porter Hoagland (WHOI) and Eric Thunberg (NEFSC) continue to work on this pilot study.

3. Portfolio management to understand the decision-making behavior of individual or coherent groups of fishermen in multi-species fisheries in the face of uncertainties and given historical patterns of regulation. This behavior may be usefully modeled as a kind of "portfolio" management, through which fishermen hedge risks by harvest choices and by maintaining permits (even if unused during some periods). Moreover, fishermen may not be pure profit maximizers; their behaviors might be better characterized as risk-minimizing, satisficing, or seeking to perpetuate particular lifestyles. A portfolio modeling approach also could be implemented at the community (*i.e.*, port or sector) scale. Preliminary modeling has been undertaken by Geret DePiper (NEFSC), data has been compiled, and a paper has been prepared. Geret DePiper (NMFS), Di Jin (WHOI), and Porter Hoagland (WHOI) continue to work on this pilot study.

4. Characterizing vehicles (institutional processes and structures) for achieving co-management. Differences exist between the EBFM approaches now being taken by the Mid-Atlantic and the Northeast regional fishery management councils. The former is taking a more incremental approach, examining at the executive level the potential for implementing EBFM, while the latter is taking a more radical approach, involving the development of an EB fishery management plan, associated environmental impact statement, and ecological spatial modeling efforts. The Mid-Atlantic does not manage any overfished stocks, but the environmental conditions there are changing rapidly, likely impacting the distribution of stocks. The Northeast Council has recently implemented a sectoral catch share program for managing groundfish. Existing institutions and stakeholders in both regions may be reluctant to adopt EBFM approaches that are significantly different from the status quo. This "institutional inertia" may affect adversely the extent to which an EBF co-management can be achieved. Bonnie McCay (Rutgers) has published a review on recent work relating to shifts in fishing grounds as fishermen adapt to climate change. Bonnie McCay (Rutgers) and Michael Paolisso (Maryland) continue to work on this pilot study.

Ongoing work on this project include:

- characterizing how the pilot studies might contribute to NEFSC research efforts on a multispecies-multifleet, length-based, spatial assessment model for the US northeast continental shelf, which is now under development by the NEFSC Ecosystems Assessment Program;

- identifying other CINAR social scientists who might collaborate on the pilot studies (and characterizing the nature of their collaborations);

- making further progress on the pilot studies and clarifying how the research efforts that constitute the pilot studies might contribute to EBFM;

- assistance in organization of a special symposium on multispecies modeling at the American Fisheries Society in August 2015; and

- continued development of products (peer-reviewed papers, technical reports, or other) that provides insights for the contribution of the social sciences to EBFM.

HIGHLIGHTS

- The pilot studies have been reported on at several international meetings and symposia.

- A number of publications have been submitted or published (see publications section)

PUBLICATIONS

Hoagland P., Dalton TM, Jin D, Dwyer J. 2015. An approach for assessing the spatial welfare and distributional effects of siting wind energy in the ocean: the Rhode Island / Massachusetts "Area of Mutual Interest". Marine Policy 58: 51-59. DOI: 10.1016/j.marpol.2015.04.010

Hoagland P, Jin D, Dalton T, Dwyer J. 2014. Coastal and marine spatial planning in the context of ecosystem-based fisheries management: assessing tradeoffs between wind farms and marine fisheries in New England. Proc. IIFET 2014. Brisbane, Queensland (11 July)

Jin D, DePiper G, Hoagland P. 2014. An empirical analysis of portfolio management as a tool for implementing ecosystem-based fishery management. Proc. IIFET 2014. Brisbane, Queensland (10 July)

Jin D, Hoagland P. 2015. Linking regional economic and food web models fro ecosystem-based management. Proc. American Fisheries Society 145th Annual Meeting (August 16-20).

Olson J, St. Martin K. 2015. Visualizing, linking, and scaling up community: why mapping communities at sea matters to fisheries management. Submitted to *Fisheries*.

St. Martin K, Olson J. 2015. Enacting community in marine ecosystem-based management: on re-reading data, counter-modeling, and reassembling assemblages. Submitted to *Society and Space*.

Commercial fishing vessel electronic trip reporting pilot study

NOAA Cooperative Agreement No. NA09OAR4320129

April 01, 2014-March 31, 2015

CINAR Investigator – Steve Eayrs - GMRI

NOAA Sponsor – Joan Palmer - NMFS

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: III. Ecosystem Management

PROJECT OVERVIEW

The goal of this project is to facilitate the use of electronic logbook software by New England groundfish fishermen and their transmission of electronic vessel trip reports (eVTRs). The scope of work includes i) working with software providers, sector managers, and NMFS staff to identify and overcome outstanding challenges and limitations to effective transmission of VTR data, and ii) facilitating the use of electronic logbook software by New England groundfish fishermen.

There have been no notable changes to project *objectives*, *methodology* or *rationale* since the last report. However our *approach* has changed in that we are now in increasing contact with charter and party boat captains as they are now permitted to electronically transmit their VTRs. This change has resulted in considerable interest by this fleet and we have already equipped 3 charter vessels with this equipment.

In addition to expanding eVTR to the charter boat area, we have finally begun preparing fishermen within the sustainable harvest sector for eVTR use, the largest NE groundfish sector in the fishery. This sector proposes to use a proprietary software system, and we believe that once their leadership decides the time is right for their vessels to begin reporting electronically, that rapid expansion of this program will occur. We have subsequently been working closely with Electric Edge Systems Group Inc. to assist their eVTR certification process by NMFS.

ACCOMPLISHMENTS

We have now equipped 37 groundfishing vessels (up from 32 last year) with new eVTR software, although only 27 are currently reporting electronically on a regular basis. Overt eh past year these vessels have together transmitted over 500 trip reports. All vessels are using the FLDRS software.

Ongoing stock abundance issues in the groundfish fishery are having a significant impact on this project. Many fishermen have left the fishery and many others are presently unable to fish. Many fishermen are also unable or willing to participate in this project citing uncertain future involvement in the fishery as a key reason.

A significant portion of project time has been spent building and maintaining relationships with fishermen, sector managers, and others, usually in one-on-one meetings or over the telephone. These times were also spent reminding them of the utility and benefits of eVTR reporting compared to paper reporting, taking the opportunity to assess their interest and specific needs, demonstrating how the eVTR software works, and discussing how they will be able to access the data. We have been very active in highlighting the benefits of timely information transmission to sector managers, and having that information largely error free and comprehensible. As issues have arisen from sector managers we've passed that through to NOAA staff and worked with them to ensure that it was resolved. A significant amount of time has also been spent responding to requests from fishermen for help with computer hardware and software issues, as well as the installation of FLDRS software upgrades.

When we receive an expression of interest from a fisherman (or by the sector manager on his behalf) we first take steps to contact the captain and explain the eVTR project including use, implications, and benefits of eVTR reporting. The next step is to meet with the fisherman on his vessel and install the software on his computer, or provide him a laptop with the software already installed. Next he is provided training in the use and operation of the computer and software, and show him how/where to send his reports. To assist them we also provide training guides for the software/upload procedure including step-by-step instructions with relevant computer screen shots. The fishermen then practice the transmission procedure. If they require additional support they call us and we work through the problem by telephone or by a further visit to their vessel.

HIGHLIGHTS

- Project staff have trained 37 fishermen 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/NOAA staff regarding eVTR issues and operation
- Presently 27 boats are active and the current software version has been installed; all users are satisfied and happy with electronic data transmission
- Project staff worked closely with Electric Edge Systems Group Inc. to assist their eVTR certification process by extensively testing and troubleshooting their software

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 of the vessel and crew
- More accurate, appropriate, and responsive analysis and management by Sector managers, NEFSC staff, and others with access to eVTR data

EDUCATION AND OUTREACH ACTIVITIES

- eVTR poster presentation at the Fisherman's Forum in Rockland, ME, in 2015.

- Project description included in a GMRI flyer, which was presented to fishermen and others at the New Bedford Working Waterfront Festival (2014) and the Maine Fishermen's Forum (2015)
- Project was described in an article published in the National Fisherman magazine.

Improving fishery-dependent data collection and integration into NMFS data systems

NOAA Cooperative Agreement No. NA09OAR4320129

April 01, 2014-March 31, 2015

CINAR Investigator – Jessica Joyce - GMRI

NOAA Sponsor – Doug Christel - NMFS

Related NOAA Strategic Plan Goal: Resilient Coastal Communities and Economies

CINAR Theme: III. Ecosystem Management

PROJECT OVERVIEW

The objective of this project is to work with industry stakeholders to articulate a vision of fishery dependent data collection and systems that contributes to NOAA Fisheries' internal review of fishery dependent data in the Greater Atlantic Region.

GMRI's work entails identifying current and future data needs and uses, evaluating the utility of current data collections, capturing the desired characteristics of an ideal data system, articulating potential tools for collection and management, and anticipating future data needs. The project is being carried out in three phases.

GMRI and our team, along with staff from SMAST and independent contractors completed Phases I and II of this project in September 2014.

Phase I: The Fishery Dependent Data Visioning Project (FDDVP) industry interviews were conducted between February and May 2014 by a team of interviewers from GMRI, SMAST, and independent contractors. The objectives of the interviews were to gain feedback on the benefits and challenges associated with the current fishery dependent data systems, explore current and future data needs of industry, science and management, and to solicit input on the design of future data systems. The results of these interviews formed the basis for further exploration of key topics as part of an industry workshop, and helped gather additional industry input that will be used to improve data collections and associated data management systems.

Phase II: An industry workshop for the FDDVP was held in New Bedford, Massachusetts over June 30th and July 1st. The workshop was organized by GMRI, SMAST, GARFO and NEFSC. The purpose of the workshop was to further explore the current and future fishery dependent data needs of industry, science, and management in the Greater Atlantic Region.

Phase III: When we submitted the proposal for this project in 2013, Phase III was envisioned to consolidate data standards and processes for third party development of reporting and monitoring products. Phase IV was planned to test a pilot information portal based on data standards and processes as a proof of concept. At this time, we are in the process of scheduling a meeting with

our NOAA program managers to determine if our remaining work under this grant still aligns with the phases we outlined in our initial proposal, or if a change in the scope of work is warranted. In September 2014, NMFS requested that we delay initiation of Phase III of this project to allow the agency sufficient time to develop a requirements document and project plan for the modernized data system. NMFS staff are working with us to see how we can maximize efforts under Phase III of the CINAR grant to improve our fishery dependent data system consistent with our vision for a future system.

