



Annual Progress Report

April 01, 2016- June 30, 2016

Donald M. Anderson, Director

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CINAR
Annual Progress Report

Reporting Period: April 01, 2016 - June 30, 2016

Submitted by:

Donald M. Anderson, Director

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Dr. Donald M. Anderson, *CINAR Director*

September 26, 2016

The enclosed report closes out CINAR's first award, which commenced on July 1, 2009. This final report includes technical and research activities associated with funded projects still active during the last three months of the award period (April 1 - June 30, 2016), and also provides summary information on CINAR projects and funding over the entirety of the award.

Over the past seven years, CINAR has served as an essential component of NOAA's research and management capability in the northeast region, which encompasses the continental shelf from Cape Hatteras to Nova Scotia - one of the world's most highly productive marine ecosystems. Through our partnership with the University of Maryland Center for Environmental Science (UMCES), Rutgers University, University of Maine (UMaine) and the Gulf of Maine Research Institute (GMRI), the CINAR consortia provides a mechanism for NOAA scientists to easily and rapidly obtain research assistance and facilities or infrastructure support for ongoing projects, and respond to technical needs through the development of instruments, models, and approaches that contribute to management decisions. Our work encompasses a variety of projects and programs to address NOAA research and management needs in the northeast region and beyond, including ocean observing and climate products, quantitative fisheries and ecosystem management, and resource protection and restoration. Our efforts to promote education and outreach have provided traineeships and fellowships at a variety of academic levels, including undergraduate Minority Traineeships, scholarships at the postdoctoral level, Fellow awards in quantitative fisheries science, and faculty support to help train future generations of scientists. In addition to the direct support provided to students and faculty, CINAR has supported multiple workshops, and numerous seminar series and webinars to enhance communication between CINAR investigators and NOAA sponsors, and to promote the exchange of new ideas and developments on topics ranging from fisheries and ecosystem acoustics to climate research.

Although this award period has ended, CINAR began its second five-year renewal award on July 1, 2014, and continues to play a critical role in addressing NOAA's research needs in the region. Serving as CINAR's director has been very rewarding, and I am proud of the scientists that have contributed so much to this program's success, as outlined here.

Sincerely,

Donald M. Anderson
CINAR Director

Partners: Gulf of Maine Research Institute • Rutgers University • University of Maine • University of Maryland Center for Environmental Science • Woods Hole Oceanographic Institution

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Executive Summary

CINAR began operation on July 1, 2009. The Woods Hole Oceanographic Institution (WHOI) is the lead institution in partnership with the University of Maryland Center for Environmental Science (UMCES), Rutgers University, University of Maine (UMaine) and the Gulf of Maine Research Institute (GMRI).

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, funding was \$0 from OAR and \$195,688 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.
- In year seven (April 1, 2015 to March 30, 2016), funding was \$681,322 from OAR, \$588,888 from NMFS, and \$129,976 from NOS.
- The period between April 1, 2016 and June 30, 2016 represents the last reporting period under NOAA Cooperative Agreement No. NA09OAR4320129. As this period does not comprise a separate funding cycle, project support is identical to levels reported previously for year seven: \$681,322 from OAR, \$588,888 from NMFS, and \$129,976 from NOS. A summary of support for the entirety of this cooperative agreement is provided on page 17.

Postdoctoral Support

Under 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. Over the past seven years of the current award, CINAR supported a total of five postdoctoral scholars: Joel Llopiz, Robert Todd, Ke Chen, Sarah Bender, and Andrew Jones. We are pleased to include a progress report from our most recent Postdoctoral Scholar Andrew Jones as part of this year's CINAR progress report.

Education and Outreach

CINAR continued its program in summer Minority Traineeships, which offers funds for one minority student to each partner. These students received training through one or more CINAR investigators. Details about the summer 2015 program are provided under Task I activities.

During the past year, we also continued our 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.

Donald Anderson – Woods Hole Oceanographic Institution

U.S. National Office for Harmful Algal Blooms

The U.S. National Office for Harmful Algal Blooms (HAB) 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.

Carin Ashjian – Woods Hole Oceanographic Institution

An Eye on the Ocean: Exploration of high Resolution Vertical Distributions of Plankton and Particles and Coincident Hydrography in the Western Chukchi Sea Data Synthesis

The overall goal of this project was 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) were compared to determine interannual variability and to understand if climate change is modifying the ecosystem. Project highlights include:

- 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.
- 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.
- The VPR was an effective means of 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.

Alexa Dayton – Gulf of Maine Research Institute

Marine Resource Education Program (MREP): Serving the Needs of Fishing Communities and Fishery Management in the Northeast Region

The program is offered as a series of workshops about fisheries science, with participants leaving the workshops with better understanding of how, when, and where to engage effectively in fishery management. Highlights over the past year include the following:

- Underserved communities in NC, VA and MD were the focus of MREP Science and Management 100, with a high percentage of “pier leaders” in attendance.
- MREP for Recreational Anglers successfully established lines of engagement with a large, diverse and poorly-informed community, laying foundations for future outreach.
- Better understanding of MRIP as a recreational data-collection system, which can be adapted and improved by concerted partnership between recreational fishing sectors and NMFS.
- Beginnings of an open-ended dialog by fishermen and scientists working on models of ecosystem-based fishery management, with opportunities for new partnerships.
- Strong participation by NMFS scientists and managers not previously engaged in MREP workshops, including Silver Spring personnel.
- Over 100 individual attendees and presenters participating in one or more of the four workshops, approximately 70% of who are new faces to the program.

Steve Eayrs – Gulf of Maine Research Institute

Commercial fishing vessel electronic trip reporting pilot study

The goal of this project is to test the feasibility of adopting electronic solutions for vessel reporting requirements across a range of sector and common pool vessels in the northeast groundfish fleet. This includes testing a range of electronic logbook products in conjunction with the NMFS’ web-based data entry system to identify obstacles in their use and to ensure their compatibility with NMFS’ data collection systems.

A two-pronged approach is being applied to achieve the goal of this project. The first is to work with software providers, sectors, and NMFS staff to identify and overcome outstanding challenges and limitations to effective transmission of VTR data. A sizeable portion of time is dedicated to the provision of IT training for fishermen, in the use and operation of computers and eVTR software, and ongoing field support. The second approach is dominated by outreach activity designed to raise awareness and facilitate the use of eVTR options. This includes contacting sector managers and fishermen to learn of their interest, needs, and concerns vis a vis eVTR. We also expect an extensive outreach campaign informing fishermen and others of the opportunity and benefits of eVTR use.

Daphne Munroe – Rutgers University

Evaluation of Larval Sources and Population Connectivity in Atlantic Sea Scallop

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 2015 project year, we simulated scallop larval dispersal with the coupled biological 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 was used to simulate larval dispersal on the Middle Atlantic Bight from 2006 through 2012. Analysis of the larval dispersal simulations is ongoing to assess general patterns of connectivity in the scallop stock and among closed areas, as well as evaluating interannual variability in dispersal patterns and how spawning timing interacts with dispersal to create this variability. Dissemination of these results to date has been via presentations at scientific meetings, and manuscripts for peer reviewed publication are in progress.

Robert Weller – Woods Hole Oceanographic Institution
Ocean Climate Observations and Analyses

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.

The Stratus ORS addresses the following ocean observing system program deliverables:

- **Sea surface temperature (SST) and surface currents.** The Stratus surface buoy has been instrumented to provide improved sea surface temperature observations. Because they sample surface and near-surface ocean temperature and because they have collocated, high-quality air-sea fluxes, Stratus ORS data are sought by investigators working on climate dynamics, air-sea interaction, diurnal warm layer dynamics, and remote sensing of SST.
- **Ocean heat content and transport.** The Stratus ORS is equipped with temperature, salinity, and velocity sensors from about 2000 m to the surface and also the deep sensors at 4500 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 Stratus ORS is equipped to make state of the art, sustained air-sea flux observations, providing the air-sea exchanges of heat, freshwater, and momentum. The Stratus 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 NOAA PMEL provides pCO₂ observations from Stratus.

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.

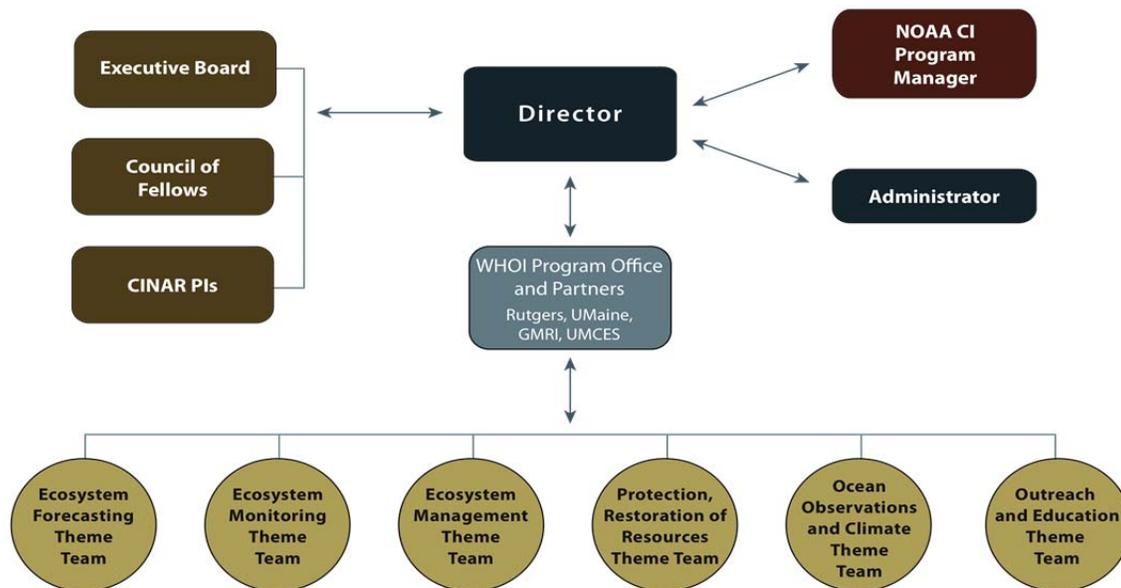


Figure 1. Organizational structure of CINAR.

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
Candice Jongsma		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
Bill Karp	NMFS/NEF SC
Ellen Mecray	NESDIS/NCDC
Candice Jongsma, <i>ex officio</i>	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).

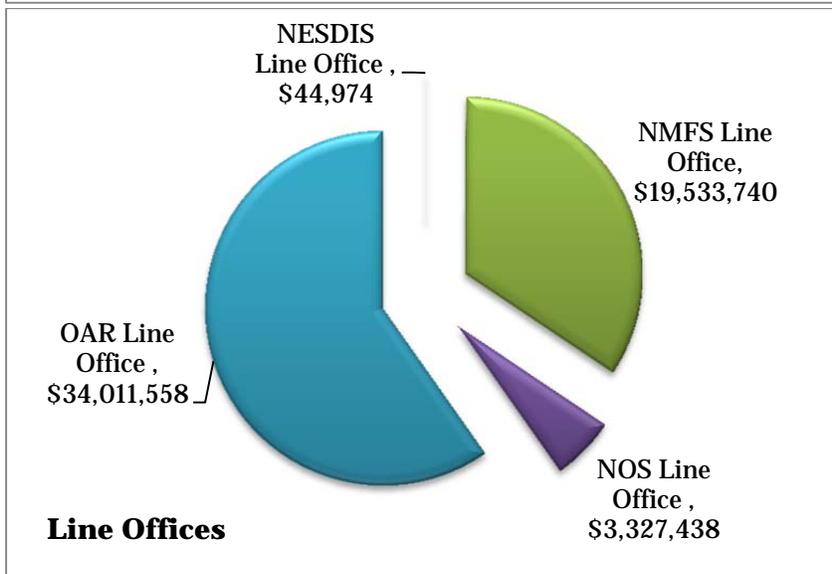
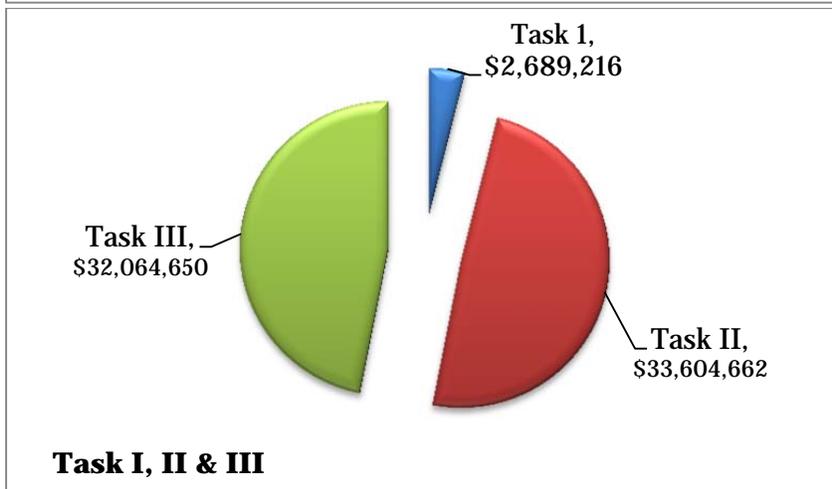
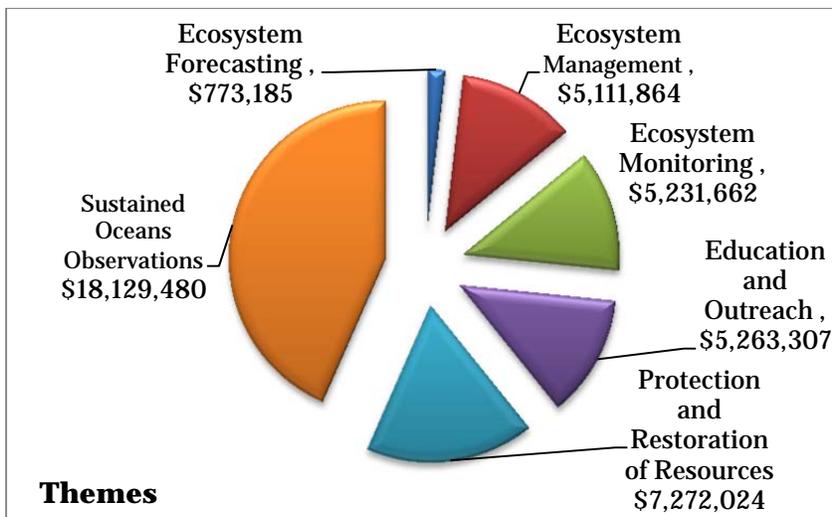
CINAR Research and Administrative staff

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. During the past year, CINAR Administrator Judy Kleindinst retired after 40 years of service to WHOI. Her role has been filled by Mindy Richlen, a research specialist in Donald Anderson's lab, and Ann Stone.

CINAR Program Office

Donald Anderson	CINAR Director
Mindy Richlen	CINAR Associate Director
Ann Stone	CINAR Administrative Professional

Distribution of NOAA Funding by Task, CINAR Themes and NOAA Line Office (2009-2016)



Task I Activities with Distribution of Funding

No new Task 1 funds were received during this period. We are providing information on activities here as well as in the report for NA14OAR4320158, as the two agreements overlap in time.

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. Over the past seven years of the current award, CINAR supported a total of five postdoctoral scholars: Joel Llopiz, Robert Todd, Ke Chen, Sarah Bender, and Andrew Jones. Currently we have one remaining CINAR Postdoctoral Scholar – Andrew Jones. His progress report begins on page 20.