ACCOMPLISHMENTS

A total of 57 individuals were interviewed, including harvesters, dealers, processors, sector managers, fleet managers, software developers, and industry association leaders from ports ranging from Maine to Maryland. All of the Greater Atlantic Regional managed fisheries and gear types were represented by the pool of interviewees, and the majority of fishery dependent data collection reporting types and requirements were included. The interview results were presented as part of the FDDVP industry workshop, held in New Bedford, MA from June 30 to July 1, 2014. An interview report was also released in September of 2014 summarizing the results of these interviews. The interview report describes the findings from these interviews: http://www.gmri.org/sites/default/files/resource/final_fdd_interview_report.pdf

The workshop brought together over 60 fisheries stakeholders from the Greater Atlantic Region, including harvesters, seafood dealers, representatives from fishing and seafood businesses, industry associations, state agencies, academic and research institutions, environmental organizations, as well as groundfish sector managers, ACCSP staff, software developers, New England and Mid-Atlantic Fishery Management Council staff, and NMFS staff. The workshop goals included:

- Goal #1: Provide context for the current data collection and storage systems, and identify benefits and challenges associated with fisheries dependent data collections and outputs.
- Goal #2: Characterize current and future data needs of industry, science, management, and enforcement.
- Goal #3: Identify desired characteristics of data collections and systems.
- Goal #4: Identify tools and approaches that would help meet fishery dependent data needs most effectively.

The workshop report describes the findings from the workshop:
http://www.gmri.org/sites/default/files/resource/final_fdd_workshop_report_91014.pdf

HIGHLIGHTS

- Interviewed 57 industry members about the FDDVP from Maine to Maryland.
- Planned and facilitated a 60+ person FDDVP workshop in June/July 2014.
- Released the *Northeast Federal Fishery Dependent Data Visioning Project Stakeholder Interview Report* in September 2014.
- Released the *Northeast Federal Fishery Dependent Data Visioning Project Industry Workshop Report* in September 2014.

SOCIETAL BENEFITS

The primary societal benefits of this project are gathering industry input and support for a significant Federal initiative to overhaul the current Fishery Dependent Data systems. Input offered during the workshop was merged with input derived from stakeholder interviews and surveys conducted before the workshop. Together, these contributions will be directly incorporated into a data systems requirements document to be developed by NMFS staff by December 2014.

The expected benefits of NOAA's overall data modernization effort include:

- more accurate and timely data;
- consistent data products for analysis and reports;
- reduced reporting burden and expense for industry;
- more efficient utilization of NOAA staff resources;
- increased communication and coordination of data by NOAA and its partners; and
- quicker and easier access to data by all users.

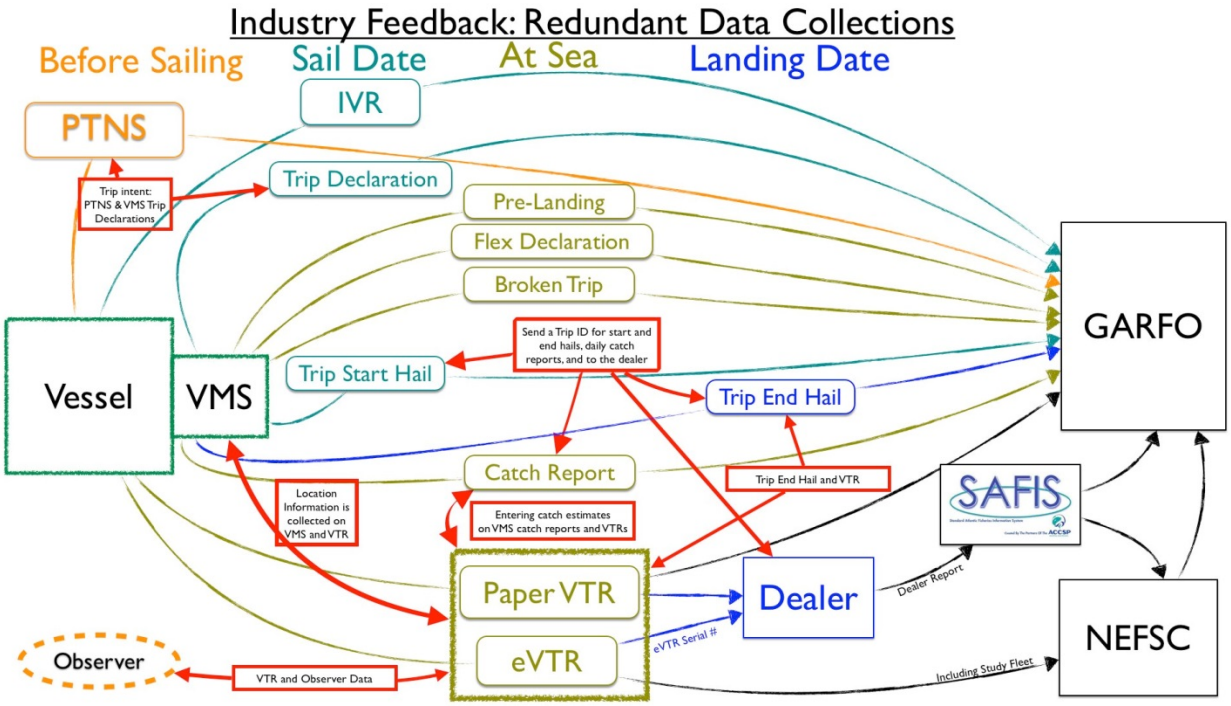
EDUCATION AND OUTREACH ACTIVITIES:

The core work in all phases of this project are essentially outreach to stakeholders, through interviews and the workshop, where we presented findings from Phase I; however, our NOAA partners did also present on the project to the mid-Atlantic Fishery Management Council in summer 2014.

PUBLICATIONS:

While we do not have peer-reviewed publications, we have the two project reports mentioned above, available on GMRI's website: http://www.gmri.org/our-work/fishing-industry-innovation/data-improvement/fishery-dependent-data

FIGURES



This figure reflects feedback from the industry interviews and depicts redundant data collections that would be reconciled in the modernized fishery depend data system.

THEME IV. PROTECTION AND RESTORATION OF RESOURCES

CINAR

Cooperative Institute for the North Atlantic Region

Bowhead whale feeding in the Western Beaufort Sea: Oceanographic conditions, whale prey distributions, and whale feeding and foraging behavior

NOAA Cooperative Agreement No. NA09OAR4320129
April 01, 2014-March 31, 2015

CINAR Investigator – Mark Baumgartner - WHOI

NOAA Sponsor – Kim Sheldon -NMFS

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: IV. Protection and Restoration of Resources

PROJECT OVERVIEW

This project was designed to characterize the diving and foraging behavior of bowhead whales on the western Beaufort Sea shelf off Barrow during the late summer. The study employed archival tags to monitor the whales' behavior and proximate oceanographic and zooplankton sampling to characterize oceanographic conditions and the distribution and abundance of the whales' prey. This tagging and fine scale sampling was designed to elucidate (1) the depths of feeding, (2) environmental conditions influencing the depth of prey layers, (3) foraging strategies, and (4) oceanographic processes that may influence the spatial distribution of bowhead whales.

ACCOMPLISHMENTS

During the reporting period, final revisions were made to a manuscript describing the dermal attachment tag, its efficacy on bowhead and humpback whales, health outcomes, and both short- and long-term behavioral effects of the tag. The paper was submitted to *Methods in Ecology and Evolution* and was published on-line in December 2014. The printed version was published in the journal during March 2015.

HIGHLIGHTS

- Publication of a new dermal attachment tagging approach for hours- to days-long tagging studies in *Methods in Ecology and Evolution*.

SOCIETAL BENEFITS

The new tagging method will enable new research on whale behavior on daily time scales, which will improve our understanding of natural behavior and the interaction between whales and human activities during both day and night. With this understanding, we can better manage human activities in the ocean to minimize their impact on endangered whales.

PUBLICATIONS

Baumgartner, M.F., T. Hammar, and J. Robbins. 2015. Development and assessment of a new dermal attachment for short-term tagging studies of baleen whales. Methods in Ecology and Evolution 6: 289-297.

Processing and interpretation of Video Plankton Recorder and other optical data collected in the Gulf of Mexico

NOAA Cooperative Agreement No. NA09OAR4320129
April 01, 2014 – March 31, 2015

CINAR Investigator – Cabell Davis - WHOI

NOAA Sponsor – Jennifer Kunzelman - NOS

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: IV. Protection and Restoration of Resources

PROJECT OVERVIEW

As part of the overall NOAA Natural Resource Damage Assessment NRDA plankton-sampling program related to the Deepwater Horizon (DWH) oil spill in the Gulf of Mexico, a suite of optical imaging systems were deployed to supplement traditional sampling using nets, pumps, and bottles. Data on taxonomic composition, abundance, and size of mesoplankton and particles were collected during four cruises between August 2010 and January 2011 using the Digital Autonomous Video Plankton Recorder (DAVPR) and on a gulf-wide survey cruise in March 2011 using the VPRII (Figs. 1, 2). The DAVPR sampling locations were located SW of the DWH Wellhead during August-September, 2010 and more broadly both east and west of the Wellhead in January 2011 (Fig. 2). The VPRII survey covered a large portion of the gulf shelf/slope region between Tampa and Galveston (Fig. 2). The raw data files from the DAVPR required post-processing to extract the CTD data together with sub-images (regions-of-interest, ROIs) of plankton and particles (marine snow). The VPRII extracted ROIs in real time during the cruise and saved them to disk with CTD and environmental data. In post-processing, the ROIs from both VPR systems were identified to major taxon using automatic and/or manual methods, time-matched with CTD data, and their sizes and abundances computed.

ACCOMPLISHMENTS

Cruise and station sampling procedures, times, and locations
DAVPR Cruises

General station sampling procedure – The basic deployment, recovery, and operation of the DAVPR was similar between the four cruises. During many deployments the DAVPR was mounted on the ship's CTD so that real-time depth and hydrography was monitored during the tow. In other cases the DAVPR SAIL was used to obtain this real time data from the DAVPR CTD. In all cases the DAVPR was launched through an A-frame located either on the stern or side of the ship. Towyos were made to 1000m (or ~10m above bottom) at a towing speed of 1 $m \cdot s^{-1}$ (= 2 knots). The DAVPR was repeatedly lowered and raised at a wire out/in rate of ~50 $m \cdot min^{-1}$. The battery was changed every 2 hours, with a typical tow consisting of 6 down-up profiles lasting a total of 6 hours. DAVPR tows were repeated at each station to during the day

and night. The DAVPR was sometimes used for single profile casts to a nominal depth of ~1000m. For tows 3, 5, 6, and 8 made on the American Diver (August 2-5, 2010), the DAVPR was mounted on an Acoustic-Optics sampler (owned by M. Sutor, LSU). This combined instrument package was towyoed at ~1m/s (~2 knots) while simultaneously sampling at the surface using a plankton pump with its intake hose pole-mounted on the port side of the ship. This combined sampling was termed acoustics-optics-pump (AOP) sampling. On the other 3 cruises, the DAVPR was usually mounted on the ship's own CTD, such that the CTD data would be recorded as normal ship CTD operations, while the DAVPR internally recorded its own CTD and video data.

Description of DAVPR cruises and tows

M/V American Diver 1 leg 2 – Significant effort was required to outfit and configure the M/V *American Diver* for oceanographic operations. This ship was small and a fixed A-frame was mounted on the stern for these operations. Eight DAVPR tows were made during the 4-day period from August 2-5, 2010. These DAVPR tows were made at distances from 50 to 156 km to the SW of the DWH Wellhead. DAVPR1 comprised a single profile to a depth of 873m. DAVPR2 also was a single profile (to 1023m) and was launched at 2116 (28.3606N - 88.7513W) and recovered at 2257 (28.3230N -88.7870W). For DAVPR3-AOP1, the DAVPR was mounted on top of an Acoustic Optics system (owned by Dr. M. Sutor, LSU). The combined instrument package was towyoed simultaneously with underway (pole-mounted) pump sampling of surface plankton, thus comprising an acoustic-optics-pump (AOP) sampling system. This combined sampling was done on DAVPR tows 3, 5, 6, and 8. DAVPR3-AOP1 (Fig. 4) was a daytime tow at a ship speed of ~1m/s, towyoing between the surface and ~150-160m.

M/V HOS Davis 2 – The M/V *HOS Davis* was better outfitted for oceanographic sampling as it had recently been used for this purpose on the previous cruise (M/V *HOS Davis* 1). On the M/V *HOS Davis* 2 cruise, DAVPR sampling was done in collaboration with ROV/bottle sampling (by Chief Scientist, Dr. James Payne, Payne Environmental). Six successful DAVPR tows (2-7) were made during this cruise, from August 30 – September 2, 2010. For tows 3, 6, and 7, the DAVPR was mounted on CSA's SBE 9 CTD and deployed through the ship's starboard A-frame. Navigation data recorded to the CTD files were interpolated to the DAVPR data for these tows during post-processing. CSA's SBE 911plus CTD system was used to determine the DAVPR depth in real time during these tows. The ship maintained heading such that the wind was on the starboard bow and the ship drifted slowly in the wind at ~0.25m/s. The DAVPR system time was recorded in UTC (standard operating procedure), while the CSA CTD time was recorded in local time (Central Daylight Time, CDT), which was UTC-5 hours.

***R/V Walton Smith* 2 –** The R/V *Walton Smith* is a UNOLS vessel operated by the University of Miami and its captain and crew had extensive experience in oceanographic operations. The DAVPR was mounted on the ship's SBE 9 CTD, as was done on the *HOS Davis* cruise. Five DAVPR/CTD tows were made from 9/20 to 9/22. The cruise ended early (9/22) due to failure of the ship's starboard engine. Day/night sampling with the DAVPR/CTD was made on transects DAVPR-6 and DAVPR-5 and daytime sampling on DAVPR-4 near the wellhead. The DAVPR transects were towyos running across the continental slope. Transects DAVPR6, DAVPR5, and DAVPR4 were 200km, 135km, and 15km from the wellhead, respectively and were sampled in that order. The daytime DAVPR6 was a cross-slope towyo from 0-1200m.

M/V Arctic – During this winter cruise (January 14-24, 2011) DAVPR sampling was conducted on eight cross-slope towyo transects that spanned the slope region from west to east of the DWH wellhead. These transects were sampled during both day and night, in the chronological order from west to east. As in the prior cruises, the DAVPR was towyoed slowly (usually ~2 knots if possible) between the surface and 1200m. During this transect sampling, the DAVPR was recovered and redeployed every ~2h in order to change the battery.

DAVPR8 was farthest from the wellhead, and included a daytime towyo with 4 profiles and a nighttime towyo with 6 profiles. DAVPR7 was another paired day-night set of towyo transects from 0-1200m. Both towyos had 6 profiles, but data from the fifth profile of the nighttime towyo was corrupted. The DAVPR6 transect was sampled at the end of the cruise (January 24) and consisted of 3 daytime profiles and one nighttime profile. DAVPR5 day/night sampling included 4 and 6 profiles, respectively. DAVPR-S3 was sampled over the region occupied by the SIPPER imaging system the previous fall (2010) and the day/night sampling consisted of 3 and 5 profiles, respectively. DAVPR4 was closest to the wellhead and consisted of day/night transects with 6/4 profiles, respectively. DAVPR3 was NE of the wellhead and consisted of a day/night pair of cross-isobath towyo transects with of 7 and 5 profiles, respectively. DAVPR2 was ~100km ENE of the wellhead and included a pair of cross-isobath towyo transects. The day and night transects consisted of 5 profiles each. DAVPR1 was >100km ESE of the wellhead and included a pair of cross-isobath towyo transects. The day and night transects consisted of 6 profiles each.

In summary, the three cruises in August – September 2010 all sampled the area SW of the wellhead, while the January 2011 cruise (M/V *Arctic*) had broader sampling, covering regions west and east of the wellhead. The sampling depths were from the surface to 1200m, thus intersecting the fluorescent plume found by the Aquatracka fluorometer.

Description of VPRII on R/V Oceanus

The VPRII sampling on the R/V Oceanus included a gulf-wide survey that covered most of the shelf and slope between Tampa and Galveston (Fig. 2). The survey covered an along track distance of 3,048 nautical miles (5645 km) and included >3,500 vertical profiles. The VPRII collected over 10^7 ROIs together with environmental data (CTD, fluorescence, OBS, PAR). The survey encompassed such diverse areas as the loop current waters, Apalachicola and Mobile coastal waters, the nearfield of the DWH wellhead, the Mississippi outflow, and the Flower Gardens.

During towing operations, a fixed amount of cable was paid out and the VPRII undulated automatically between the surface and a specified depth, with a vertical ascent/decent rate of 0-1m/s. The maximum sampling depth of a given profile was within 20m of the bottom depth, unless an underwater obstruction was present on the navigation chart. In addition, the length of cable in the water was adjusted as needed to remain less than the bottom depth. When approaching the surface, at 30m depth, the VPRII automatically steered itself to the starboard side of the ship to remain out of the turbulent wake. These variables were monitored in the ship's lab during towing operations.

During post-cruise processing, data files for the plankton abundance, sizes, and biomass estimates were created, together with corresponding environmental data. The whole survey contained >250K data points at 4-6s intervals.

HIGHLIGHTS

- The DAVPR and VPRII sampling from August 2010 through March 2011 and post-processing yielded a large amount of data that on distributional patterns of plankton, particles, and hydrography.

SOCIETAL BENEFITS

The data obtained is being used together with historical and other data sets in an overall effort to assess environmental impact on the pelagic environment of the Gulf of Mexico.

EDUCATION AND OUTREACH ACTIVITIES

Example plankton images from the VPR were displayed on the WHOI website with a description of the overall work in the Gulf.

FIGURES

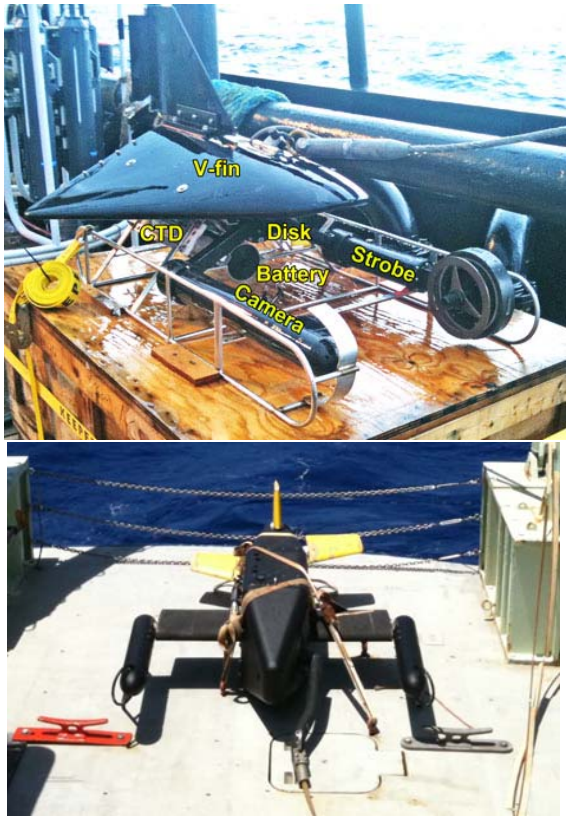
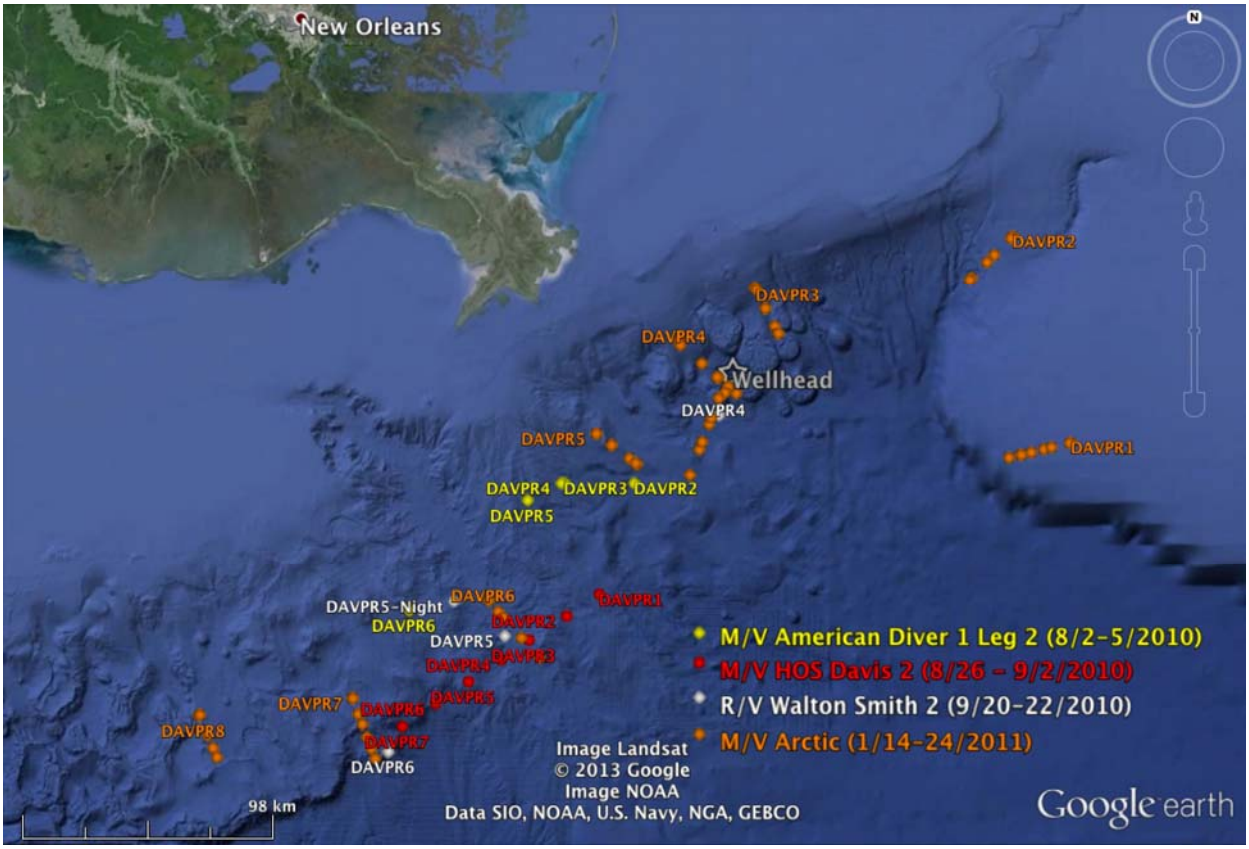