Undergraduate student training: CINAR continued its Minority Traineeship program in 2016, which provides funding for one undergraduate minority traineeship at each partner institution each summer. This program will continue through the duration of our CINAR renewal award.

Outreach

WHOI-NEFSC Special Seminar Series on Fisheries and Ecosystems Acoustics

This seminar series continued through 2015-2016, 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, including how soundscapes can be used to identify differences in the composition of coral reef communities (T. Aran Mooney, WHOI), the use of sonar technologies to estimate eel abundance, determine distribution, and describe behavior (Christopher W.D. Gurshin, Normandeau Associates, Inc.), and the use of broadband acoustic techniques to classify swimbladder-bearing fish (Timothy Stanton, WHOI).

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.

2016 CINAR Postdoctoral Scholar Progress Report

NOAA Cooperative Agreement No. NA09OAR4320129
April 1, 2016 – June 30, 2016

Postdoctoral Scholar – Andrew Jones, WHOI

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: Protection and Restoration of Resources

PROJECT OVERVIEW

The overall goal of this work is related to two main research themes: 1) work on the conservation, management, and basic biology of diadromous fishes, and 2) exploring the trophic ecology of marine fishes from northeast U.S. continental shelf.

ACCOMPLISHMENTS

A significant portion of time in the spring, summer, and fall of 2015 was dedicated to conducting research on the biology of diadromous fishes; specifically, conducting fieldwork for two distinct projects that were both focused on river herring. The first of these projects was an exploration of the factors that affect growth of larvae in their freshwater habitats. This project was led by Joel Llopiz and funded by Woods Hole Sea Grant. While this project is still ongoing, preliminary results were recently presented at a national conference. The second of these projects was an investigation of the movement patterns of river herring in the local Coonamessett River watershed. This project was a collaborative effort with researchers from the Marine Biological Laboratory and local volunteer groups, and generated high-quality information on the timing and duration of migration of both species of river herring. These topics are poorly understood and of great importance in management and restoration efforts. Results from this project have been the subject of numerous local interest stories, and have been presented at local, regional, and national conferences.

Dr. Jones was also involved in a collaborative project with researchers from NMFS and the North Carolina Museum of Science to explore dietary patterns in marine fishes from the northeast U.S. continental shelf; specifically, assessing dietary variation below the species level. 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. Work from this project was presented at a national meeting and has progressed to the stage of a draft manuscript. These efforts have also laid the groundwork for future work on the importance of trophic intraspecific trophic variation in this ecosystem.

HIGHLIGHTS

- Generation of a novel dataset on herring growth and survival.
- Generation of a novel dataset on herring migration.
- Novel analysis of existing finfish diet data from the northeast continental shelf ecosystem.

SOCIETAL BENEFITS

Like the subject matter of this project, the benefits of this work are diverse. Perhaps the most value will come from an increased understanding of basic river herring biology. Despite our proximity to these migratory fish, our understanding of their basic biology is limited, and this has negative impacts on our ability to manage these ecologically important species.

EDUCATION AND OUTREACH ACTIVITIES

Outside of these core projects, Dr. Jones has been involved in many grant applications and outreach activities. He has served on the board of two local non-profits and on the advisory committee of a third. Dr. Jones has also given lectures to a diverse set of audiences and served as the co-instructor for a college level Biology of Fishes course run by the Marine Studies Consortium.

CINAR Research Projects (2009-2016)

Below is a comprehensive list of all research projects funded by CINAR from on July 1, 2009 through June 30, 2016 under NOAA Cooperative Agreement No. NA09OAR4320129. The projects are organized by theme. The subsequent section contains research summaries and technical reports of the ten CINAR projects that received an extension of the period of performance during the period April 1, 2016 through June 30, 2016.

Theme I. Ecosystem Forecasting

- *Nutrient Dynamics on the NE Continental Shelf; Sample Analyses*

David Townsend (University of Maine at Orono)

NOAA Program Manager: Timothy Sheehan (NOAA Fisheries Service)

- *Development of National Ocean Service Operational Forecast Systems based on the Regional Ocean Model System*

John Wilkin (Rutgers University)

NOAA Program Manager: Aijun Zhang (NOAA NOS/COOP)

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

David Mountain (University of Arizona) and Donald Anderson (WHOI)

NOAA Program Manager: Jonathan Hare (NOAA NMFS Oceanography Branch)

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

Josh Kohut (Rutgers University)

NOAA Program Manager: John Hoey (NMFS/NEFSC)

- *Effects of Varied pCO₂ on Atlantic Surf Clams – Culture Experiments*

Daniel McCorkle and Anne Cohen (Woods Hole Oceanographic Institution)

NOAA Program Manager: James Widman (NMFS/NEFSC)

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

Donald Anderson (WHOI)

NOAA Program Manager: Jonathan Hare (NMFS)

- *Technical Services and Improvement of FVCOM for NOAA Modeling Activities*

Robert Beardsley (WHOI)

NOAA Program Manager: Frank Aikman (NOS)

- *Stratification Indices for Stock and Ecosystem Assessment from a Data Assimilative Circulation Model*

Rubao Ji (WHOI)

NOAA Program Manager: Jonathan Hare (NMFS)

- *Habitat Suitability Modeling for Deep-Sea Corals and Sponges in the Northeast and Mid-Atlantic Regions: Ground-Truthing Potential Deep-sea Coral Areas*

Timothy Shank (WHOI)

NOAA Program Manager: Martha Nizinski (NMFS/NEFSC)

- *Nutrient Dynamics on the NE Continental Shelf: Sample Analyses*

David W. Townsend (UMaine)

NOAA Program Manager: Jonathan Hare (NMFS)

- *Sustaining Development of National Ocean Service Operational Forecast Systems Based on the Regional Ocean modeling System*

James Wilkins (Rutgers)

NOAA Program Manager: Aijun Zhang (NOS)

- *Gulf of Maine 2013 Cyst Cruise and Sample Analysis*

Donald Anderson (WHOI)

NOAA Sponsor: Richard Stumpf (NOS)

- *Technical Support and Improvement of FVCOM for NOAA Modeling Activities*
Robert Beardsley (WHOI)
NOAA Sponsor: Frank Aikman (NOS)
- *Estimating early mortality and implications for reference points for the Atlantic menhaden stock*
Hongsheng Bi (UMCES)
NOAA Sponsor: Jonathan Hare (NMFS)
- *Stratification indices for stock and ecosystem assessments from a data assimilative circulation model*
Rubao Ji (WHOI)
NOAA Sponsor: Jonathan Hare (NMFS)
- *Accounting for habitat-dependent observation error in bottom trawl survey indices for pelagic stocks using butterfish (*Peprilus triacanthus*) as a model*
Josh Kohut and Nickitas Georgas (Rutgers)
NOAA Sponsor: John Manderson and John Hoey (NMFS)
- *Assessing marine climate impacts in North America using species range shifts and climate velocity*
Malin Pinsky (Rutgers)
NOAA Sponsor: Jonathan Hare (NMFS)
- *Nutrient dynamics on the NE continental shelf: Sample analyses*
David Townsend (UMaine)
NOAA Sponsor: Jonathan Hare (NMFS)
- *Sustaining development of National Ocean Service operational forecast systems based on the Regional Ocean Modeling System*
James Wilkin (Rutgers)
NOAA Sponsor: Aijun Zhang (NOS)
- *Social Science Performance Measure and Indicator Outreach*
Meredith Mendelson (GMRI)
NOAA Program Manager: Patricia Pinto da Silva (NMFS / NEFSC)

Theme II. Ecosystem Monitoring

- *Field Testing and Expansion of Capabilities of the Environmental Sample Processor: Necessary Steps toward Operational HAB Monitoring and Forecasting in the Gulf of Maine*

Donald Anderson (WHOI)

NOAA Program Manager: Juli Trtanj (NOS/ASTADM)

- *Groundfish Vessel Crew Rapid Assessment*

Kate Burn and Jessica Joyce (GMRI)

NOAA Program Manager: Patricia Pinto da Silva (NOAA/NMFS)

- *Development of a HabCAM System for NOAA/NMFS Phase I of III: Construction of a Stereo Camera and Telemetry System*

Scott Gallager (WHOI)

NOAA Program Manager: Russell W. Brown (NOAA/NMFS)

- *Image Analyses Tools for Quantitative Mensuration and Classification of High Resolution Optical Imagery, Improving Visual Survey Methods for Groundfish and Reef Fish Using the SeaBED AUV*

Hanumant Singh (WHOI)

NOAA Program Manager: John Rooney (Pacific Islands Fisheries Science Center)

- *SeaBED AUV Tech Support and Development*

Hanumant Singh (WHOI)

NOAA Program Manager: Elizabeth Clarke (NOAA/ NWFSC)

- *Development of Automated Tools for Underwater Photographic Analysis: Improving Visual Survey Methods for Groundfish and reef Fish Using the SeaBED AUV*

Hanumant Singh (WHOI)

NOAA Program Manager: Elizabeth Clarke (NOAA/ NWFSC)

- *Autonomous Gliders for Passive Real-Time Acoustic Remote Sensing*

Mark F Baumgartner (WHOI)

NOAA Program Manager: Sofie Van Parijs (NMFS)

- *Foraging Ecology and Habitat of North Pacific Right Whales*

Mark F Baumgartner (WHOI)

NOAA Program Manager: Philip Clapham (NMFS)

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

Mark F. Baumgartner (WHOI)

NOAA Program Manager: Sofie Van Parijs (NMFS)

- *2011 HABCAM Survey of George's Bank and Phase II of NOAA HABCAM Project*

Scott Gallager (WHOI)

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

David C. Fisichella (WHOI)

NOAA Program Manager: Kelly Taranto (NMFS/NEFSC)

- *Inshore Gulf of Maine Herring Acoustic Survey*

Graham Sherwood (GMRI)

NOAA Program Manager: Michael Jech (NMFS/NEFSC)

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

Hanumant Singh (WHOI)

NOAA Program Manager: Elizabeth Clarke (NMFS/NWFSC)

- *Integrating a Forward Looking Sonar on the SeaBED AUV*

Hanumant Singh (WHOI)

NOAA Program Manager: John Rooney (Pacific Island Fisheries Science Center)

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

Hanumant Singh (WHOI)

NOAA Program Manager: M. Elizabeth Clarke (NMFS/NWFSC)

- *Nutrient Dynamics on the NF Continental Shelf: Sample Analyses*

David W. Townsend (University of Maine)

NOAA Program Manager: Jon Hare: (NMFS/NEFSC)

- *Gulf of Maine Annual Cyst Cruise and Sample Analysis*

Donald Anderson (WHOI)

NOAA Sponsor: Richard Stumpf (NOS)

- *Technical support and improvement of FVCOM for NOAA modeling activities*

Robert Beardsley (WHOI)

NOAA Sponsor: Eugene Wei (NOS)

- *Estimating early mortality for reference points for the Atlantic menhaden stock*

Hongshen Bi (UMCES)

NOAA Sponsor: Jonathan Hare (NMFS)

- *Nutrient dynamics on the NE continental shelf: Sample analyses*

David Townsend (UMaine)

NOAA Sponsor: Jonathan Hare (NMFS)

- *Using the American lobster settlement index and environmental indicators to forecast lobster fishery recruitment*

Richard Wahle (UMaine)

NOAA Sponsor: Larry Jacobson (NMFS)

- *Development and testing of a new method for selecting among stock assessment models*

Michael Wilberg (UMCES)

NOAA Sponsor: Brian Linton (NMFS)

- *Sustaining development of National Ocean Service operational forecast systems based on the Regional Ocean Modeling System*

John Wilkin (Rutgers)

NOAA Sponsor: Aijun Zhang (NOS)

- *Development of a Conceptual Framework for the Contribution of the Social Sciences (CSS) to Ecosystem- Based Fishery Management (EBFM)*

Donald Anderson, Porter Hoagland (WHOI), Bonnie McCay (GMRI)

NOAA Program Manager: Matt McPherson (NMFS/ NEFSC)

- *2012 ROV Jason Use for VENTS - NeMO*

Andrew Bowen (WHOI)

NOAA Program Manager: Dan Simon (OAR/PMEL)

- *A Preliminary Study to Develop an Abundance Index for Cusk from their Bycatch in the Gulf of Maine*

Yong Chen (UMaine)

NOAA Program Manager: Earl Meredith (NMFS/NEFSC)

- *Development of a Sentinel Survey/Fishery in the Eastern Gulf of Maine*

Yong Chen (UMaine)

NOAA Program Manager: John Hoey (NMFS/ NEFSC)

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

Josh Kohut (Rutgers)

NOAA Program Manager: John Hoey (NMFS/NEFSC)

- *Using Remus 100 Autonomous Underwater Vehicles to Conduct NEFSC Scallop Surveys*

Michael Purcell, Norman Farr (WHOI)

NOAA Program Manager: Jack Moakley (NMFS)

- *TowCam Exploration for Chemosynthetic Ecosystems at the Chile Triple Junction*

Timothy Shank (WHOI)

NOAA Program Manager: John Hoey (NMFS/ NEFSC)

- *Inshore Gulf of Maine Herring Acoustic Survey*

Graham Sherwood (GMRI)

NOAA Program Manager: Michael Jech (NMFS/ NEFSC)

- *Development of Protocols and Tools to Assess Fish Populations and Habitats Using SeaBED AUV*

Hanumant Singh (WHOI)

NOAA Program Manager: M. Elizabeth Clarke (NMFS/ NWFSC)

- *Integrating a Forward looking Sonar on the SeaBED AUV*

Hanumant Singh (WHOI)

NOAA Program Manager: John Rooney (NMFS)

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

Hanumant Singh (WHOI)

NOAA Program Manager: M. Elizabeth Clarke (NMFS/ NWFSC)

- *Obstacle Avoidance For Reef Fish Stock Assessment*

Hanumant Singh (WHOI)

NOAA Program Manager: John Rooney (NMFS)

- *Systems Level Sensing and navigation Integration for the SeaBED AUV*

Hanumant Singh (WHOI)

NOAA Program Manager: M Elizabeth Clarke (NMFS/ NWFSC)

- *2013 ROV Jason and AUV Sentry use for NOAA/OER (Deepwater Canyons)*

Andrew Bowen (WHOI)

NOAA Sponsor: John Tomczuk (OAR)

- *NDSF vehicle engineering days*

Andrew Bowen (WHOI)

NOAA Sponsor: Karen Kohanowich (OAR)

- *The Eastern Gulf of Maine sentinel jigging/longline survey / fishery in 2013*

Yong Chen (UMaine)

NOAA Sponsor: John Hoey (NMFS)