Fig. 1 (Top) DAVPR with major components labeled. (Bottom) VPRII on *Oceanus*



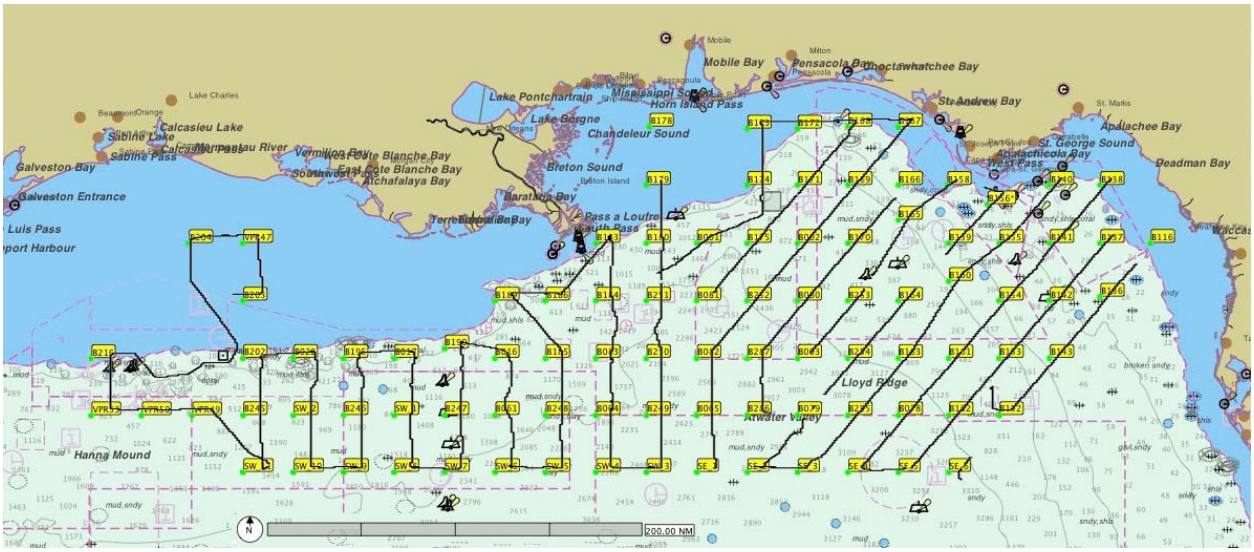


Fig 2. (Upper) Locations of DAVPR tows during 2010-2011. (Lower) Locations of VPRII data collection (black line) along survey lines through SEAMAP stations.

Evaluation of larval sources and population connectivity in the Atlantic sea scallop

NOAA Cooperative Agreement No. NA09OAR4320129
April 01, 2014-March 31, 2015

CINAR Investigator - Daphne Munroe - Rutgers

NOAA Sponsor - Dvora Hart - NMFS

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: IV. Protection and Restoration of Resources

PROJECT OVERVIEW

The Atlantic sea scallop (*Placopecten magellanicus*) fishery is the most valuable fishery in the U.S. This fishery has shown remarkable recovery from a severely overfished state in the early 1990s. One probable contributor to the recent recovery is the system of rotational fishery closures that have enhanced broodstock biomass and may have led to elevated downstream recruitment. Our overall project objective is to examine the linkage between increased broodstock abundance and potential for increased recruitment downstream.

During the 2014 project year, we implemented the scallop larval model within a circulation model of the Middle Atlantic Bight and Gulf of Maine based upon the Regional Ocean Modeling System (ROMS). This coupled bio-physical model has now been run for multiple years of larval dispersal simulations to assess general patterns of connectivity in the scallop stock and among closed areas, as well as to allow evaluation of interannual variability in dispersal patterns.

ACCOMPLISHMENTS

Bio-Physical Larval Dispersal Model
A ROMS domain has been created that includes the region of the federal scallop fishery, with the portions of the stock of interest in this study (Hudson Canyon South and Elephant Trunk) included. A larval model has been developed that simulates the growth and swimming for Atlantic Sea scallop (*Placopecten magellanicus*) larvae (as reported previously). This larval model was coupled with the physical model to generate patterns of connectivity in the federal Atlantic scallop stock. Larval release points in the model have been identified, with larval release density scaled relative to adult biomass estimated from annual stock assessments at that location. Biomass scaling has been conducted independently for each of the seven years from 2006 through 2012, and larval dispersal has been tracked for releases that span tidal cycles within each day, on 6 days within each month from May through October of each year (a total of 108 releases each year).

Preliminary analysis of these simulations has specifically examined annual variability in larval survival and growth, as well as trajectories of dispersal from areas of increased scallop biomass

that resulted from management actions (area closures). All simulations have been performed twice, once with the full suite of larval behavior active in the model, and again with larval behavior inactive. Comparison of the behavior and no-behavior simulations allows us to quantify the importance of larval swimming and sinking behavior on patterns of larval survival and connectivity. Specifically, with respect to rotational closures, larval dispersal out of a closed area was simulated before, during and after a closure (2006-2012). Results of these targeted hindcast simulations show that larvae dispersal out of the closed areas (1) has good connectivity to other parts of the fishery, (2) recapitulates observed patterns of high recruitment following closures and (3) may rely heavily on interaction of spawn timing and annually varying oceanographic conditions on the shelf. Larval dispersal patterns provide information pertinent to scallop management decisions such as frequency and duration of closures as well as the utility of extending rotational management to the rest of the Mid-Atlantic Bight. Further, information about sea scallop connectivity in the Mid-Atlantic will assist development of metapopulation stock-recruit models, rather than a simple whole stock dynamic pool relationship.

HIGHLIGHTS

- A bio-physical larval scallop model was developed that calculates larval dispersal and connectivity for Atlantic Sea scallops in the Mid Atlantic Bight.
- Connectivity patterns in the federal Sea scallop stock have been calculated for multiple years (2006 to 2012) and used to assess connectivity among rotating closed areas.
- Preliminary results demonstrate strong connectivity among rotating closed areas and recruitment elsewhere in the stock.
- Larval swimming behavior plays a strong role in successful dispersal of scallop larvae.
- Sea scallop larval dispersal distances on average are on the order of 100 km, but these distances vary seasonally and annually.

SOCIETAL BENEFITS

- This research will provide a greater understanding of population connectivity in an economically and ecologically important fishery along the Atlantic coast.
- Results of larval dispersal simulations will aid in the understanding of how rotating stock closures and fishery management of the Mid-Atlantic Bight Sea scallop stock is interacting with recent increases in stock biomass.

EDUCATION AND OUTREACH ACTIVITIES

- Munroe, D., Hart, D., Shank, B., Haidvogel, D., Powell, E., Klinck, J., and Hofmann, E. 2013. ‘The Role of Larval Sources and Population Connectivity in Rotating Closures in the Atlantic Sea scallop (*Placopecten magellanicus*) Fishery, MidAtlantic Council Meeting, Annapolis MD, Dec. 10 2013'.
- Munroe, D., Hart, D., Shank, B., Haidvogel, D., Powell, E, Klinck, J., Hofmann, E. 2014. The Role of Larval Sources and Population Connectivity in Rotating Closures in the Atlantic Sea scallop (*Placopecten magellanicus*) Fishery. Poster presentation, National Shellfisheries Association Annual Meeting, Jacksonville, FL, March 29-April2, 2014.

- Munroe, D., Hart, D., Shank, B., Haidvogel, D., Wang, Z., Powell, E., Klinck, J., Hofmann, E. 2014. The Role of Larval Dispersal from Rotating Closures in the Atlantic Sea scallop (*Placopecten magellanicus*) Fishery. Oral presentation. American Fishery Society Annual Meeting, Quebec City, August 18-22, 2014.
- Hart, D. 2015. Evaluation of larval sources and connectivity in Mid-Atlantic sea scallop populations. FATE Science Conference at the SWFSC, La Jolla, Jan 14, 2015.

Funding sector operations and dockside monitoring in fishing year 2011

NOAA Cooperative Agreement No.- NA09OAR4320129
April 01, 2014-March 31, 2015

CINAR Investigator - Jonathan Labaree – GMRI

NOAA Sponsors - Melissa Hooper and Barry Clifford - NMFS

Related NOAA Strategic Plan Goal: Resilient Coastal Communities and Economies

CINAR Theme: IV: Protection and Restoration of Resources

PROJECT OVERVIEW

The overall objective of the project is to assist New England's groundfish fleet during the transition to sector management. This new output-based approach replaces the effort controls for the vast majority of the fleet. The change, however, requires new organizations - sectors - and vastly increased level of catch monitoring. The project establishes GMRI as the administrator for federal support of the new management regime and assists the new sectors in start-up costs and dockside monitoring (third-party witnessing of the offload of fish from vessel to dealer).