- *Benthic imaging in support of habitat mapping for renewable energy*
Scott Gallager (WHOI, with subaward to Kevin Stokesbury, UMass)
NOAA Sponsor: Vincent Guida (NMFS)
- *Transition of HabCam Technology to NOAA Operations and Technology Upgrade*
Scott Gallager (WHOI)
NOAA Sponsor: Robert Johnston (NMFS)
- *The Development of Light Field Cameras for AUV Obstacle Avoidance*
Hanumant Singh (WHOI)
NOAA Sponsor: Elizabeth Clarke (NMFS)
- *Publication of a special issue of Oceanography magazine on emerging themes in ocean acidification science*
Heather Benway (WHOI)
NOAA Sponsor: Elizabeth Jewett (OAR)
- *Characterizing the Penobscot River estuarine transition zone to determine environmental challenges for Atlantic salmon, their prey, and other sea-run species*
Damian Brady (UMaine)
NOAA Sponsor: John Kocik (NMFS)
- *Annual Eastern Gulf of Maine sentinel jigging/longline survey/fishery*
Yong Chen (UMaine)
NOAA Sponsor: John Hoey (NMFS)
- *Operational support for Habcam V4 on scallop surveys, post-cruise processing, machine vision efforts, habitat classification, yellowtail surveys, and lobster habitat*
Scott Gallager (WHOI)
NOAA Sponsor: Dvora Hart (NMFS)
- *Impacts of a changing ecosystem on Atlantic salmon marine productivity*
Kathy Mills (GMRI)
NOAA Sponsor: Timothy Sheehan (NMFS)
- *Field experimentation to determine catchability of advanced technologies*
Hanumant Singh (WHOI)
NOAA Sponsor: Elizabeth Clarke (NMFS)

- Investigating coral communities in the Gulf of Maine
Rhian Waller (UMaine)
NOAA Sponsor: Martha Nizinski (NMFS)
- *Acquisition of a pressure housing and array of reaction chambers (pucks) for the Environmental Sampling Processor (ESP)*
Donald M. Anderson (WHOI)
NOAA Program Manager: Zdenka S. Willis (NOS/ IOOS)
- *HabCam Data Processing (Leg 3 of the Scallop Survey)*
Scott M. Gallager (WHOI)
NOAA Program Manager: Russell Brown (NMFS / NEFSC)
- *Funding Dockside Monitoring for New England Groundfish Sectors in FY2010*
Jonathan Labaree (GMRI)
NOAA Program Manager: Kevin Chu (NMFS / NERO)

Theme III Ecosystem Management

- *US National Office for Harmful Algal Blooms*
Donald Anderson (WHOI)
NOAA Program Manager: Dr. Quay Dortch (NOAA CSCOR)
- *The Mid Atlantic Cold Pool and Stock Assessments: Developing Environmental Indices at the Range Limit of Species*
Donald Anderson (Woods Hole Oceanographic Institution) and David Mountain (University of Arizona)
NOAA Program Manager: Jonathan Hare (NMFS)
- *Bowhead Whale Feeding in the Western Beaufort Sea; Oceanographic Conditions, Whale Prey Distribution and Whale Foraging Behavior*
Carin Ashjian (WHOI)
NOAA Program Manager: David Rugh (NMML/AFSC)

- *Bowhead Whale Feeding in the Western Beaufort Sea; Oceanographic Conditions, Whale Prey Distribution and Whale Foraging Behavior*

Mark Baumgartner (WHOI)

NOAA Program Manager: David Rugh (NMML/AFSC)

- *Autonomous Gliders for Real Time Passive Acoustic Remote Sensing*

Mark Baumgartner (WHOI)

NOAA Program Manager: Dr. Sofie Van Parijs (NMFS)

- *Incorporating Sediment and Hydrography Data in Assessments for Tilefish and Lobster*

Yong Chen (UMaine)

NOAA Program Manager: Kristen Larson (NMFS)

- *Social Capital in the NE Ground Fish Industry: Request for Supplemental Funding*

Daniel Holland (GMRI)

NOAA Program Manager: Patricia Pinto da Silva (NEFSC/ Social Science Branch)

- *Understanding the Economic Structure of the Gulf of Maine Lobster Industry*

Daniel Holland (GMRI)

NOAA Program Manager: Eric Thunberg (NEFSC/ Social Science Branch)

- *CINAR Workshops-2011*

Donald M. Anderson (WHOI)

NOAA Program Manager: Michael Fogarty (NMFS/ NEFSC)

- *Facilitating the Submission of Electronic Vessel Trip Reports by Northeast Fisherman*

Steve Eayrs (GMRI)

NOAA Program Manager: Joan Palmer (NMFS)

- *Vessel Safety & Fisheries Management*

Di Jin (WHOI)

NOAA Program Manager: Chad Demarest (NEFSC- Social Science Branch)

- *A US- Canada Science Symposium: The American Lobster in a Changing Ecosystem*

Paul Anderson (UMaine)

NOAA Program Manager: Russell Brown (NMFS/ NEFSC)

- Workshop on Stock Structure of Atlantic Cod in the Gulf of Maine Region

John Annala- GMRI

NOAA Program Manager: Russell Brown (NMFS/ NEFSC)

- *Electronic Vessel Trip Reports*

Steve Eayrs (GMRI)

NOAA Program Manager: Joan Palmer (NMFS/ NEFSC)

- *Social Capital in the NE Ground Fish Industry*

Jessica Joyce, Dan Holland (GMRI)

NOAA Program Manager: Patricia Pinto da Silva (NEFSC Social Science Branch)

- *Vessel Safety and Fishery Management*

Di Jin (WHOI)

NOAA Program Manager: Chad Demarest (NMFS/NEFSC)

- *Chesapeake Bay National Estuarine Research Reserves (CBNERRS): An integrated system of sentinel sites to understand baywide climate impacts for stakeholders*

Raleigh Hood (UMCES)

NOAA Sponsor: Bob Wood (NOS)

- *Statistical analysis of trip cost data collected by the Northeast Observer Program*

Di Jin (WHOI)

NOAA Sponsor: Andrew Kitts (NMFS)

- *Indicators of marine climate impacts in North America*

Malin Pinsky (Rutgers)

NOAA Sponsor: Jonathan Hare (NMFS)

- *Physiological ecology and habitat suitability: Combining experiments and surveys to inform stock assessments*

Grace Saba (Rutgers)

NOAA Sponsor: Jonathan Hare (NMFS)

- *Advancing the 6th International Deep-Sea Coral Symposium*

Timothy Shank (WHOI)

NOAA Sponsor: Martha Nizinski (NMFS)

- *Accessing and visualizing satellite data for use by fisheries managers in the Northeast*

Riley Young Morse (GMRI)

NOAA Sponsor: Walter Glance (NESDIS)

- *An Experimental Investigation of the Impact of Ocean Acidification on the Early Life Stages of Surfclams, and the Interactive Effects of Feeding*

Daniel McCorkle and Anne Cohen (WHOI)

NOAA Program Manager: James Widman (NMFS/ NEFSC)

- *Evolution of Groundfish Sectors Business Model*

Jen Sun (GMRI)

NOAA Program Manager: Andrew Kitts (NMFS/ NEFSC)

- *Evaluating the mechanisms underlying distribution shifts and age-truncation on silver hake (*Merloccius bilinearis*) survey data*

James Churchill (WHOI)

NOAA Sponsor: David Richardson (NMFS)

- *Evaluation of cranial facial bone formation and tissue histopathology of embryonic and juvenile commercially important finfish species exposed to increasing levels of Co₂ and Ph due to ocean acidification*

Keith Cooper (Rutgers)

NOAA Sponsor: Chris Chambers (NMFS)

- *An empirical analysis of portfolio management as a tool for implementing Ecosystem Based Fishery Management*

Di Jin and Porter Hoagland (WHOI)

NOAA Sponsor: Gerit Depiper (NMFS)

- *Improving Fishery Dependent Data Collection and Integration into NOAA Fisheries Data Systems*

Jessica Joyce (GMRI)

NOAA Sponsor: Douglas Christel (NMFS)

- *Thermal Habitat Dynamics in the Northeast Atlantic and the Role of Habitat Squeeze*

Josh Kohut and Enrique Curchitser (Rutgers)

NOAA Sponsor: John Hoey (NMFS)

- *Developing Wideband Acoustic Methods for Improving Fisheries and Ecosystem Assessments*

Gareth Lawson and Andone Lavery (WHOI)

NOAA Sponsor: Michael Jech (NMFS)

- *Scientific Leadership for the NOAA Ocean Exploration and Research Program*

Timothy Shank (WHOI)

NOAA Sponsor: Gene Smith (OAR)

- *Evolution of Groundfish Sectors Business Model*

Jenny Sun (GMRI)

NOAA Sponsor: Andrew Kits (NMFS)

- *The Effect of Catch Restrictions on Recreational Catch*

Michael Wilberg (UMCES)

NOAA Sponsor: Scott Steinback (NMFS)

- *Commercial Fishing Vessel Electronic Trip Reporting Pilot Study*

Steve Eayrs (GMRI)

NOAA Program Manager: Joan Palmer (NMFS / NEFSC)

- *Understanding Determinants of Success of New England Groundfish Sectors*

Dan Holland (GMRI)

NOAA Program Manager: Patricia Pinto da Silva (NMFS / NEFSC)

Theme IV. Protection and Restoration of Resources

- *Evaluation of Biomarkers and Bioindicators for Fundulus heteroclitus in a Contaminated and Reference Location*

Keith Cooper (Rutgers)

NOAA Program Manager: Reyhan Mehran (NOAA Assessment and Restoration Division)

- *Funding Sector Operations and Dockside Monitoring in Fishing Year 2011*

Jonathan Labaree (GMRI)

NOAA Program Manager: Dan Morris (NMFS)

- *Marine Mammal Health and Entanglement Research*

Michael Moore (WHOI)

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

- *Health Implications of Entanglements of Large Whales*

Michael Moore (WHOI)

NOAA Program Manager: Richard Merrick (NMFS/ NEFSC)

- *Impact on Oceanographic Changes on Atlantic Salmon Survival in the Northwest Atlantic*

Andrew Pershing (UMaine)

NOAA Program Manager: Timothy Sheehan (NMFS)

- *Evaluation of the Importance of Predator and Prey Field and Ocean Circulation on Atlantic Salmon Growth and Survival in the Gulf of Maine*

Jason Stockwell (GMRI)

NOAA Program Manager: Kelly Taranto (NMFS/ NEFSC)

- *Collaborative Research Program Focusing on Behavioral Ecology and Reactions to Sound Populations of Short-Finned Pilot Whales and Other Cetaceans Off Cape Hatteras, North Carolina*

Peter Tyack (WHOI)

NOAA Program Manager: Kenric Osgood (NMFS Office of Science and Technology / Marine Ecosystems Divisions)

- *High Resolution 3D Mapping using the VPR*

Cabell Davis (WHOI)

NOAA Program Manager: Tony Penn (NOS/ORR/ARD)

- *Holocam and Video Plankton Recorder*

Cabell Davis (WHOI)

NOAA Program Manager: Tony Penn (NOS/ORR/ARD)

- *Estimates of Harbor Seal Numbers in New England*

James R. Gilbert (UMaine)

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

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

William Lange (WHOI)

NOAA Program Manager: Joseph Hoyt (Monitor National Marine Sanctuary)

- *Human Interaction Investigations in Marine Mammals*

Michael J. Moore (WHOI)

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

- *Real Time Assessment of Baleen Whale Occurrence Using Moored Passive Acoustics*

Mark Baumgartner (WHOI)

NOAA Program Manager: Sophie Van Parijs (NMFS/ NEFSC)

- *Characterizing North Atlantic Right Whale Habitat through Integration of Satellite Tagging, Acoustic, and Visual Survey Data*

Mark Baumgartner (WHOI)

NOAA Program Manager: Sophie Van Parijs (NMFS/ NEFSC)

- *Evaluation of the Importance of Predator and Prey Field and Ocean Circulation on Atlantic Salmon Growth and Survival in the Gulf of Maine*

Carrie Byron (GMRI)

NOAA Program Manager: John Kocik (NMFS)

- *Migration of post Smolt Atlantic Salmon in the Gulf of Maine and Gulf of Saint Lawrence*

Carrie Byron (GMRI)

NOAA Program Manager: John Kocik (NMFS)

- *Estimation of Harbor Seal Numbers in New England*

James Gilbert (UMaine)

NOAA Program Manager – Gordon Waring NMFS/NEFSC

- *Funding Sector Operations and Dockside Monitoring in Fishing Year 2011*

Jonathan Labaree, GMRI

NOAA Program Manager: Dan Morris (NMFS/NER)

- *Human Interaction Investigations in Marine Mammals*

Michael Moore (WHOI)

NOAA Program Manager: Teresa Rowles (NMFS)

- *Marine Mammal Health and Entanglement Research*

Michael Moore (WHOI)

NOAA Program Manager: Teresa Rowles (NMFS)

- *Analysis of CYP1A1 Expression in Cetacean Tissue Samples*

John J. Stegeman (WHOI)

NOAA Program Manager: Teresa Rowles (NMFS)

- *Analysis linking study fleet data to habitat and statistic models in the Mid Atlantic Bight*
Josh Kohut and Olaf Jensen (Rutgers)
NOAA Sponsor: John Hoey (NMFS)
- *An experimental investigation of the impact of ocean acidification on the early life stages of surfclams, and the interactive effects of feeding*
Daniel McCorkle and Anne Cohen (WHOI)
NOAA Sponsor: Lisa Milke (NMFS)
- *Marine mammal stranding responses capacity building*
Michael Moore (WHOI)
NOAA Sponsor: Teresa Rowles (NMFS)
- *Evaluation of larval sources and population connectivity in Atlantic sea scallop (*Placopecten magellanicus*)*
Daphne Munroe (Rutgers)
NOAA Sponsor: Devorah Hart (NMFS)
- *Analysis of CYP1A1 expression in cetacean tissue samples*
John Stegeman (WHOI)
NOAA Sponsor: Teresa Rowles (NMFS)
- *Passive acoustic monitoring from autonomous platforms*
Mark Baumgartner (WHOI)
NOAA Sponsor: Sofie Van Parijs (NMFS)
- *Carbonate mineralogy of Alaskan corals*
Anne Cohen (WHOI)
NOAA Sponsor: Dwight Gledhill (OAR)
- *East coast marine mammal health assessment*
Michael Moore (WHOI)
NOAA Sponsor: Teresa Rowles (NMFS)
- *Effects of drag from entanglement in fishing gear in right whales*
Michael Moore (WHOI)
NOAA Sponsor: Peter Corkeron (NMFS)

- *A Passive Acoustic Ocean Observing System for Monitoring and Mapping Marine Mammals and Noise in the Chukchi Sea Ecosystem*

Donald Peters (WHOI)

NOAA Sponsor: Julie Ann Mocklin (NMFS)

- *Habitat Suitability Modeling for Deep-Sea Corals and Sponges in the Northeast and Mid-Atlantic Regions - Version 2 and Ground Truthing of Potential Deep-Sea Coral Areas*

Timothy Shank (WHOI)

NOAA Sponsor: Martha Nizinski (NMFS)

- *Image Analyses Tools for Quantitative Mensuration and Classification of High Resolution Optical Imagery*

Hanumant Singh (WHOI)

NOAA Sponsor: Scott Ferguson (NOAA /NMFS)

- *Development of Automated Tools for Underwater Photographic Analysis*

Hanumant Singh (WHOI)

NOAA Sponsor: Elizabeth Clarke (NMFS / NWFSC)

- *Health Implications of Entanglements of Large Whales*

Michael J. Moore (WHOI)

NOAA Sponsor: Richard Merrick (NMFS / NEFSC)

Theme V. Sustained Ocean Observations and Climate

- *WHOI Contribution ARGO Float Program (2010-2011)*

W. Brechner Owens (WHOI)

NOAA Sponsor: Steven Piotrowicz (CPO)

- *NOAA State of the Arctic Report (2010)*

Andrey Proshutinsky (WHOI)

NOAA Sponsor: Dr. John Calder (CPO)

- *Development, Enhancement and Operation of Software Components for the IOOS Data Portal*

Thomas Shyka and Riley Young Morse (GMRI)

NOAA Sponsor: Zdenka Willis (NOAA Integrated Ocean Observing Program)

- *R/V Atlantis Support of NOAA CalNEX 2010 Cruise*

Albert Suchy (WHOI)

NOAA Sponsor: LCDR James Illg (OAR/PMEL)

- *R/V Okeanos Use in Support of NOAA/AOML's Western Boundary Time Series Research*

Albert Suchy (WHOI)

NOAA Sponsor: Diane Stanitski (Climate Program Office / Climate Observation Division)

- *Ocean Climate Observations and Analyses (2010-2011)*

Robert Weller (WHOI)

NOAA Program Manager: David Goodrich (CPO)

- *Global Ocean Surface Heat Flux Analysis*

Lisan Yu (WHOI) and Robert A. Weller (WHOI)

NOAA Sponsor: David Legler (CPO)

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

Carin Ashjian (WHOI)

NOAA Sponsor: Kim Shelden (NMFS)

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

Mark F Baumgartner (WHOI)

NOAA Sponsor: Kim Shelden (NMFS)

- *FY 2011 IOOS Data Registry, Catalog and Viewer Development*

Riley Young Morse (GMRI)

NOAA Sponsor: Zdenka S. Willis (NOAA Integrated Ocean Observing System Program Office)

- *WHOI Contribution ARGO Float Program (2011-2012)*

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

NOAA Sponsor: Steve Piotrowicz (CPO)

- NOAA State of the Arctic Report

Andrey Proshutinsky (WHOI)

NOAA Sponsor: John A. Calder (CPO Arctic Research Climate Program Office)

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

Albert Suchy (WHOI)

NOAA Sponsor: Robert Embley (Pacific Marine Environmental Lab, VENTS Program)

- *Ocean Climate Observations and Analyses (2011-2012)*

Robert A. Weller and Albert J. Plueddemann (WHOI)

NOAA Sponsor: David Legler (Climate Observations Division)

- *Global Ocean Surface Heat Flux Analysis*

Lisan Yu (WHOI)

NOAA Sponsor: Joel Levy (CPO)

- *Quarterly Climate Reports*

Donald Anderson (WHOI)

NOAA Sponsor: Ellen Mecray NESDIS

- *Bilateral Workshop*

Donald Anderson (WHOI)

NOAA Sponsor: Ellen Mecray NESDIS

- *An Eye in the Ocean Exploration of High-Resolution Vertical Distributions of Plankton and Particles and Coincident Hydrography in the Western Chukchi Sea Using a Video Plankton Recorder*

Carin Ashjian (WHOI)

NOAA Sponsor: Kathleen Crane (OAR/CPO)

- *Pacific Artic Group (PAG) Secretariat Office*

Jessica Grebeier (UMCES)

NOAA Sponsor: John Calder (OAR CPO)

- *WHOI Contribution ARGO Float Program (2012-2013)*

W. Brechner Owens, Steven R. Jayne and Paul E. Robbins-WHOI

NOAA Sponsor: Dr. Steven Piotrowicz

- *Ocean Climate Observations and Analyses (2012-2013)*

Robert A. Weller and Albert J. Plueddeman, WHOI

NOAA Sponsor: Diane Stanitski (OAR CPO)

- *50 Year Analysis Global Ocean Surface Heat Flux*

Lisan Yu (WHOI)

NOAA Sponsor: Kathy Tedesco (NOAA Climate Observations Division)

- *Global Ocean Observing Coordination Activities*

Donald Anderson (WHOI)

NOAA Sponsor: Candyce Clark (OAR)

- *CINAR Input Into Fisheries/Climate Regional Products*

Donald Anderson (WHOI)

NOAA Sponsor: Ellen Mecray (NESDIS)

- *Satellite Derived Climate Data Records of Ocean-Atmosphere Exchange*
Carol Anne Clayson (WHOI)
NOAA Sponsor: Jeff Privette (NESDIS)
- *Macroinfauna community structure, biomass and sediment studies during the RUSALCA program*
Jacqueline Grebmeier (UMCES)
NOAA Sponsor: Kathleen Crane (OAR)
- *Pacific Arctic Group (PAG) secretariat office 2013-2014*
Jacqueline Grebmeier (UMCES)
NOAA Sponsor: Kathleen Crane (OAR)
- *WHOI contribution to Argo Float Program*
Steven Jayne, P.E. Robbins, and W. Brechner Owens (WHOI)
NOAA Sponsor: Steven Piotrowicz (OAR)
- *Circulation in the Western Chukchi Sea and its role in the ecosystem*
Robert Pickart (WHOI)
NOAA Sponsor: Kathleen Crane, OAR
- *Synthesis of physical measurements from the Pacific Arctic Group: Flux of Pacific water through Barrow Canyon, Chukchi Sea*
Robert Pickart - WHOI
NOAA Sponsor: Kathleen Crane, OAR
- *50 year analysis global surface heat flux*
Lisan Yu - WHOI
NOAA Sponsor: Joel Levy, OAR
- *Ocean climate observations and analyses (2013-2014)*
Robert Weller and Albert Plueddemann, WHOI
NOAA Sponsor: Diane Stanitsky, OAR

- *Global Ocean Observing Coordination Activities*
Donald Anderson - WHOI
NOAA Sponsor: Stephen Piotrowicz - OAR
- *An eye in the ocean: Exploration of high-resolution vertical distributions of plankton and particles and coincident hydrography in the western Chukchi Sea*
Carin Ashjian - WHOI
NOAA Sponsor: Kathleen Crane - OAR
- 2014 ROV Jason use for Chadwick Moyer cruise
Andrew Bowen - WHOI
NOAA Sponsor: Thomas Peltzer - OAR
- *Assessing regional sea-ice predictability in the US Arctic: A multi-model approach*
Enrique Curchitser - Rutgers
NOAA Sponsor: Jessie Carman - OAR
- *Satellite-derived climate data records of ocean-atmosphere exchange: Ocean surface bundle CDR*
Carol Anne Clayson - WHOI
NOAA Sponsor: Xuepeng Zhao - OAR
- *Exploration of the Arctic Ocean with the Nereid under-ice vehicle*
Christopher German - WHOI
NOAA Sponsor: John McDonough - OAR
- *Pacific Arctic Group (PAG) Secretariat Office 2014-2015*
Jacqueline Grebmeier - UMCES
NOAA Sponsor: Kathy Crane - OAR
- *Synthesis activities within the RUSALCA Program 2014-2015*
acqueline Grebmeier - UMCES
NOAA Sponsor: Kathleen Crane - OAR
- *WHOI contribution to the ARGO Float Program (2014-2015)*
Steven Jayne - WHOI
NOAA Sponsor: Steven Piotrowicz – OAR

- *The Impact of Ocean Acidification on Larval Sea Scallops (Placopecten magellanicus) and Possible Mitigation by Feeding: An Initial Experimental Study*

Daniel McCorkle (WHOI)

NOAA Sponsor: Elizabeth Jewett - OAR

- *Climate adaptation in fishery ecosystems*

Andrew Pershing and Kathy Mills - GMRI

NOAA Sponsor: Roger Griffis - NMFS

- *Synthesis of physical measurements from the Pacific Arctic Group: Flux of Pacific water through Barrow Canyon, Chukchi Sea*

Robert Pickart (WHOI)

NOAA Sponsor: Kathleen Crane - OAR

- *The Western Chukchi Sea: Physical drivers and biological and geochemical responses*

Robert Pickart (WHOI)

NOAA Sponsor: Kathleen Crane - OAR

- *Building tools for applying climate science to fisheries management*

Riley Young Morse - GMRI

NOAA Sponsor: Ellen Mecray - NESDIS

- *Ocean climate observations and analyses (2014-2015)*

Robert Weller and Albert Plueddemann (WHOI)

NOAA Sponsor: Diane Stanitski - OAR

- *50 year analysis: global ocean surface heat flux*

Lisan Yu (WHOI)

NOAA Sponsor: Kathy Tedesco – OAR

Theme VI. Education and Outreach

- *US National Office for Harmful Algal Blooms*

Donald M. Anderson (WHOI)

NOAA Sponsor: Quay Dortch (NOS)

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

Kate Burns (GMRI)

NOAA Sponsor: Drew Kitts and Matt McPherson (NMFS)

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

James H. Churchill (WHOI)

NOAA Sponsor: Jonathan Hare (NMFS/ NEFSC)

- *Research and education in quantitative fisheries and ecosystem science*

Donald Anderson (WHOI)

NOAA Sponsor: Russell Brown (NMFS)

- *Refining eastern region stakeholder needs for climate products and services*

Donald Anderson (WHOI)

NOAA Sponsor: Ellen Mecray (NESDIS)

- *Marine Resource Education Program: Serving the needs of fishing communities and fishery management in the Northeast region*

Alexa Dayton (GMRI)

NOAA Sponsor: Earl Meredith (NMFS)

- *Marine Resource Education Program for fishermen in the Southeast fisheries region*
Alexa Dayton (GMRI)
NOAA Sponsor: Kim Amendola (NMFS)
- *GC × GC Capacity Building in South Korea in the Wake of the Hebei Spirit Oil Spill*
Robert K. Nelson (WHOI)
NOAA Sponsor: Brendan Bray (Office of Response and Restoration)
- *Research and Education in Quantitative Fisheries and Ecosystem Science*
Donald Anderson (WHOI)
NOAA Sponsor: Richard Merrick (NMFS NEFSC)
- *US National Office for Harmful Algal Blooms*
Donald Anderson (WHOI)
NOAA Sponsor: Quay Dortch (NOS CSCOR)
- *Marine Resource Education Program: Professional Training for Fisherman in the Northeast Region and a Forum for Dialogue among Fishermen, Scientists and Managers.*
Alexa Dayton (GMRI)
NOAA Sponsor: Jon Hoey (NMFS)
- *Fisheries Science and Management Education for fishermen in the Southeast Fisheries Region*
Alexa Dayton (GMRI)
NOAA Sponsor: Kim Amendola (NMFS/SER/SERO)
- *Research and education in quantitative fisheries and ecosystem science*
Donald Anderson (WHOI)
NOAA Sponsor: Russell Brown (NMFS)

- *Marine Resources Education Program: Northeast region*
Alexa Dayton (GMRI)
NOAA Sponsor: John Hoey (NMFS)
- *Marine Resources Education Program: Southeast fisheries region*
Alexa Dayton (GMRI)
NOAA Sponsor: Kim Amendola (NMFS)
- *UMaine Cooperative Education*
Gayle Zydlewski (UMaine)
NOAA Sponsor: Richard Langton (NMFS)
- *MREP as a Catalyst for Cooperation*
Meredith Mendelson (GMRI)
NOAA Sponsor: Earl Meredith (NMFS / NERO)
- *Student Fellowship: Habitat Use and Dietary Patterns of Diadromous Fishes in the Northwest Atlantic: Making the Connections Between River Restoration and Sustainability of Federally Managed Fisheries*
Thomas J. Miller (UMCES)
NOAA Sponsor: Jason Link (NMFS / NEFSC)

CINAR Research Summaries (April 1, 2016-June 20, 2016)

The following pages provide research summaries of the ten CINAR projects that received an extension of the period of performance through June 30, 2016. The projects are organized by theme. Note that not all themes are represented in this report, as most are covered by the CINAR renewal award.

Theme I. Ecosystem Forecasting

- No Projects for this theme

Theme II. Ecosystem Monitoring

- Donald Anderson, WHOI – *Integrated Approaches to Ecosystem Based Fisheries Management Combining Social and Ecological Perspectives through Pilot Fishery Ecosystem Plans*

Theme III. Ecosystem Management

- Steven Eayrs, GMRI – *Commercial Fishing Vessel Electronic Trip Reporting Pilot Study*
- Jonathan Labaree, GMRI – *Improving Fishery-dependent Data Collection and integration into NOAA Fisheries Data Systems*

Theme IV. Protection and Restoration of Resources

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

Theme V. Sustained Ocean Observations and Climate

- Carin Ashjian, WHOI – *An Eye on the Ocean*
- Mark Baumgartner, WHOI – *Bowhead Whale feeding in the Western Beaufort Sea : Oceanographic Conditions, Whale Prey Distribution and Whale Feeding and Foraging Behavior*
- Robert Weller, WHOI – *Ocean Climate Observations and Analyses*
- Robert Weller / Albert Plueddemann, WHOI – *Supplement – Ocean Climate Observations*

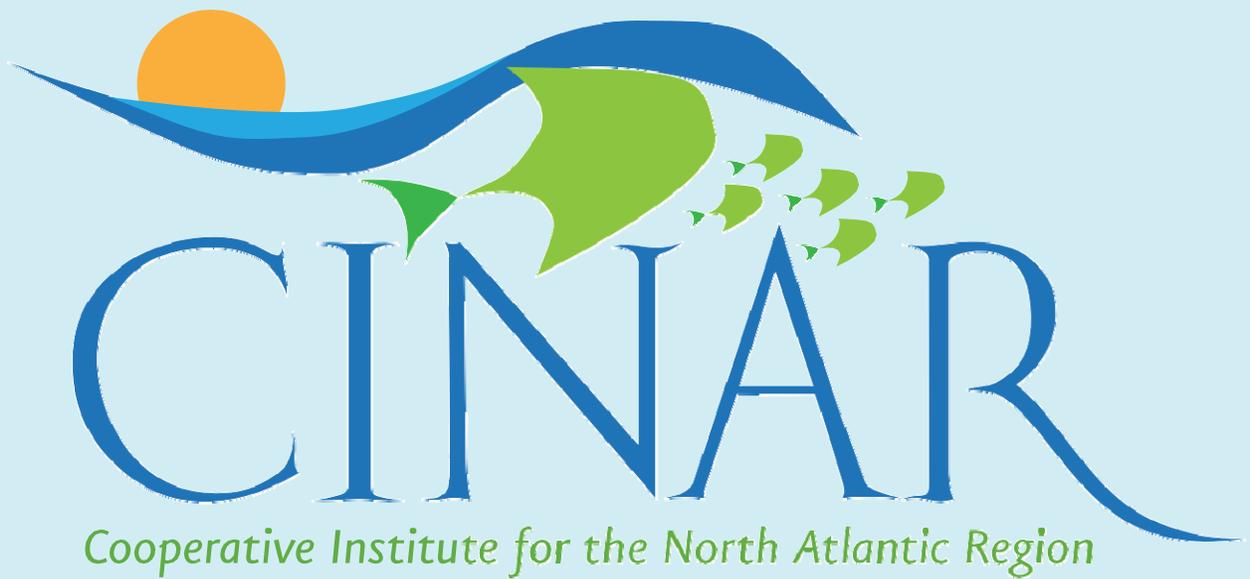
Theme VI. Education and Outreach

- Donald Anderson, WHOI – *U.S. National Office for Harmful Algal Blooms*
- Alexa Dayton, GMRI – *Marine Resource Education Program (MREP): Serving the Needs of Fishing Communities and Fishery Management in the Northeast Region*

THEME: ECOSYSTEM.FORECASTING



THEME II. ECOSYSTEM MONITORING



Integrated Approaches to Ecosystem Based Fisheries Management (EBFM) Combining Social and Ecological Perspectives through Pilot Fishery Ecosystem Plans

NOAA Cooperative Agreement No. NA09OAR4320129
July 1, 2009 – June 30, 2016

***CINAR Investigators – Donald Anderson and Porter Hoagland, WHOI, and Bonnie McCay,
Rutgers***

NOAA Sponsor – Barbara Roundtree, NMFS

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: 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 in the organization and support of a symposium on multispecies fishery modeling. The PIs and collaborating investigators recognize that progress on the pilot studies must of necessity rely upon complementarities among ongoing research efforts funded through other sponsors.