Federal monitoring regulations governing the portion of New England's groundfish fleet enrolled in sectors changed in 2011 when dockside monitoring no longer became mandatory. In response, NOAA staff from the Northeast Regional Office requested that funds formally set aside to cover monitoring costs be redirected to fund the development of the groundfish sectors. Thus, the $600,000 in monitoring funds in this grant were reallocated to support sector operations.

In April of 2013, we received an extension and an amendment to the scope of work to utilize remaining project funds for convening meetings over the summer when it was anticipated that NMFS would be cost-sharing at-sea monitoring costs with the industry. Ultimately, our project managers at NOAA decided not to hold these meetings when it was announced that NMFS had funding to cover at-sea monitoring costs in Fishing Year 2014.
In Summer 2014, our NOAA project members amended the scope of work again to engage GMRI in the development of a cost analysis report comparing the costs of at-sea monitoring and electronic monitoring for both the groundfish and herring fleets. For this report, GMRI staff researched and drafted sections on: the costs of dockside monitoring; new and emerging technologies in electronic monitoring; and methods for distributing or disposing of unmarketable catch.

ACCOMPLISHMENTS

During the reporting period, GMRI staff conducted literature reviews and interviews with various individuals in the region and internationally to draft the following three sections in NOAA's report; *An Initial Cost Assessment of Potential Monitoring Programs in Northeast Fisheries*: *Dockside Monitoring and Port Sampling*; *Unmarketable Fish; and Current and*

Emerging Technologies. For the dockside monitoring section, we analyzed the cost data we have from providing the federal assistance funds to the sectors to cover the costs of dockside monitoring in fishing year (FY) 2010 and part of FY 2011. For the current and emerging technologies section, we researched existing reports and literature on the matter, as well as discussing technologies current under research and development with their principle investigators on the West Coast and in Alaska. For the unmarketable fish section, we developed a series of questions for phone interviews with groundfish and herring dealers and processors in New England as well as fishery policy representatives internationally in Norway, New Zealand, and England.

In addition to contributing to the report with original content, we also provided a stipend to the three existing EM providers in North America. The stipend enabled these companies to allocate staff time to prepare costs estimates and descriptions based on the EM models NMFS developed for groundfish and herring. We subcontracted with these companies, and coordinated with the NMFS project manager, Melissa Hooper, and now Barry Clifford, to receive and review drafts and final versions of the estimates from each provider. The final report will help the industry, regulators and Council members understand the costs and benefits of ASM and EM for two major fisheries in the region. Previously, the only existing document comparing these costs was focused at the national level, with only short case study sections for New England.

HIGHLIGHTS

- Subcontracted with and distributed $4,000 to each of the three EM providers in North America as a stipend for them to develop costs estimates for EM systems based on the NMFS EM models for groundfish and herring.
- Researched and drafted three sections of the NMFS cost comparison report. (At present, the final completed report was in final NMFS internal review.)
- Coordinated with NMFS and the EM providers around confidentiality and the release of the report.

SOCIETAL BENEFITS

The Greater Atlantic Regional Office has announced that Electronic Monitoring will be implemented in the region in May 2017. To date, there have not been any estimates of the true costs of electronic monitoring, in comparison with the current costs of the at-sea monitoring program. Following the *Northeast Regional Workshop on Electronic Monitoring*, held in Portsmouth, NH in May 2014, NMFS followed through with an outcome from this workshop to develop such a cost estimate report. This report uses the best available information to design an EM model for both the groundfish and herring fisheries, to start the conversation in the region around the costs and benefits of each monitoring system.

EDUCATION AND OUTREACH ACTIVITIES

The report entitled, *An Initial Cost Assessment of Potential Monitoring Programs in Northeast Fisheries,* will be released to the public in spring 2015, and ideally will be presented to the Northeast Fisheries Management Council during their April 2015 meeting.

THEME V. SUSTAINED OCEAN OBSERVATIONS AND CLIMATE

CINAR

Cooperative Institute for the North Atlantic Region

An eye in the ocean: Exploration of high-resolution vertical distributions of plankton and particles and coincident hydrography in the Western Chuckchi sea – data synthesis

NOAA Cooperative Agreement No. NA09OAR4320129

April 01, 2014-March 31, 2015

CINAR Investigator – Carin Ashjian - WHOI

NOAA Sponsor – Kathleen Crane - OAR

Related NOAA Strategic Plan Goal: Climate Adaptation and Mitigation

CINAR Theme: V: Sustained Ocean Observations and Climate

PROJECT OVERVIEW

The overall goal of the proposed work is to describe the high-resolution vertical distributions of zooplankton and particles over a range of spatial and temporal scales. Video Plankton Recorder Surveys were conducted in 2009 and 2012 as part of the Russian-American Long-Term Census of the Arctic (RUSALCA) interdisciplinary cruises. Both a broad-scale survey of the different water masses and regions of the Chukchi Sea and a high-resolution survey of Herald Valley were conducted to obtain the high-resolution distribution of plankton/particles and coincident hydrography and to describe physical-biological interactions in Herald Valley. The VPR data from the three RUSALCA interdisciplinary cruises (2004, 2009, 2012) will be compared to determine interannual variability and to understand if climate change is modifying the ecosystem. For this year, the main goal was to finish the data processing and start data synthesis.

ACCOMPLISHMENTS

During the past year progress has been made on the synthesis effort led by M. Pisareva and R. Pickart. The paper will include data collected using the VPR in Herald Canyon in 2009.

HIGHLIGHTS

- The vertical distributions of copepods and diatoms and marine snow particles were closely associated with the vertical structure of the water column and with different water mass types (Figure 1).
- Herald Canyon was very dynamic, with multiple water masses and complex velocity patterns. Plankton and particles were spatially heterogeneous. Along- or cross-canyon flux of plankton and particles in this region revealed that most types were primarily advected to the north while on the western side of the canyon substantial flux of algal mats was observed. (Figure 2)
- The VPR was an effective means to obtain high-resolution vertical distributions of plankton and particles that can be coupled to hydrography and to velocity in achieving a

better understanding of the complex interaction between biology and physics that structures this ecosystem.

SOCIETAL BENEFITS

Predicting the impact of climate on ecosystems requires an understanding of the important components and interactions in the ecosystem, both to identify change and to develop a predictive modeling capability for the ecosystem. Such information can ultimately be used to help us better conserve Arctic ecosystems and, in the future, potentially manage Arctic fisheries. Information on the high-resolution distributions of plankton in association with hydrography and currents can enhance our understanding of the ecosystem and contribute ultimately to better modeling of the system.

FIGURES

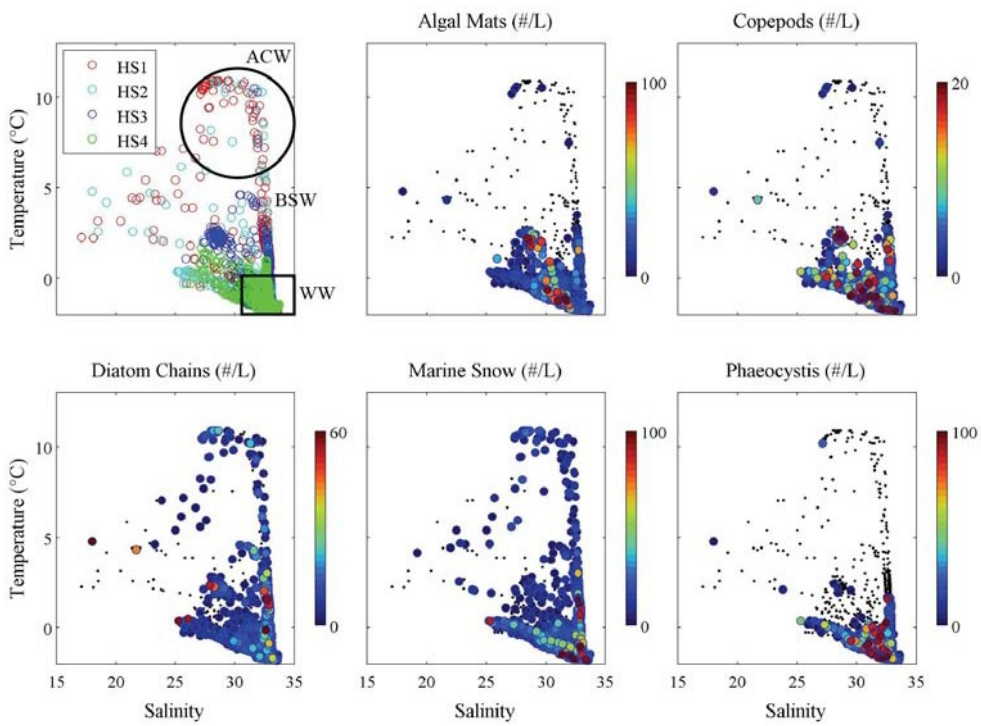


Figure 1. Temperature-salinity-plankton diagrams for Herald Canyon in August 2004. Upper left panel shows the TS for all of the tows with the different transects indicated in different colors and dominant water types indicated. The remaining panels shows TSP plots for dominant plankton/particles. Strong affinities of some types to different water masses were seen. In particular, algal mats, phaeocystis, and copepods were in highest abundance in the upper water column, above the cold, salty remnant Winter Water (WW). Marine snow and diatom chains were found in all water mass types, including the warm Alaska Coastal Water (ACW) seen primarily on transects HS1 and HS2 and in the Bering Sea Water (BSW).