ACCOMPLISHMENTS

The pilot studies have been reported on, discussed, and improved at international meetings and symposia. Results of the research have been reported at several international meetings. These studies also were 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 described below.

Spatial mapping to characterize the extent of overlap between EPU (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 EPU and such “communities at sea” might imply more successful management of the EPU as common property resources. A second is that linking EPU 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 EPU. Kevin St. Martin (Rutgers) and Julia Olson (NEFSC) are continue to work closely with Mike Fogarty and his colleagues at the NEFSC Ecosystems Assessment Program on understanding the relationships between EPU and communities-at-sea and spatial resource dependencies (St. Martin and Olson 2015; Olson and St. Martin 2015).

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 (Jin et al. 2012). Di Jin (WHOI), Porter Hoagland (WHOI) and Eric Thunberg (NEFSC) collaborated on this pilot study. Work accomplished this project year included the publication of papers on the welfare and inequality effects of the displacement of commercial fisheries by renewable energy facilities (Hoagland et al. 2015, 2014) and presentation of the CGE approach to the modeling of EBFM at the annual meeting of the American Fisheries Society in Portland, OR (Jin 2015).

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. Geret DePiper (NEFSC), Di Jin (WHOI), and Porter Hoagland (WHOI) collaborated on this pilot study. Work accomplished included presentation of the approach at the American Fisheries Society (DePiper 2015) and publication of a paper on portfolio management at a range of scales: the Northeast Large Marine Ecosystem, EPU, and ports (Jin et al. 2016).

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 a 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) and Michael Paolisso (Maryland) collaborated on this pilot study. Bonnie McCay has presented her work on climate change, fisheries, and communities to a Mid-Atlantic Fisheries Management Council session on the Ecosystem Approach to Fisheries Management (McCay 2015). Bonnie McCay previously published a review on recent work relating to shifts in fishing grounds as fishermen adapt to climate change (McCay 2012).

Future research projects identified by this work include:

Characterizing how the pilot studies might contribute to NEFSC research efforts on a multispecies-multifleet, length-based, spatial assessment model for the U.S. northeast continental shelf, which is now under development by the NEFSC Ecosystems Assessment Program; incorporating estimates of fisheries biomass explicitly into the portfolio management model; identifying other social scientists with whom we might collaborate on the work we have undertaken; and clarifying how the research efforts that constitute the pilot studies would contribute to realizing 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

DePiper G. 2015. Assessing risk-reward tradeoffs in multispecies modeling frameworks using financial portfolio theory. Presentation at session on: Multispecies Modeling (Including Humans!) for Fisheries Management: Where Are We Now and Where Can We Go? Part 1. *145th Annual Meeting of the American Fisheries Society* in Portland, OR (August 18).

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.

Jin D. 2015. Linking regional economic and marine food web models for ecosystem-based management. Presentation at session on: Multispecies Modeling (Including Humans!) for Fisheries Management: Where Are We Now and Where Can We Go? Part 1. *145th Annual Meeting of the American Fisheries Society* in Portland, OR (August 18).

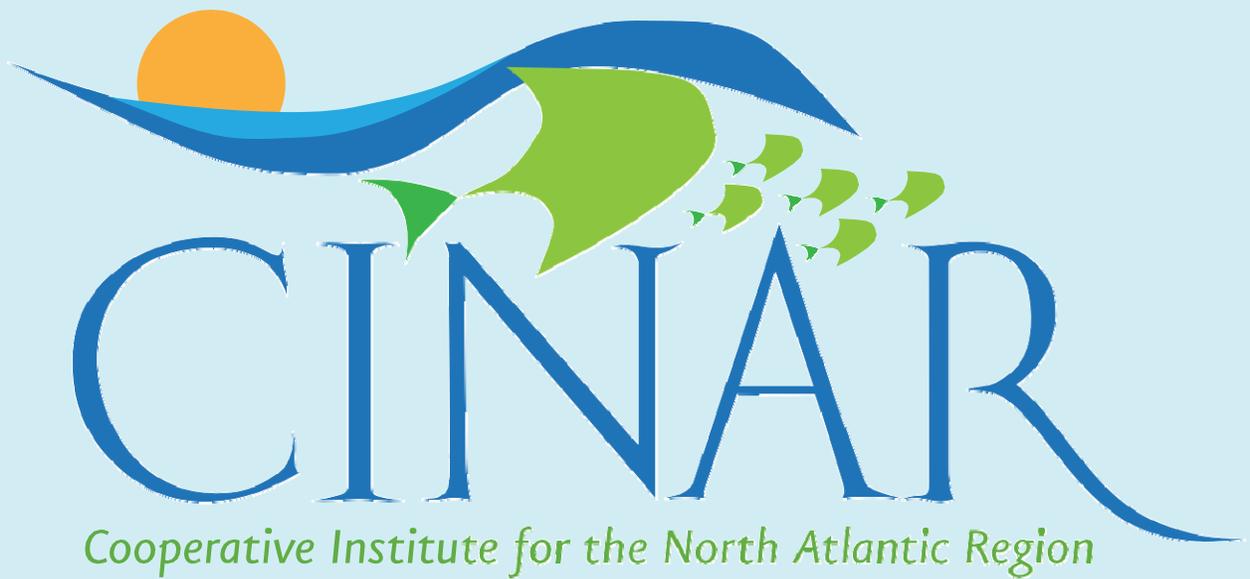
Jin D, DePiper G, Hoagland P. 2016. An empirical analysis of portfolio management as a tool for implementing ecosystem-based fishery management. *No. Am. J. Fish. Mgmt.* 36:652-669.

Jin D, Hoagland P. 2015. Linking regional economic and marine food web models for 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. For submission to *Fisheries*.

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

THEME III. ECOSYSTEM MANAGEMENT



Commercial Fishing Vessel Electronic Trip Reporting Pilot Study

NOAA Cooperative Agreement No. NA09OAR4320129
July 01, 2009 – June 30, 2016

CINAR Investigator – Steve Eayrs, GMRI

NOAA Sponsor – Joan Palmer, NEFSC

Related NOAA Strategic Plan Goal: Resilient Coastal Communities and Economics

CINAR Theme: Ecosystem Management

PROJECT OVERVIEW

The goal of this project is to test the feasibility of adopting electronic solutions for vessel reporting requirements across a range of sector and common pool vessels in the northeast groundfish fleet. This includes testing a range of electronic logbook products in conjunction with the NMFS' web-based data entry system to identify obstacles in their use and to ensure their compatibility with NMFS' data collection systems.

A two-pronged approach is being applied to achieve the goal of this project. The first is to work with software providers, sectors, and NMFS staff to identify and overcome outstanding challenges and limitations to effective transmission of VTR data. A sizeable portion of time is dedicated to the provision of IT training for fishermen, in the use and operation of computers and eVTR software, and ongoing field support. The second approach is dominated by outreach activity designed to raise awareness and facilitate the use of eVTR options. This includes contacting sector managers and fishermen to learn of their interest, needs, and concerns vis a vis eVTR. We also expect an extensive outreach campaign informing fishermen and others of the opportunity and benefits of eVTR use.

ACCOMPLISHMENTS

Over the past few years, captains from over 30 vessels have been provided with equipment, software, training, and support under this project. Review of the project to-date indicates that electronic Vessel Trip Reports (eVTR) are a plausible method of reporting vessel activity.

However, recent problems in the groundfish fishery including reduced quota for cod and flatfish has caused significant turmoil and uncertainty within the fishing fleet. Subsequently, many fishermen have left and many others are considering their future in the fishery. In this environment it has been a significant challenge encouraging additional groundfish fishermen to adopt eVTRs. We have therefore spent considerable time promoting eVTR use to charter and party boat captains as well as to lobster fishermen that also have a groundfish permit.

HIGHLIGHTS

The highlights of this project during the reporting period are as follows:

- We have now equipped 41 groundfishing vessels (up from 37 last year) with the new eVTR software, although only 22 are consistently reporting electronically at present.
- These vessels have together transmitted over 1,500 trip reports over the past fishing year.
- We have instituted a brief eVTR questionnaire of eVTR users to better understand their i) rationale for using eVTRs, ii) their perspectives regarding related computer software, and iii) perceived benefits and disadvantages of eVTRs. This questionnaire is designed to help guide our efforts including attracting greater number of fishermen to use eVTRs.

SOCIETAL BENEFITS

The societal benefits of this project are an increasingly computer savvy fishing industry, and transmitting fishing data quickly and efficiently to NOAA for the purpose of vessel monitoring.

EDUCATION AND OUTREACH ACTIVITIES

The educational and outreach activities of this project during this reporting period are as follows:

- Poster presentation at the Maine Fishermen's Forum, one of the largest annual gatherings of fishermen in New England.
- Project report in the International Council for the Exploration of the Sea (ICES) Fishing Technology and Fish Behaviour Working Group meeting in Merida, Mexico.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS



Figure 1: GMRI Research technician, Aaron Whitman (wearing cap) providing eVTR training at the Cap Cod Commercial Fishermen's Alliance in Chatham, MA.

Improving Fishery Dependent Data Collection and Integration into NOAA Fisheries Data System

NOAA Cooperative Agreement No. NA09OAR4320129
July 01, 2009 – June 30, 2016

CINAR Investigator – Jonathan Labaree, GMRI

NOAA Sponsor – Doug Christel, NMFS

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: Ecosystem Management

PROJECT OVERVIEW

1. Scoping

- Research the scope of the problem, including how dealers link their purchase back to the vessel when they do not have direct contact with the vessel.
- Research how other parts of the country, or international organizations deal with this gap.

2. Convening

- Convene stakeholders, including, fishermen, truckers, dealers, fisheries managers, and researchers from GMRI to brainstorm a viable solution to the vessel to dealer data gap. This will result in recommended business rules to establish a linkable data chain from vessel to dealer.
- Where practicable, work closely with GMRI seafood team to ensure the outcome of this project is well aligned with regional efforts around seafood traceability. The primary purpose of incorporating traceability is to provide incentives for vessel and dealers to adhere to the suggested business rules and strive to create solutions.

3. Testing (optional)

- If a testing phase is deemed useful by NMFS and GMRI, a proof of concept experiment will be conducted that fits within the suggested business rules and creates a concrete link between vessel and dealer.

4. Reporting

- Deliver a final report to the FDDC staff to guide decisions for implementing a solution to the vessel to dealer data gap.

Due to requests from GARFO leads Jen Anderson and Jonathan Oniel we are focusing our attention mostly to the issues that arise when trucking is involved in the chain. This is more focused than the original goal of focusing on any situation where there is a breakdown in the data flow between vessels and dealers. We have been informed that the broader issues will be addressed by NOAA and another contractor.

Due to the uncertain nature of the greater Fisheries Dependent Visioning Project, the "testing phase" will likely be short or non-existent. We feel it will be more powerful to provide a breath of options to resolve the trucker to dealer data gap rather than digging deep into one solution. This will allow for more flexibility and increase the possibility of one of the solutions being able to fit well within the greater project.

ACCOMPLISHMENTS

GMRI has conducted 13 interviews from a variety of stakeholders including fisherman, truckers, fleet managers, offload locations, dealers, book keepers, and controllers. Through these interviews, we have been able to identify a variety of issues pertaining to data flow from trucks.

We have worked with each party interviewed to brainstorm viable solutions to their unique problems. We then worked with our sub-contractor, supply chain and traceability experts, and Fish LLC to use the knowledge gained from participants meeting to develop four possible solutions to the problems we uncovered.

Currently we are refining these ideas and soliciting feedback from participants, including their critiques of the solutions in order to make them more robust. Our participants will also help us to understand the impacts that each solution may have if implemented. This process will give us the ability to suggest solutions that have been vetted by the industry, which should result in smoother implementation of such solutions.

HIGHLIGHTS

The GMRI team has:

- Successfully documented the issues pertaining strictly to the vessel to dealer trucking gap through interactions with industry along the entire supply chain.
- Developed four possible solutions to improve data transmission from truckers to dealer and ultimately to SAFIS/GARFO (these solutions are currently being shopped around and vetted by a wide variety of stake holders).

SOCIETAL BENEFITS

Poor quality fishery dependent data is being transmitted to state and federal agencies for use in management. By creating solutions to increase that data quality we will improve those agencies' ability to use such data and ultimately better manage fisheries.

Also, by improving this process there should be significant savings in time and money that is allocated to retroactively correcting poor quality data.

EDUCATION AND OUTREACH ACTIVITIES

None to this point, although we have uncovered a need for more formal Vessel Trip Report training and outreach. This need will be addressed in detail in the final report.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS



Figure 1. Example of data tags used in New England. Note the corrections and lack of clarity.

THEME IV. PROTECTION AND RESTORATION OF RESOURCES



Evaluation of Larval Sources and Population Connectivity in Atlantic Sea Scallop

NOAA Cooperative Agreement No. NA09OAR4320129
July 01, 2009 – June 30, 2016

CINAR Investigator – Daphne Munroe, Rutgers

NOAA Sponsor – Devora Hart, NEFSC

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: 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 2015 project year, we simulated scallop larval dispersal with the coupled biological 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 was used to simulate larval dispersal on the Middle Atlantic Bight from 2006 through 2012. Analysis of the larval dispersal simulations is ongoing to assess general patterns of connectivity in the scallop stock and among closed areas, as well as evaluating interannual variability in dispersal patterns and how spawning timing interacts with dispersal to create this variability. Dissemination of these results to date has been via presentations at scientific meetings. Manuscripts for peer reviewed publication are in progress.

ACCOMPLISHMENTS

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).

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) is well connected 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 the 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), using release strategies that cover the range of stock biomass and possible spawn timing.
- This model has been 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.
- The interaction of spawn timing and success due to physical dispersal may be important in understanding stock dynamics.
- 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

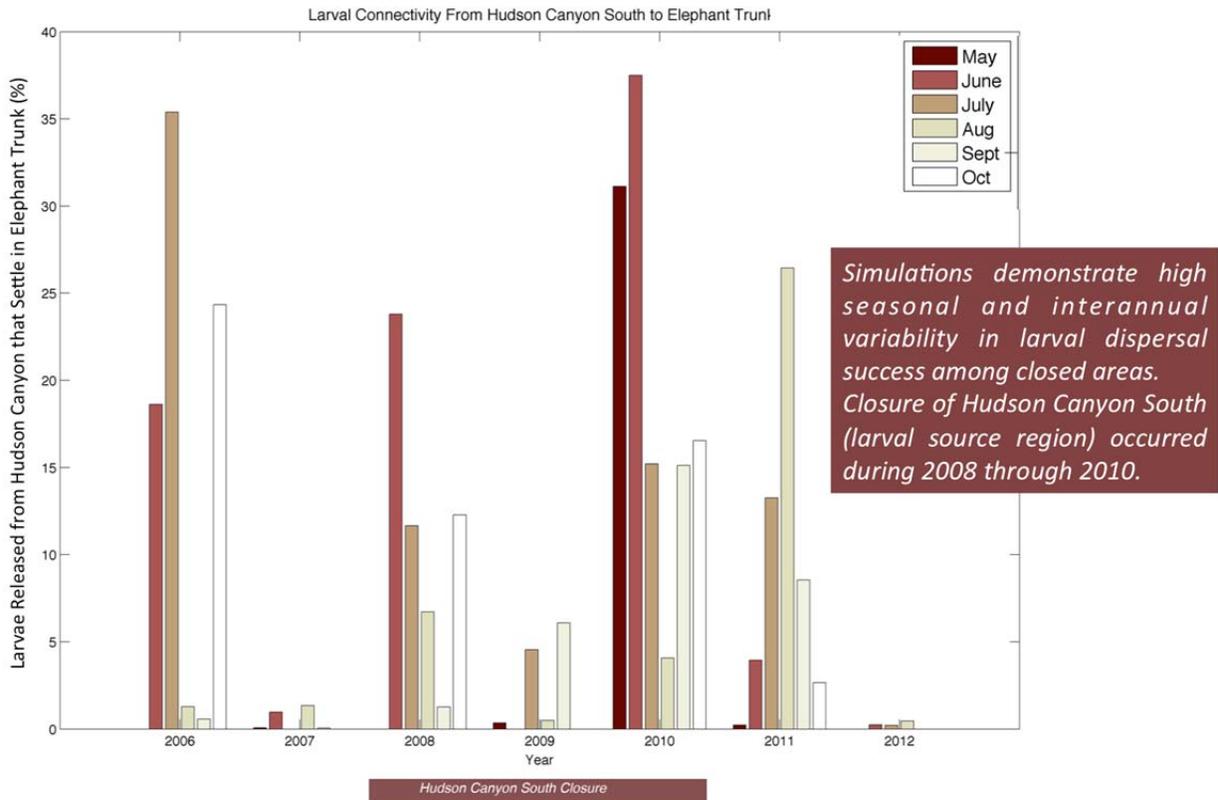
- Hart, D. 2015. Evaluation of larval sources and connectivity in Mid-Atlantic sea scallop populations. FATE Science Conference at the SWFSC, La Jolla, Jan 14, 2015.
 - Munroe D., Hart DR, Shank B, Haidvogel D, Wang Z, Powell EN, Klinck J, Hofmann E. 2015. Managing the Supply Side: Larval Dispersal from Rotating Closures in the Atlantic Sea Scallop (*Placopecten magellanicus*) Fishery. Oral presentation. The 20th International
-

Pectinid Workshop, 22nd-28th April 2015, Galway, Ireland.

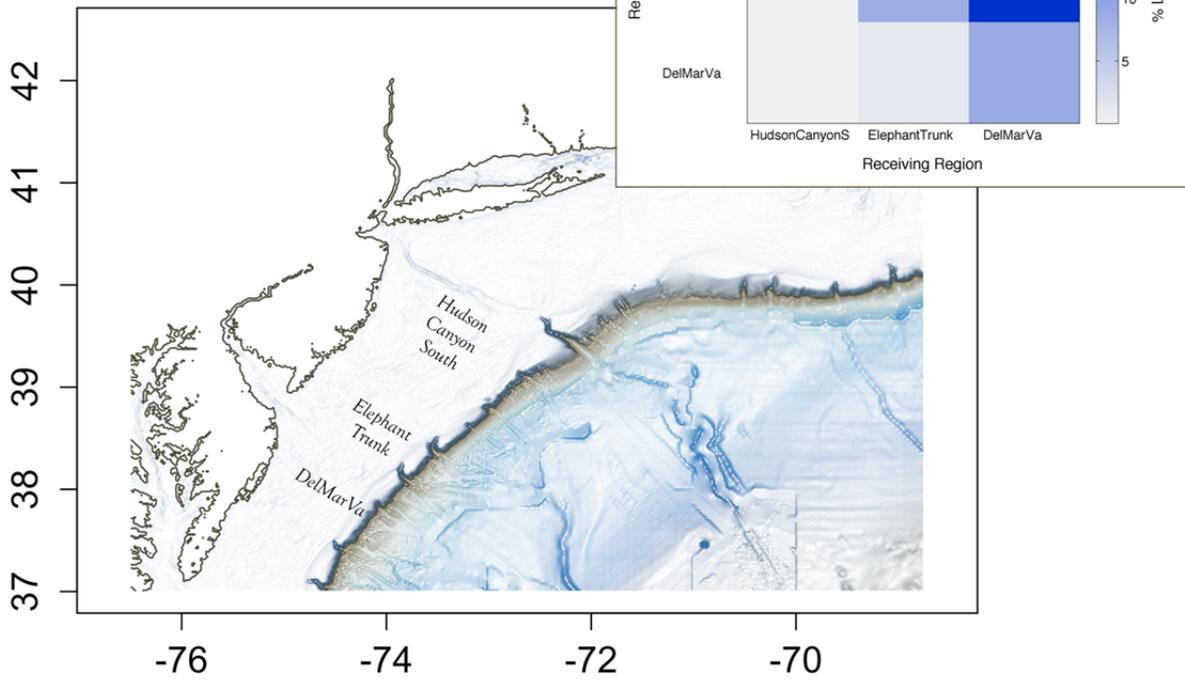
PUBLICATIONS

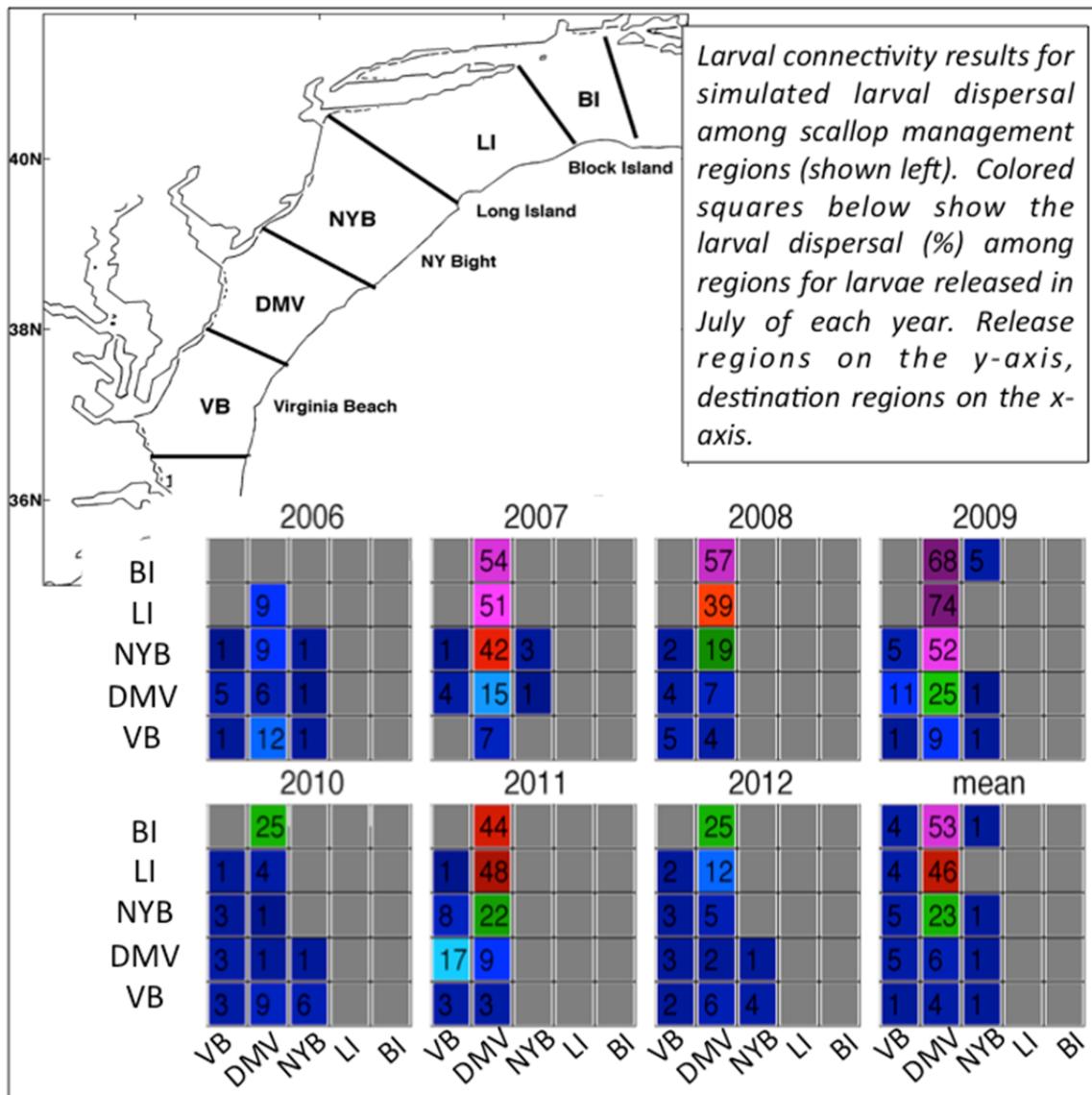
Munroe D, Wang, J, Haidvogel D, Klinck J, Powell E, Hofmann E, Levin J, Shank B, Hart D. Modeling larval dispersal and connectivity in the Atlantic sea scallop (*Placopecten magellanicus*) in the Middle Atlantic Bight. In Preparation.

FIGURES/PHOTOGRAPHS/ ILLUSTRATIONS



Simulations show successful larval dispersal among scallop management regions in the Mid Atlantic Bight. At the end of the closure in Hudson Canyon South (2010), strong connectivity is demonstrated from Hudson Canyon to Elephant Trunk and DelMarVa.





THEME V. SUSTAINED OCEAN AND OBSERVATIONS AND CLIMATE



An Eye in the Ocean: Exploration of High-Resolution Vertical Distributions of Plankton and Particles and Coincident Hydrography in the Western Chukchi Sea Data Synthesis

NOAA Cooperative Agreement No. NA09OAR4320129
July 1, 2009 – June 30, 2016

CINAR Investigator – Carin Ashjian, WHOI

NOAA Sponsor – Kathleen Crane / Jeremy Mathis, OAR

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: Sustained Ocean Observations and Climate

PROJECT OVERVIEW

The overall goal of the proposed work was 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.

ACCOMPLISHMENTS

All data were archived at the RUSALCA data archive. A paper that included VPR data was included in the special issue of Oceanography highlighting the RUSALCA program.

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 (Figures 2 & 3).
- The VPR was an effective means of 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.

PUBLICATIONS

Pisareva, M.N., Pickart, R.S., Iken, K., Ershova, E.A., Grebmeier, J.M., Cooper, L.W., Bluhm, B.A., Nobre, C., Hopcroft, H.R., Hu, Haoguo, Wang, J., Ashjian, C.J., Kosobokova, K.N., Whitley, T.E. 2015. The relationship between patterns of benthic fauna and zooplankton in the Chukchi Sea and Physical Forcing. *Oceanography* 28(3):69-83. doi:10.5670/oceanog.2015.58.

FIGURES/PHOTOGRAPHS/ILLUSTRATIONS

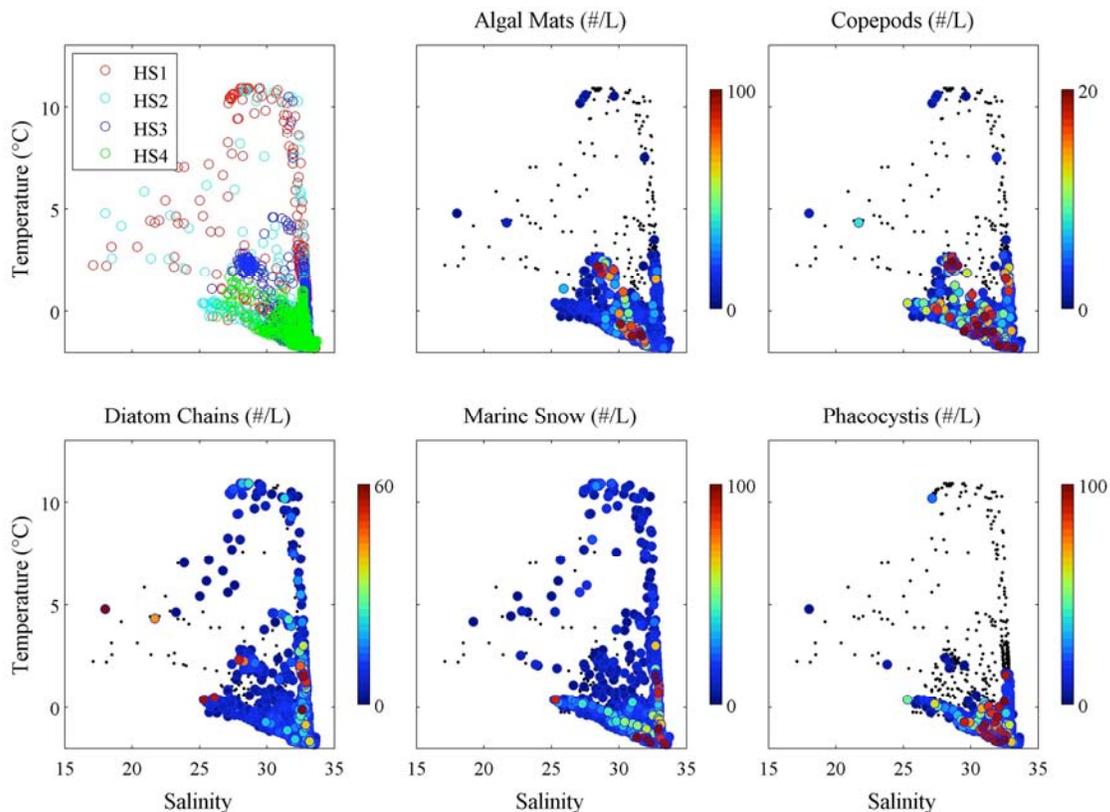


Figure 1. Temperature-salinity-plankton diagrams for Herald Canyon in August 2004. Upper left panel shows the TS for all of the tows with the different transects indicated in different colors and dominant water types indicated. The remaining panels show TSP plots for dominant plankton/particles. Strong 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).

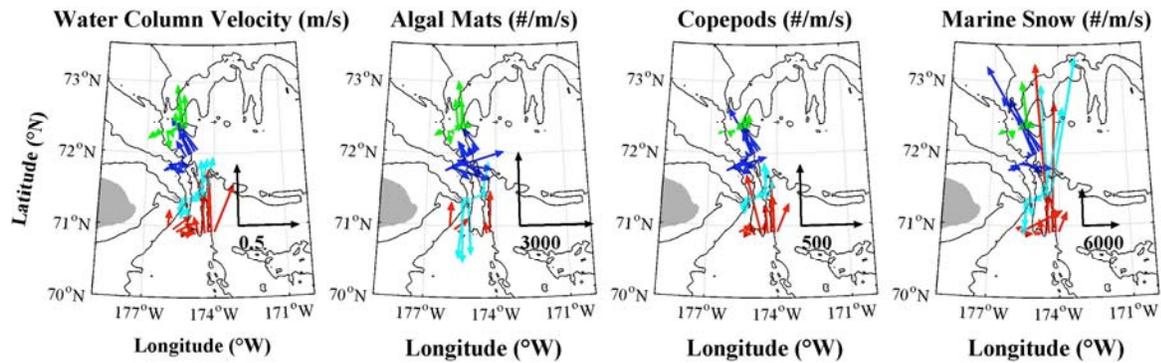


Figure 2. Mean water column velocity (m/sec) and the mean water column flux (#/m/sec) of algal mats, copepods, and marine snow through Herald Canyon in the western Chukchi Sea in August 2004. Flux was calculated by combining the water column abundance of plankton or particles with the mean water column 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.