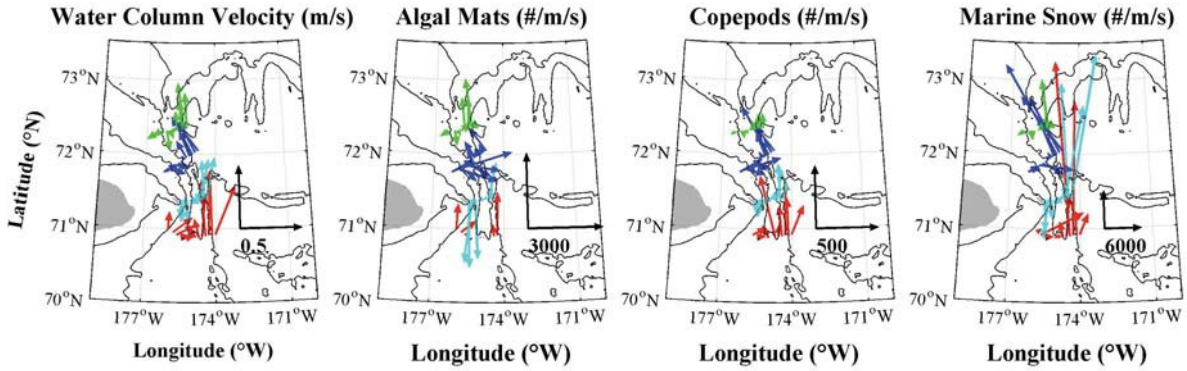


Figure 2. Mean water column velocity (m/sec) and the mean water column flux (#/m/sec) of algal mats, copepods, and marine snow through Herald Canyon in the western Chukchi Sea in August 2004. Flux was calculated by combining the water column abundance of plankton or particles with the mean water column velocity. Concentration data for plankton and particles measured using the Video Plankton Recorder. High flux results from high velocities and/or from high abundances of the target particle or plankton. Note the high southward flux of algal mats in the western side of the Canyon on the two middle lines (blue and cyan). High abundances of algal mats in those regions relative to other locations resulted in a high flux. By contrast, flux of copepods was much less on the western side of the Canyon because fewer copepods were present there.

R/V Knorr use in support of NOAA/PMEL WACS II research cruise

NOAA Cooperative Agreement No. NA09OAR4320129

April 01, 2014-March 31, 2015

CINAR Investigator – Albert Suchy

NOAA Sponsor – Thomas Peltzer, OAR

Related NOAA Strategic Plan Goal: Climate Adaptation and Mitigation

CINAR Theme: V: Sustained Ocean Observations and Climate

PROJECT OVERVIEW

The Woods Hole Oceanographic Institution provided the R/V Knorr with two SSSG Technicians for Patricia Quinn to characterize the chemical and meteorological processes that transform aerosols and their precursor gases and lead to perturbations to the region's radiation budget. Data is being used to improve simulations of radiative forcing of climate by ocean and continentally-derived aerosols with a particular emphasis on African dust; characterize the emission, properties, and cloud nucleating ability of sea spray aerosol over a range of ocean conditions; and provide scientific information to support effective policy decisions.

Sea spray aerosol (SSA) impacts the Earth's radiation budget indirectly by altering cloud properties including albedo, lifetime, and extent, and directly by scattering solar radiation. The overarching scientific objective of WACSII characterizes the properties of SSA in its freshly emitted state to improve model calculations of the climate impacts of SSA. In addition, simultaneous measurements of surface seawater were made to assess the impact of ocean properties on SSA.

ACCOMPLISHMENTS

The UNOLS vessel Knorr went to sea in May 2014 and deployed the SEA SWEEP unit which is a sea spray aerosol generator. Atmospheric samples were successfully taken. Accomplishments included:

- Vans for sampling operations were successfully established on the bow of Knorr
- Multiple deployments and recoveries with samples from in situ sea spray particle generator
- CTD sampling of seawater at several depths were performed to assess which portion(s) of the seawater carbon pool impacts the composition of SSA.
- Atmospheric sampling was conducted continuously while the ship was in transit between Sea Sweep working areas.
- Measurements were made in both high and low chlorophyll waters and relevant surface seawater parameters were measured in situ.

HIGHLIGHTS

- The highlight of this CINAR sponsored voyage was being able to successfully assess how ocean biogeochemistry impacts sea spray particles.

SOCIETAL BENEFITS

Characterization of the properties of Sea Spray Aerosol, in its freshly emitted state, will provide an accurate model for calculations of climate impacts.

EDUCATION AND OUTREACH ACTIVITIES

The data/information sharing plan was made publicly available and posted with the published data. Scientific posters, brochures, booklets, and written materials were created for public outreach and education by the science investigators.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

Knorr Mobilized at WHOI for Voyage

SEA SWEEP Sea Spray aerosol generator

Deployment of SEA SWEEP Sea spray aerosol generator.

R/V Knorr Cruise Track 2014 CINAR VOYAGE

Ocean Reference Stations

NOAA Cooperative Agreement No. NA09OAR4320129

April 01, 2014-March 31, 2015

CINAR Investigators – Robert Weller and Albert Plueddemann

NOAA Sponsor – Diane Stanitski - OAR

Related NOAA Strategic Plan Goal: Climate Adaptation and Mitigation

CINAR Theme: V: Sustained Ocean Observations and Climate

PROJECT OVERVIEW

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 are the Stratus ORS, the NTAS (Northwest Tropical Atlantic Station) ORS, and the WHOTS (WHOI Hawaii Ocean Timeseries Site) ORS. Together, the three sites form a comprehensive array by sampling distinct branches of the trade wind regime while focusing on specific regional processes.
In FY2014, the WHOI Ocean Reference Station project carried out cruises to the three sites to recover moorings that had been in service for a year or more and deploy new moorings. NTAS was serviced by the NOAA ship RH Brown in October 2013. Stratus was serviced by the NOAA ship RH Brown during a February and March 2014 cruise. WHOTS was recovered and redeployed in July, 2014 on the NOAA Ship Hi'ialakai. Each cruise resulted in the collection of the internally recorded data on the instrumentation on the buoy and the mooring line and supporting data sets from the ships, such as meteorological data for comparison with the buoy meteorological data. From the deployment of a new buoy onward, the surface meteorological data are available in near-real time, with hourly averages typically telemetered via Service Argos. The WHOI Ocean Reference Station data are not placed on GTS; instead they are used as independent data for validation of models by users such as ECMWF (European Centre for Medium Range Weather Forecasts) and NCEP (National Centers for Environmental Prediction) and for quantification of error in fields such as the surface fluxes by investigators working in coordination with the CLIVAR Global Synthesis and Observations Panel (GSOP).

ACCOMPLISHMENTS

The basic deliverables from the ORS are the high quality data, supported by the documentation of the methods. The directly observed data fall into three main categories: 1) Surface meteorology and air-sea fluxes. The surface wind speed and direction, air temperature, relative humidity, barometric pressure, incoming shortwave radiation, incoming longwave radiation, and rain rate are measured at a once per minute rate. Logged at the same time are buoy bridle temperature and salinity; 2) Surface oceanographic data; 3) Ocean observations of temperature, salinity, and velocity along the mooring line; Stratus has recently added dissolved oxygen

measurements. The surface meteorology, surface temperature, and surface current are used with the bulk formulae to compute a fourth product: 4) Air-sea fluxes of heat, freshwater, and momentum; 5) Deep T and S - All of the ORS moorings include additional sensors to obtain deep ocean temperature and salinity. Ancillary observations by cooperating investigators add: 6) surface wave data by NDBC at Stratus and NTAS; 7) pCO_2 by NOAA PMEL at Stratus and WHOTS; 8) dissolved oxygen observations at Stratus by Lothar Stramma from Kiel, Germany; and 9) in the water radiance observations at WHOTS by Sam Laney of WHOI. Surface meteorology is available in real time and the remaining data follow in delayed mode.

The surface moorings have proven to be a very effective methodology. The WHOTS mooring has been on station 100%. Stratus and NTAS have provided 94% and 95% of the planned station time. This is a very important statistic, as record length is a key determinant of statistical significance in examining trends. Our methodology of deploying meteorological instrumentation with sufficient redundancy to ensure close to 100% return of high quality surface meteorological and air-sea flux time series has been particularly effective.

The ORS in particular address the following ocean observing system program deliverables:
• **Sea surface temperature and surface currents**. The ORS surface buoys have been instrumented to give improved sea surface temperature observations. Because they sample surface and near-surface ocean temperature and because they have collocated, high quality air-sea fluxes, ORS data sets are sought by investigators working on diurnal warm layer dynamics and remote sensing of SST.
• **Ocean heat content and transport.** The ORS buoys are equipped with temperature, salinity, and velocity sensors from the upper thermocline to the surface (at Stratus, these go deeper, to 1,800 m). As a result, the temporal evolution of the mixed layer and its heat storage can be tracked as well as the heat content of the upper ocean.
• **Air-Sea Exchanges of Heat Momentum and Freshwater.** The ORS are equipped to make state of the art, sustained air-sea flux observations, providing the air-sea exchanges of heat, freshwater and momentum. The ORS surface meteorological and air-sea flux data, uniquely, are both high quality and withheld from real-time assimilation into weather and climate models.
• **Ocean Carbon Uptake and Content**. Collaboration with Chris Sabine at NOAA PMEL has added pCO_2 observations to Stratus and WHOTS.

HIGHLIGHTS

• Eastern South Pacific Heat and Salt Budgets. The longer Stratus record now available allowed Holte et al. (2014) to re-examine the heat and salt budgets of the upper ocean in the Stratus region and improve upon the earlier work by Colbo and Weller (2007). In this work the data from Argo floats in the region are included in the synthesis (Figure 1). The major new finding is that horizontal advection plays the major role in cooling and freshening the upper ocean. This greatly improves the understanding of the dynamics of the region and provides a basis for validation/verification of ocean models.
•Variabilty and Trends. Weller (2014) reports finding long-term trends in surface meteorology and air-sea fluxes at the Stratus ORS. Using the first ten years of Stratus data, which provide nine full calendar years, statistically significant trends were found in wind speed, wind stress, latent heat flux, and het heat flux. Increases in wind speed, wind stress, and latent heat flux over

nine years were 0.8 m s^{-1}, 0.022 N m^{-2}, and 20 W m^{-2} or 13, 29, and 20% of the respective nine-year means. The decrease in the annual mean net heat flux was 39 W m^{-2} or 104% of the mean.

•Hawaii Region Hydrological Cycle. Our partnership with the University of Hawaii (R. Lukas with NSF funding) has provide key insights in the regional hydrological cycle. Recent work by Lukas points to several processes acting to control the local ocean state, including changes in the balance between surface rainfall and evaporation and transports by eddies of masses of water from distant locations. Salinity in the mixed layer is increasing in association with a negative freshwater flux (loss of freshwater from the ocean) while temperature is decreasing, resulting in a density increase that is statistically significant over the first 8 years of the WHOTS record. Comparisons with global models show that the WHOTS observations are regionally representative, yet the models do not necessarily show seasonal to decadal variability in surface fluxes consistent with those of the observations.

• Atlantic Trade Wind Region Dynamics. The NTAS ORS is in a region where the mechanisms controlling SST and upper ocean heat content are of interest. A decade of data (2001-2011) allows a typical year to be characterized from observations. The seasonal cycle dominates the net heat flux, with the migration of the ITCZ modulating cloud cover and rainfall. Interannual variability is evident in the minimum and maximum seasonal values as well as the timing of seasonal transitions. The extent to which NWP forecasts and reanalyses reproduce the amplitude and timing of the annual cycle and seasonal transitions is being evaluated. NTAS is a region where interaction between wind, evaporation and SST are important, and there is interest in the role of advective cooling during periods of wind relaxation when evaporative cooling is reduced and thus there is a tendency for local SST increase (without advection).

SOCIETAL BENEFITS

The ORS results are particularly significant in two areas: 1) Providing benchmarks to validate and improve climate and weather models and 2) Quantifying the processes at work to maintain the state of the upper ocean. The ability of society to prepare for and mitigate weather and climate variability depends heavily on the accuracy of models, and the withheld, high quality time series from the ORS are a key asset in the effort to improve models. The ORS data are also of high value in building an improved understanding of the role of the ocean in the earth system.

EDUCATION AND OUTREACH ACTIVITIES

Whenever possible, ORS cruise involve NOAA Teachers at Sea, undergraduate and graduate students.

"Sustained Observations of Air-Sea Fluxes and Air-Sea Interaction at the Stratus Ocean Reference Station" – EGU, Vienna – May 2014

"A ten-year look at the trade wind regime off Northern Chile" – invited talk, Oregon State Univ, Corvallis – May 2014

“In-Situ Observations of Air-Sea Interaction in the South East Pacific”, AMS annual meeting, January 2015, Phoenix AZ.

PUBLICATIONS

Mechoso, C. R., R. Wood, R. Weller, C. S. Bretherton, A. D. Clarke, H. Coe, C. Fairall, J. T. Farrar, G. Feingold, R. Garreaud, C. Grados, J. McWilliams, S. P. de Szoeke, S. E. Yuter, and P. Zuidema, 2014. Ocean-Cloud-Atmosphere-Land Interactions in the Southeastern Pacific: The VOCALS Program. *Bull. Amer. Meteor. Soc.*, **95**, 357–375. doi: http://dx.doi.org/10.1175/BAMS-D-11-00246.1

Stramma, L., Weller, R. A., Czeschel, R. and Bigorre, S., 2014: Eddies and an extreme water mass anomaly observed in the eastern south Pacific at the Stratus mooring. Journal of Geophysical Research - Oceans, 119 (2). pp. 1068-1083. DOI 10.1002/2013JC009470.
Weller, R. A., S. Majumder, and A. Tandon, 2014. Diurnal restratification events in the Southeast Pacific trade wind regime. *J. Phys. Oceanogr.*,44, 2569–2587.

Holte, J., Straneo, F., Farrar, J. T., and R.A. Weller, 2014. Combining mooring and Argo data to estimate a heat budget for the southeast Pacific. *J. Geophys. Res.*,119, 11, pages 8162–8176
Czeschel, R., L. Stramma, R.A. Weller, and T. Fischer, 2014. Circulation, eddies, oxygen and nutrient changes in the eastern tropical South Pacific Ocean. *Ocean Sciences Discussion,* 11, 2205-2243

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS:

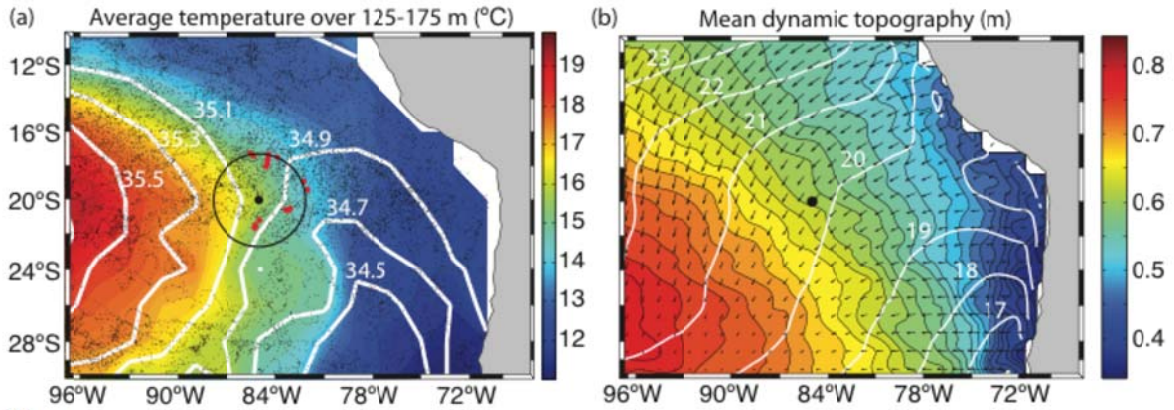


Figure 1. From Holte et al. (2014), panel a shows the Stratus ORS site at 20°S, 85°W and the small black dots are 12,628 Argo float profiles used to map the temperature (color) and salinity (white contours) fields in the region. Panel b shows the Ekman transport (arrows), mean SST contours (white), and dynamic topography (color).

THEME VI. EDUCATION AND OUTREACH

CINAR

Cooperative Institute for the North Atlantic Region

U.S. National Office for Harmful Algal Blooms

NOAA Cooperative Agreement No.- NA09OAR43201529
April 01, 2014-March 31, 2015

CINAR Investigator - Donald M. Anderson - WHOI

NOAA Sponsor - Quay Dortch - NOS

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR 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 receives between 6,500 and 7,500 visits each 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 post approximately 2-3 announcements per week to our Harmful Algae Facebook account for the National Office – typically these are links to harmful bloom events in the US. We have received positive response from the community about this effort with 604 "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 (WGHABD):

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). At the 2015 WGHABD meeting, PI Anderson presented a US summary of events for 2014.

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: *Karenia* event, Florida; cyanoHABs, Toledo; loggerhead sea turtles (*Karenia*), Florida; and mapping of a *Karenia* bloom, Florida.

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 16th International HAB Conference, Korea, the Eighth US HAB symposium, California, and an International Conference on HABs and Desalination in Oman.

US HAB symposia. Kleindinst served on the Steering Committees for the *Eighth Symposium on Harmful Algae in the U.S.,* to be held November, 2015 in Long Beach, CA. She is working closely with the organizers to plan the meeting and communicate updates and announcements to the U.S. HAB community. The National Office will also solicit and process travel awards for students and managers for the HAB symposium.

International HAB Conferences. Anderson served on the Steering Committee for the *16th International Conference on Harmful Algal Blooms* which was held in New Zealand, October 2014. The National Office handled travel reimbursements for nine students receiving support to attend the meeting.

International Conference on HABs and Desalination. This conference took place in April 2014 in Muscat, Oman. PI Anderson served as co-Chair of the meeting, helping to secure funding, plan the scientific program, invite speakers, review and make decisions on presentations, etc. He also gave a plenary talk on HABs.

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. Kleindinst provides administrative support to this group and both she and Anderson serve as *ex officio* members. Kleindinst 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.

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., Plenary, "Harmful algal blooms", International Conference on Harmful Algal Blooms and Desalination, Muscat, Oman (April, 2014)
- Anderson, D.M., US Summary of HAB Events – 2014, ICES WGHABD, Lisbon, Portugal, April, 2015)
- Harmful algae website – http://www.whoi.edu/redtide
- National HAB Committee Web Site: www.whoi.edu/nationalhab/
- Northeast PSP website - http://www.whoi.edu/northeastpsp/

PUBLICATIONS

Anderson, D.M. HABs in a changing world: a perspective on harmful algal blooms, their impacts, and research and management in a dynamic era of climactic and environmental change. 2014. In: Kim, H.G., B. Reguera, G. Hallegraeff, C.K Lee, M.S. Han and J.K Choi. (Eds). *Harmful Algae 2012, Proceedings of the 15th International Conference on Harmful Algae.* International Society for the Study of Harmful Algae pp. 3-25.

Marine Resources Education Program: Northeast Region

NOAA Cooperative Agreement No.- NA09OAR43201529
April 01, 2014-March 31, 2015

CINAR Investigator – Alexa Dayton - GMRI

NOAA Sponsor – John Hoey - NMFS

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: VI. Education and Outreach

Related NOAA Strategic Plan Goal Plan: Healthy Oceans

CINAR Theme: VI. Education and Outreach

PROJECT OVERVIEW

For the period April 1, 2014 to March 30, 2015 the MREP Implementation Team proposed to carry out five initiatives:

- Deliver one MREP Science 100 module and one MREP Management 100 module in a Mid-Atlantic location;
- Deliver a MREP 200 *Insights into Stock Assessments* for New England and Mid-Atlantic fishermen;
- Convene a taskforce of select fishery leaders, NMFS, MAFMC, NEFMC and institutional partners to design a long-term governance structure appropriate to a permanent regional program and a strategy for transition;
- Develop a new MREP 200 module, focused on Ecosystem-based management, to be offered to MREP graduates; and
- Perform active outreach in building a fishing community network to support MREP training and recruiting throughout the Northeast Region, and seek opportunities to expand the program training reach to more fishermen at less cost.

We further proposed that program delivery will be evaluated along established protocols, with continuing development of instruments to track program relevance. Testimonials and other feedback have been captured both in writing and with photography.

ACCOMPLISHMENTS

We delivered the following workshops as outlined in our proposed scope of work:
October 27 - 28, 2014 MREP 200 Science – 2 Days, Woods Hole, MA
Jan 13 – 15, 2015 MREP 100 Science workshop – 3 Days**,** Warwick, RI
March 10 -12 MREP 100 Management – 3 Days**,** Warwick, RI
Following informal consultation with community members in the growing MREP network, the Implementation Team determined that greatest demand currently is from a spectrum of fisheries

operating primarily in Southern New England and the Mid-Atlantic Bight, and the MREP 200 Insights into the stock assessment workshop continues to be highly relevant.