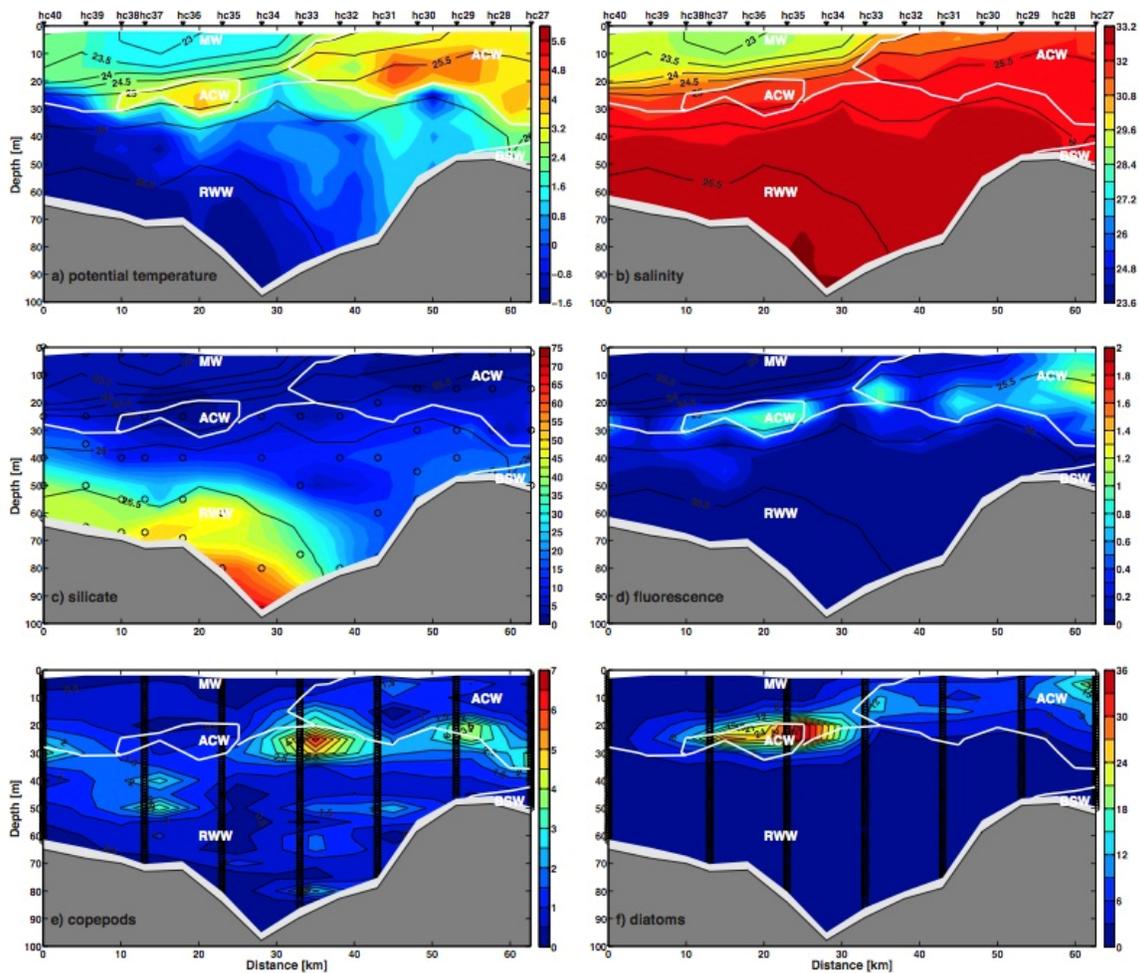


Figure 3. Vertical sections from across Herald Canyon. Thick black lines on lower plots indicate locations of VPR casts. Diatoms, fluorescence, and copepods were concentrated along the pycnocline at the junction of warm Alaskan Coastal Water and cold Remnant Winter Water. Silicate was exhausted in the upper water column. Phytoplankton at the pycnocline could take advantage of slightly higher nutrient concentrations below the pycnocline while still experiencing sufficient light to grow. Copepods migrated to the elevated phytoplankton to feed. Figure by M. Pisareva.

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

NOAA Cooperative Agreement No. NA09OAR4320129
July 01, 2009 – June 30, 2016

CINAR Investigator – Mark Baumgartner, WHOI

NOAA Sponsor – Kim Sheldon NMML/AFSC

Related NOAA Goal Plan: Healthy Oceans

CINAR Theme: Sustained Ocean Observations and Climate

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

The small amount of remaining funds in the grant was used to support a Ph.D. student project on bowhead whales in the Canadian Arctic. Funds were used primarily for shipping.

Ocean Climate Observations and Analyses

NOAA Cooperative Agreement No. NA09OAR4320129
July 01, 2009 – June 30, 2016

CINAR Investigator – Robert Weller, WHOI

NOAA Sponsor – Diane Stanitski, OAR

Related NOAA Strategic Plan Goal: Climate Adaptation and Mitigation

CINAR Theme: 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 FY 2015, 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. In April 2015, the Chilean Navy vessel *Cabo de Hornos* was used to recover and redeploy the Stratus ORS. In July 2015, the WHOTS mooring was recovered and a fresh mooring deployed from the NOAA Ship *Hi'ialakai*. In January-February 2016, the NTAS ORS was recovered and redeployed using *RV Endeavor*. Each cruise resulted in the collection of the internally recorded data from the instrumentation on the buoy and on the mooring line, and of 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 telemetered via satellite. The WHOI ORS data are not placed on the global telecommunication system (GTS); instead, they are used as independent data for model validation 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 collected by the Stratus ORS 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 long wave 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, velocity, and dissolved oxygen along the mooring line. The surface meteorology, surface temperature, and surface current are used with the bulk formulae to compute the following fourth product: (4) Air-sea fluxes of heat, freshwater, and momentum. In addition, the Stratus ORS obtains: (5) Deep temperature and salinity – all three moorings carry additional sensors near the sea floor to record deep temperature and salinity; (6) Surface wave data using a NOAA National Data Buoy Center wave package; (7) pCO₂ observations using NOAA Pacific Marine Environmental Laboratory (PMEL) instrumentation; (8) Dissolved oxygen using sensors deployed both under this project and by Dr. Lothar Stramma from Geomar in Kiel, Germany; and (9) In water radiance observations at WHOTS by Sam Laney of WHOI.

The surface moorings are a very effective methodology. The WHOTS mooring has been on station 100% of the desired time. The Stratus and NTAS moorings have each provided 94% of the planned station time. Close to a complete (99.6%) record of surface meteorology has been delivered by the three ORS. In spite of biofouling, fishing gear entanglement, and other challenges 87% of the ocean sensor data sought while on station has been recovered; and, with redundancy in ocean instrumentation on the moorings, the result has been very effective observation of the variability and structure of the upper ocean.

The ORS addresses the following ocean observing system program deliverables:

- **Sea surface temperature (SST) and surface currents.** The ORS surface buoys have been instrumented to provide 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 are sought by investigators working on climate dynamics, air-sea interaction, diurnal warm layer dynamics, and remote sensing of SST.
- **Ocean heat content and transport.** The ORS are equipped with temperature, salinity, and velocity sensors concentrated from about 1000 m to the surface and also the deep sensors close to the bottom. 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 Stratus 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 NOAA PMEL provides pCO₂ observations from Stratus and WHOTS.

HIGHLIGHTS

- Weller (2015) reported finding long-term trends in surface meteorology and air-sea fluxes at the Stratus ORS. 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.
 - Comparisons of annual mean wind stress magnitudes from the Stratus ORS and the NCEP2 and ERA-Interim Reanalyses should differences. ERA winds reproduce the temporal variability in stress observed at the buoy quite well, but the ERA winds have a strong high
-

bias. NCEP2 winds, while closer to the means from the buoy, have different year-to-year variability and a weaker slope. Indeed, from 2000 to 2007, NCEP2 wind stress would suggest a negative slope or decreasing wind stress (Figure 1).

- The vertical structure of the ocean at the Stratus ORS and the presence of a low oxygen layer has been the focus of continued attention through our partnership with German investigators (Lothar Stramma, Kiel). To address this, we have added oxygen sensors and added instruments from Stramma.
- WHOTS, like the other ORS, records local air-sea forcing (exchanges of heat, freshwater and momentum) as well as local ocean variability. We partner with the University of Hawaii (R. Lukas and M. Church, with NSF funding) on the oceanographic instrumentation, and recent work by R. 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. It is found that 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 10 years of the WHOTS record. Our own results from the buoy data point to trends in WHOTS surface forcing (net heat flux, net shortwave, and rain) and surface salinity (Figure 2).
- The NTAS ORS is in a region where the mechanisms controlling SST and upper ocean heat content are of interest. 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). We have looked to see if the Atlantic trade wind regime has shown significant trends as seen at WHOTS and Stratus and have not yet found significant trends at NTAS (Figure 3).

Significance of these scientific advancements: The ORS results are particularly significant in two areas:

1. Benchmarking three trade wind sites – the three ORS now provide accurate local climatologies of surface forcing and upper ocean variability. As such they form the basis for us to go forward and examine model errors and biases and identify those that are characteristic of how these models represent the trade wind region. They also form the basis for tracking anomalies in surface forcing and upper ocean heat content and identifying the spatial representativeness of such anomalies by looking at decorrelation scales in the atmosphere (in model and OA Flux fields) and in the ocean (in Argo float data).
2. Quantifying the processes at work to maintain the state of the upper ocean – the combination of accurate local forcing and good time/space resolution in the upper ocean allows us to identify the major contributors to local heat, freshwater, and momentum balances. Stratus, for example, at first obtained accurate fluxes that showed, in contrast to models, that the upper ocean there was heated by the atmosphere and needed ocean processes for cooling and freshening. Subsequently, Stratus data has motivated modelers and other researchers to examine the roles of ocean eddies and vertical mixing and, more recently, to examine the ability of models to reproduce and explain the trends observed in the surface forcing at Stratus. In addition, with the partnership with Stramma, the Stratus ORS now serves as a focal point for collaborative study of the low oxygen layer found below the upper thermocline.

We have now started two related efforts, working with R. Lukas and J. Potemera of U. Hawaii. These are an examination of tropical biases in models and an effort to define climate indicators. Both will use the ORS data. The accurate and quality-controlled ORS surface forcing and coincident, high vertical and temporal resolution ocean time series are ideally suited to these efforts.

SOCIETAL BENEFITS

The ORS long-term observing effort is particularly significant in two areas: (1) It provides benchmarks to validate and improve climate models in a region important to global climate but presently not well-modeled, and (2) Identifying and quantifying the processes at work across the air-sea interface and in the ocean that maintain the state of the upper ocean, including the SST and heat content. The ability of society to prepare for and mitigate weather and climate variability and impacts depends heavily on the realism of models, and the withheld, high quality time series from the ORS are a key asset in the effort to improve models and build an improved understanding of the earth system.

EDUCATION AND OUTREACH ACTIVITIES

- Whenever possible, cruises to the Stratus ORS have involved NOAA Teachers at Sea and also undergraduate and graduate students, including some from Chilean universities.
- “Variability and Trends in Surface Meteorology and Air-Sea Fluxes at a Site off Northern Chile”, International Conference on Southern Hemisphere Meteorology and Oceanography, Santiago, Chile, October 2015
- Visit to the Department of Meteorology, Universidad de Chile, Santiago, Chile, October 2015
- Visit to the First Naval District Headquarters, Chilean Navy, Valparaiso, Chile, April 2015
- “Research at the Stratus ORS”, talk on board the Chilean Navy vessel *Cabo de Hornos*, April 2015
- “Oceanic Response to Surface Forcing off Northern Chile”, seminar at the Department of Meteorology, Universidad de Chile, Santiago, Chile, October 2015
- “Spatial analysis of abyssal temperature variations observed from the Aloha cabled observatory and WHOTS moorings”, Ocean Sciences Meeting, February 2016, given by Santiago-Mandujano, U. Hawaii
- “Accelerating salinity trends at Station ALOHA in the North Pacific Subtropical Gyre”, ”, Ocean Sciences Meeting, February 2016, given by Santiago-Mandujano, U. Hawaii
- “Circulation, eddies, oxygen and nutrient changes in the eastern tropical Pacific Ocean”, European Geophysical Union annual meeting, April 2016, given by Czeschel

PUBLICATIONS

Czeschel, R., L. Stramma, R.A. Weller, and T. Fischer, 2015. Circulation, eddies, oxygen and nutrient changes in the eastern tropical South Pacific Ocean. *Ocean Sci.*, 11, 455-470, doi:10.5194/os-11-455-2015

Weller, R.A., 2015: Variability and Trends in Surface Meteorology and Air–Sea Fluxes at a Site off Northern Chile. *J. Climate*, **28**, 3004–3023. doi: <http://dx.doi.org/10.1175/JCLI-D-14-00591.1>

Sutton, A.J., C. L. Sabine, R. A. Feely, W-J Cai, M. F. Cronin, M. J. McPhaden, J. M. Morel, J. A. Newton, J-H Noh, S. R. Olafsdottir, J. E. Salisbury, U. Send, D. C. Vandermark, and R.A. Weller, 2016: Using present-day observations to detect when anthropogenic change forces surface ocean carbonate chemistry outside pre-industrial bounds. *Biogeosciences Discuss.*, doi:10.5194/bg-2106-104.

FIGURES/PHOTOGRAPHS/ ILLUSTRATIONS

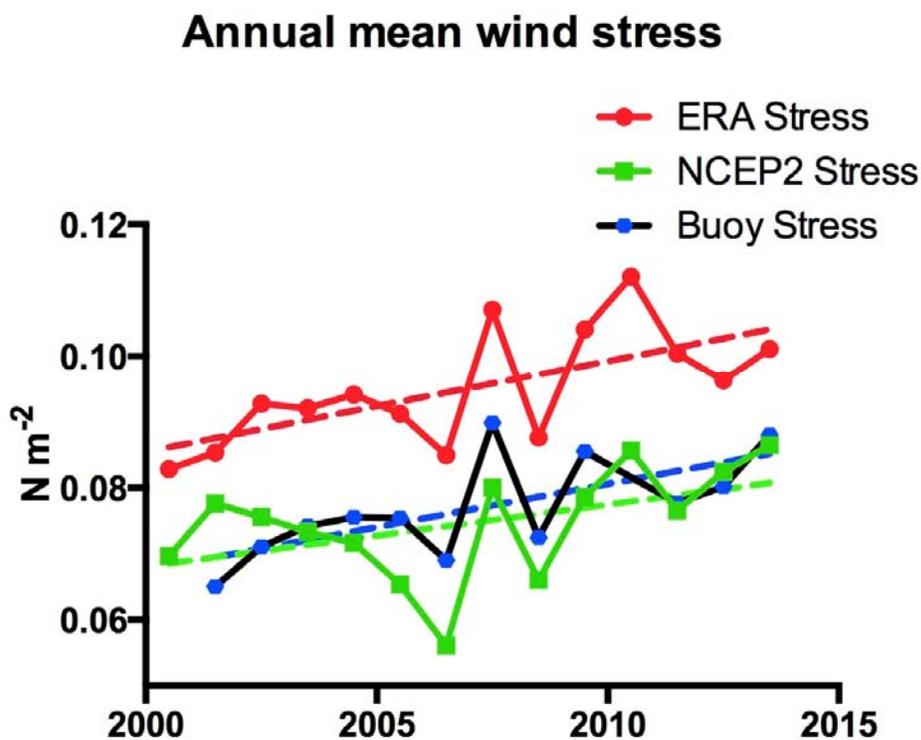


Figure 1. Annual mean magnitudes of wind stress at the Stratus ORS location from the buoy observations (blue), from NCEP2 Reanalysis (green), and ERA Interim Reanalysis (red).