The team hosted the MREP 200 workshop in Woods Hole, MA with a tour of the Bigelow at her berth in Newport, RI. Gloucester, MA fishermen, who have been highly articulate about voicing their ongoing concerns over stock assessments for Gulf of Maine cod, remarked on the extraordinary access they had to leading scientists who addressed their issues in a straightforward manner. The culmination of the two-day workshop came during a tour of the NOAA fishing gear warehouse, when tribal leader Sam Novello had opportunity to talk with the Bigelow gear technicians and examine the trawl survey net and ground gear. "It's good," said Sam kicking the sweep. Others in the party agreed. Since this workshop, continued interaction with the industry on the topic of stock assessments continues to reveal lack of trust n the outcome, but coupled with a degree of respect for NOAA fisheries, and appreciation for the survey sampling branch. Industry has focused on the spatial and temporal coverage of the Bigelow and fishery independent surveys, and suggested that more sampling is needed to understand impacts associated with changing climate.

Fishermen in the Southern New England area very often are targeting a mix of species, some of which are managed by the Mid-Atlantic Fishery Management Council, some by the New England Council. The decision was to locate the 2015 Science 100 and Management 100 modules in Warwick, RI, within easy driving distance of New Bedford and Montauk, and a short flight from Baltimore and Philadelphia. Though the roster of participants for both modules contained attendees from across the eleven-state Northeast Region, the majority hailed from ports in New Jersey, New York, Rhode Island and New Bedford, MA. This new mix of interests challenged us to reevaluate the modules' curricula content, to add species managed by both Councils, and to recruit science and management presenters from both New England and "The Mid". An additional twist is the growing participation of recreational fishermen, primarily from the for-hire fisheries between Rhode Island to New Jersey.

To encourage this emerging recreational sector participation we enlisted charter boat captain Rick Bellavance to moderate the Science 100 module, added a component on near-shore ecosystems, expanded a presentation from ASMFC staff and added a discussion of monitoring and data-collection issues in management of Black Sea Bass.

The Super Fish Case Study continues as a highlight of the Management Module, with improvements coming with each iteration; this year's exercise employed staff members from both Fishery Management Councils serving as advisors on process as participants negotiated a hypothetical resource allocation. To accommodate the larger numbers, the class was divided into two separate negotiations, with additional roles assigned. Individuals were given detailed instructions on their unique negotiation parameters, and people with similar assignments were allowed to caucus in advance to explore and share options for pursuing their assigned objectives. Individual role instructions have been further refined based on input from previous Case Study exercises. Participants demonstrated an enthusiastic response to the case study and the post-negotiation discussion of "lessons learned" was animated, with participants, Councils' staff and NMFS professionals sharing experiences.

A new Science 200 curriculum on marine ecosystems and fishery productivity is under development by the Implementation Team. Initial conversations with NMFS personnel in Sandy Hook, Narragansett and Woods Hole have yielded an outline of possible topics; curriculum discussions are continuing with key agency personnel and others in the greater community exploring ecosystem-based management principles. A central challenge is to identify ways to make this, as much as possible, a hands-on learning experience.

HIGHLIGHTS

In the 2014-2015 presentation cycle, MREP made substantial progress in three areas:

- Expanded our network structure to incorporate new and underserved communities;
- Integrated workshop recruiting, delivery and curricula to attract fishermen across the Mid-Atlantic and New England regions; and
- Adapted module delivery to allow larger, more diverse classes, reaching more fishermen.
  - Delivered 3 workshops total, attracting 54 total unique participants.
  - Expanded speaker's bureau and program content to meet evolving industry needs and increased geographic breadth.

SOCIETAL BENEFITS

- MREP workshops provide a foundation for improved trust in the Fishery Management process.
- MREP has prepared industry members for meaningful engagement as articulated and envisioned by Magnusson Stevens Act.
- MREP has provided a critical platform for dialog around Gulf of Maine stock assessment.

EDUCATION AND OUTREACH ACTIVITIES

Building on our experience with a condensed "introductory" MREP workshop delivered in 2014 in ports of Gloucester and Chatham, we made it a priority to recruit participation of Cape Ann fishermen for the advanced MREP 200, Insights into Stock Assessments, offered in Woods Hole in October 2014. Recruiting participants was a coordinated effort by NESSN, the Northeast Seafood Coalition and Gloucester Fishermen's Wives resulting in eight prominent figures from the Gloucester waterfront attending.

We further leveraged the MREP alumni networks and proactively approached several key figures in the mid Atlantic and southern New England areas to assist with targeted recruiting. The turning point for recruiting participants from the recreational sector for the MREP 100 workshops came during a Mid-Atlantic Fishery Management Council regulatory action on Black Sea Bass in November. Attending were party boat owners (whose clientele target the species) including MREP alumni Monty Hawkins and Skip Feller. Over lunch with a dozen of their colleagues at the table, Skip described the MREP curriculum to his fellow captains and invited a short presentation from the MREP Team. Skip and Monty then followed up in recruiting efforts.

Roster size for the three modules in this cycle ranged from 22 to 28, up from a typical 18-person class size in past modules. We believe the new approach to networking into new areas of the

industry have huge merit, and have a revealed a significant and untapped audience for the MREP program, further deepening our impact.

FIGURES/PHOTOGRAPHS/ ILLUSTRATIONS

DRINK WHAT ALES YOU.

APPENDIX 1: CINAR Personnel Summary:

April 1, 2014– March 31, 2015

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	Ecosystem Monitoring	Fall 2010 (18 Month appt.)	Simon Thorold Carin Ashjian
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	Sustained Ocean Observations and Climate	Fall 2012 (18 Month appt.)	Glen Gawarkiewicz Steven Lentz
Dr. Sarah Bender University of Washington	Ecosystem Monitoring	Fall 2013 (18 Month appt.)	Max Saito
Dr. Andrew Jones		Fall 2014 (18 Month appt.)	Joel Llopiz

APPENDIX 2 : CINAR Personnel Summary Chart :

April 1, 2013 – March 31, 2014

Category	Number	B.S	M.S	PhD.
Employees who 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	10	5	5	0
Administrative	0	0	0	0
Total	14	6	6	2

Category	Number	B.S	M.S	PhD.
Employees who receive < 50% NOAA Funding (not including Students)				
Research Scientist	38	4	9	25
Visiting Scientist	1	0	0	1
Post Doctoral Fellow	1	0	0	1
Research Support Staff	45	24	16	5
Administrative	14	7	1	0
Total	99	35	26	32

Students	-	-	-	-
Undergraduate Students	5	0	0	0
Graduate Students	4	0	2	2
Total	9	0	2	2

Obtained NOAA employment within the last year	0	0	0	0

APPENDIX 3: CINAR Publications for Reporting Period:

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
CI Lead Author	1 PR 2 NPR	12 PR 2 NPR	11 PR 0 NPR	19 PR 2 NPR	21 PR 12 NPR	8 PR 3 NPR
NOAA Lead Author	0 PR 2 NPR	0 PR 0 NPR	5 PR 0 NPR	1 PR 1 NPR	3 PR 0 NPR	0 PR 0 NPR
Other Lead Author	0 PR 0 NPR	30 PR 1 NPR	7 PR 1 NPR	31 PR 3 NPR	6 PR 0 NPR	3 PR 0 NPR

*PR = Peer Reviewed
NPR = Non-Peer Reviewed

Anderson, D.M. HABs in a changing world: a perspective on harmful algal blooms, their impacts, and research and management in a dynamic era of climactic and environmental change. 2014. In: Kim, H.G., B. Reguera, G. Hallegraeff, C.K Lee, M.S. Han and J.K Choi. (Eds). *Harmful Algae 2012, Proceedings of the 15th International Conference on Harmful Algae.* International Society for the Study of Harmful Algae pp. 3-25.

Baumgartner, M.F., T. Hammar, and J. Robbins. 2015. Development and assessment of a new dermal attachment for short-term tagging studies of baleen whales. Methods in Ecology and Evolution 6: 289-297.

Czeschel, R., L. Stramma, R.A. Weller, and T. Fischer, 2014. Circulation, eddies, oxygen and nutrient changes in the eastern tropical South Pacific Ocean. *Ocean Sciences Discussion,* 11, 2205-2243.

Hoagland P., Dalton TM, Jin D, Dwyer J. 2015. An approach for assessing the spatial welfare and distributional effects of siting wind energy in the ocean: the Rhode Island / Massachusetts "Area of Mutual Interest". Marine Policy 58: 51-59. DOI: 10.1016/j.marpol.2015.04.010

Hoagland P, Jin D, Dalton T, Dwyer J. 2014. Coastal and marine spatial planning in the context of ecosystem-based fisheries management: assessing tradeoffs between wind farms and marine fisheries in New England. Proc. IIFET 2014. Brisbane, Queensland (11 July)

Holte, J., Straneo, F., Farrar, J. T., and R.A. Weller, 2014. Combining mooring and Argo data to estimate a heat budget for the southeast Pacific. *J. Geophys. Res.,*119, 11, pages 8162–8176

Jin D, DePiper G, Hoagland P. 2014. An empirical analysis of portfolio management as a tool for implementing ecosystem-based fishery management. Proc. IIFET 2014. Brisbane, Queensland (10 July)

Jin D, Hoagland P. 2015. Linking regional economic and food web models fro ecosystem-based management. Proc. American Fisheries Society 145th Annual Meeting (August 16-20).

Olson J, St. Martin K. 2015. Visualizing, linking, and scaling up community: why mapping communities at sea matters to fisheries management. Submitted to *Fisheries*.

St. Martin K, Olson J. 2015. Enacting community in marine ecosystem-based management: on re-reading data, counter-modeling, and reassembling assemblages. Submitted to *Society and Space*.

Honig, P., A.D. York, and S.M. Gallager. Automated Optical Identification of Marine Substrate. Submitted J. Oceanography.

Mechoso, C. R., R. Wood, R. Weller, C. S. Bretherton, A. D. Clarke, H. Coe, C. Fairall, J. T. Farrar, G. Feingold, R. Garreaud, C. Grados, J. McWilliams, S. P. de Szoeke, S. E. Yuter, and P. Zuidema, 2014. Ocean-Cloud-Atmosphere-Land Interactions in the Southeastern Pacific: The VOCALS Program. Bull. Amer. Meteor. Soc., 95, 357–375. doi: http://dx.doi.org/10.1175/BAMS-D-11-00246.1

Stramma, L., Weller, R. A., Czeschel, R. and Bigorre, S., 2014: Eddies and an extreme water mass anomaly observed in the eastern south Pacific at the Stratus mooring. Journal of Geophysical Research - Oceans, 119 (2). pp. 1068-1083. DOI 10.1002/2013JC009470.

Weller, R. A., S. Majumder, and A. Tandon, 2014. Diurnal restratification events in the Southeast Pacific trade wind regime. *J. Phys. Oceanogr.*,44, 2569–2587.