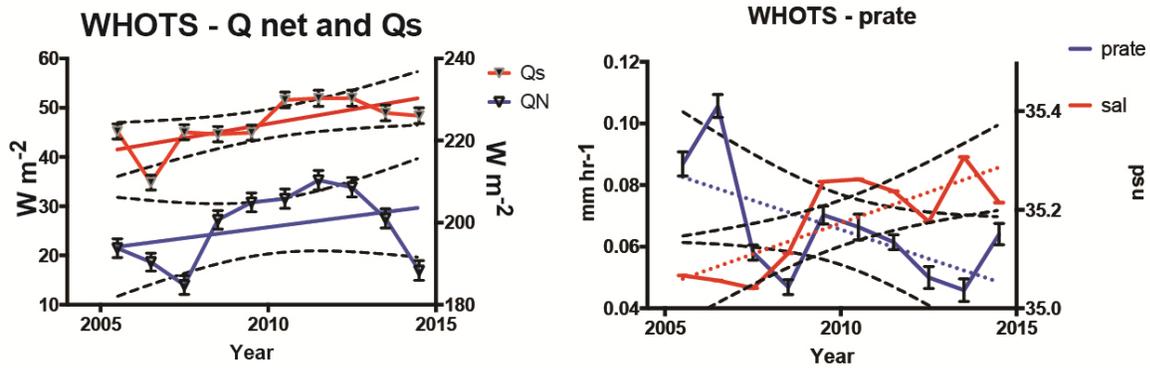


Figure 2. (Left) Annual means of net heat flux (blue) with a linear fit with a slope of $2.0 W m^{-2} yr^{-1}$, and annual means of net shortwave radiation (red) with linear fit with a slope of $1.7 W m^{-2} yr^{-1}$. 95% confidence intervals are shown on the mean value, and the dashed lines show the envelope of possible slopes. (Right) Annual means of precipitation rate (blue) with a linear fit with a slope of $-0.005 mm hr^{-1} yr^{-1}$, and annual means of surface salinity with linear fit with a slope of $0.03 psu yr^{-1}$.

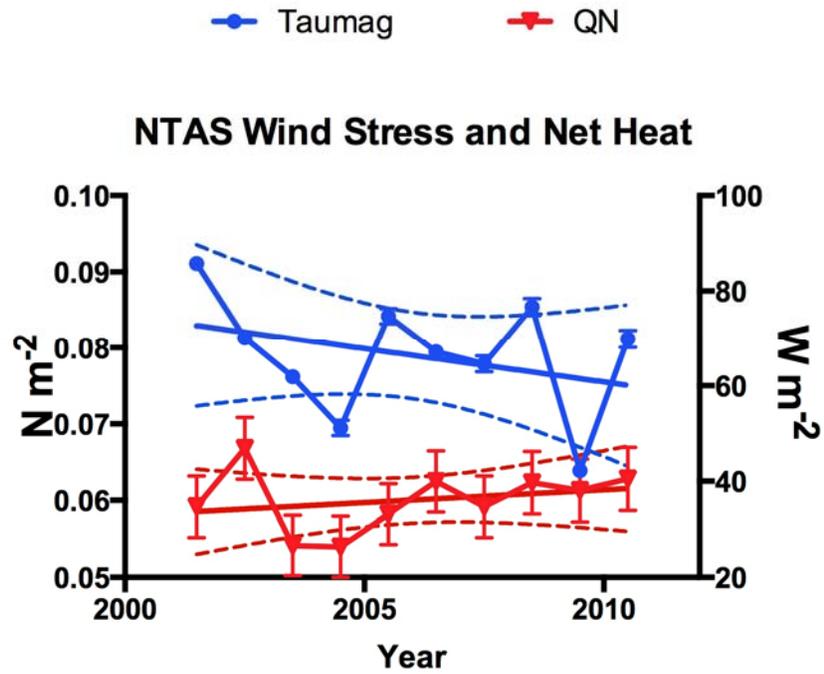


Figure 3. Annual means and linear fits for NTAS wind stress magnitude and net heat flux. These trends are not statistically significant, and the dashed lines show the envelope of possible slopes. 95% confidence intervals are shown as well.

Supplement – Ocean Climate Observations

NOAA Cooperative Agreement No. NA09OAR4320129
July 1, 2009 – June 30, 2016

CINAR Investigator – Robert Weller / Albert Plueddemann, WHOI

NOAA Sponsor – Diane Stanitski, OAR

Related NOAA Strategic Plan Goal: Climate Adaptation and Mitigation

CINAR Theme: 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 April 2015, the Chilean Navy vessel *Cabo de Hornos* was used to recover and redeploy the Stratus ORS. This project provided the necessary additional funds required to carry out work on the Stratus ORS subsequent to the recovery cruise and in preparation for the planned recovery and redeployment cruise in 2016. The work included refurbishment of recovered instrumentation and mooring hardware, processing and quality control of the data recovered from the instruments recovered in April 2015, and preparations for the redeployment cruise planned for the *RV Nathaniel B. Palmer* in mid-2016.

ACCOMPLISHMENTS

The basic deliverables from the ORS are the high quality data, supported by the documentation of the methods. The directly observed data collected by the Stratus ORS 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 long wave 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, velocity, and dissolved oxygen along the mooring line. The surface meteorology, surface temperature, and surface current are used with the bulk formulae to compute the following fourth product: (4) Air-sea fluxes of heat, freshwater, and momentum. In addition, the Stratus ORS obtains: (5) Deep temperature and salinity – the Stratus mooring carries additional sensors near the sea floor to record deep temperature and salinity; (6)

Surface wave data using a NOAA National Data Buoy Center wave package; (7) pCO₂ observations using NOAA Pacific Marine Environmental Laboratory (PMEL) instrumentation; and (8) Dissolved oxygen using sensors deployed both under this project and by Dr. Lothar Stramma from Geomar in Kiel, Germany.

The Stratus ORS thus addresses the following ocean observing system program deliverables:

- **Sea surface temperature (SST) and surface currents.** The Stratus surface buoy has been instrumented to provide improved sea surface temperature observations. Because they sample surface and near-surface ocean temperature and because they have collocated, high-quality air-sea fluxes, Stratus ORS data are sought by investigators working on climate dynamics, air-sea interaction, diurnal warm layer dynamics, and remote sensing of SST.
- **Ocean heat content and transport.** The Stratus ORS is equipped with temperature, salinity, and velocity sensors from about 2000 m to the surface and also the deep sensors at 4500 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 Stratus ORS is equipped to make state of the art, sustained air-sea flux observations, providing the air-sea exchanges of heat, freshwater, and momentum. The Stratus 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 NOAA PMEL provides pCO₂ observations from Stratus.

HIGHLIGHTS

- A unique, high quality long time series data set is being provided the Stratus Ocean Reference Station Stratus site, deployed since October 2000 under the marine stratus clouds, in the eastern boundary of the South Pacific. This is a region of very high scientific interest and challenge, as evidenced by biases found there in ocean and climate models and by it being a region of little change in sea surface temperature or even cooling in a world where SST is generally warming. The uniqueness of the Stratus ORS time series stems from their being withheld and independent of the models, their high quality, their provision of coincident surface forcing and ocean variability, and their high vertical and temporal resolution in the upper ocean.
- Weller (2015) has found long-term trends in surface meteorology and air-sea fluxes at the Stratus ORS. Using the first ten years of Stratus data, statistically significant trends were found in wind speed, wind stress, latent heat flux, and net heat flux. Increases in wind speed, wind stress, and latent heat flux were 0.8 m s^{-1} , 0.022 N m^{-2} , and 20 W m^{-2} or 13, 29, and 20% of the respective means. The decrease in annual mean net air-sea heat flux was 39 W m^{-2} or 104% of the mean.

SOCIETAL BENEFITS

The Stratus ORS long-term observing effort is particularly significant in two areas: (1) It provides benchmarks to validate and improve climate models in a region important to global climate but presently not well-modeled, and (2) Identifying and quantifying the processes at

work across the air-sea interface and in the ocean that maintain the state of the upper ocean, including the SST and heat content. The ability of society to prepare for and mitigate weather and climate variability and impacts depends heavily on the realism of models, and the withheld, high quality time series from the Stratus ORS are a key asset in the effort to improve models and build an improved understanding of the earth system.

EDUCATION AND OUTREACH ACTIVITIES

- Whenever possible, cruises to the Stratus ORS have involved NOAA Teachers at Sea and also undergraduate and graduate students, including some from Chilean universities.
- “Variability and Trends in Surface Meteorology and Air-Sea Fluxes at a Site off Northern Chile”, International Conference on Southern Hemisphere Meteorology and Oceanography, Santiago, Chile, October 2015.
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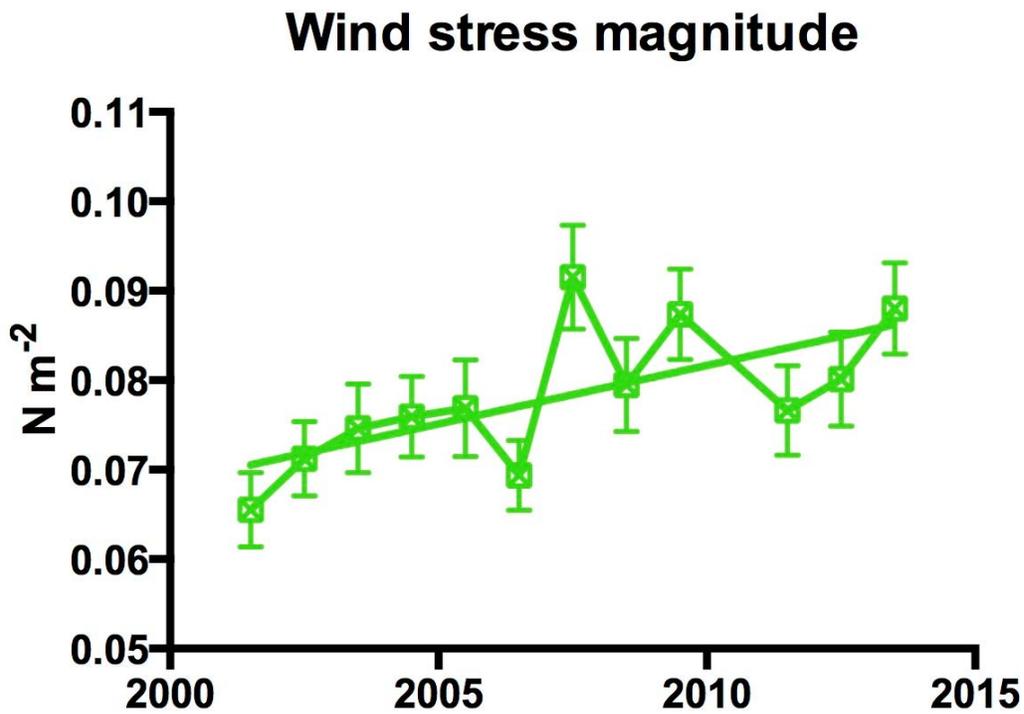


Figure 1. Annual mean wind stress magnitudes, with 95% confidence limits, plotted using Stratus ORS data. The linear fit line is $0.0013 \pm 0.0008 \text{ N m}^{-2} \text{ yr}^{-1}$.

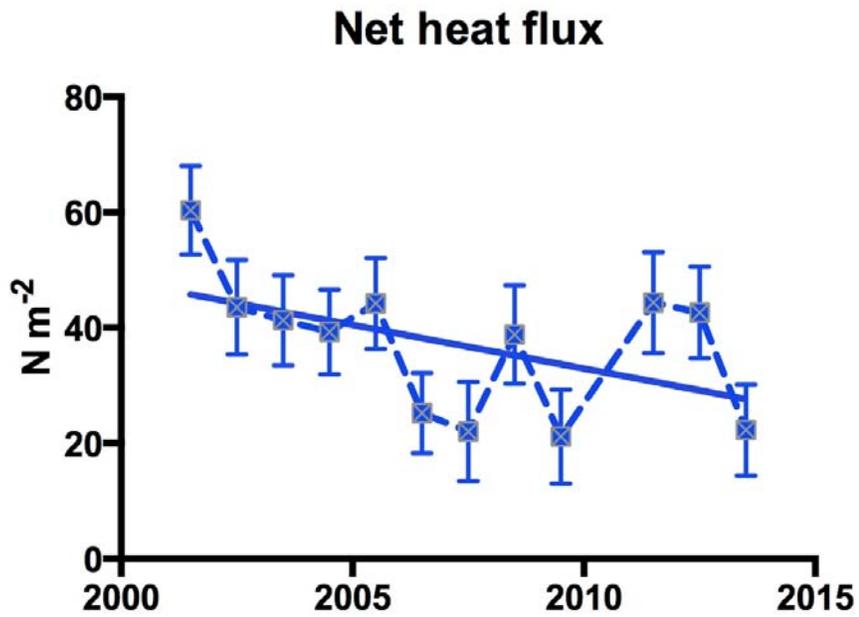


Figure 2. Annual mean net air-sea heat flux, positive meaning the ocean gains heat, plotted with 95% confidence limits using data from the Stratus ORS. The linear fit line is given by $-1.5 \pm 0.8 \text{ W m}^{-2} \text{ yr}^{-1}$ and shows a statistically significant decrease in the amount of heat the ocean gains from the atmosphere each year.

THEME VI. EDUCATION AND OUTREACH



U.S. National Office for Harmful Algal Blooms

NOAA Cooperative Agreement No. NA09OAR4320129
July 1, 2009 – June 30, 2016

CINAR Investigator – Donald Anderson, WHOI

NOAA Sponsor – Quay Dorth, NOS

Related NOAA Strategic Plan Goal: Healthy Oceans

CINAR Theme: Education and Outreach

PROJECT OVERVIEW

The U.S. National Office for Harmful Algal Blooms (HAB) 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.who.edu/redtide) serves as a critical resource for the U.S. HAB community. The site is among the top three WHOI sites visited each month, with between 6,500 to 7,500 visits per month. In addition to maintaining the Web Site, conference announcements, funding opportunities, reports, etc. of interest to the HAB community are routinely posted and circulated through our numerous listservers.

Harmful Algae Facebook Page: In addition to maintaining the *Harmful Algae* Web Site, we maintain the Harmful Algae Facebook Page: (<https://www.facebook.com/pages/Harmful-Algae/210160985681846>). This site is updated on a near daily basis with news reports and other announcements related to HAB events and research. This is a very popular method for disseminating information to the HAB community, the general public, and Congressional staff. It is viewed between 4,000 and 20,000 times every month, and according to Facebook statistics accessed on May 20th, this site has received 1,269 total page “likes” since its inception. Over the

last 30 days alone, 5,800 people were “reached” by its posts. In February, a single post about whale deaths in Alaska was clicked on by over 1,000 people, 366 of whom then shared or forwarded the link, resulting in a total “reach” in excess of 22,000 people.

HAB community mailing lists: The National Office maintains a U.S. HAB community e-mail distribution list used for announcing meetings, funding opportunities, and other issues of relevance to the broad group of those involved in U.S. HAB research, monitoring, and management. Currently the list comprises over 600 individuals representing a growing HAB research community that has come to rely on us to distribute important messages to their colleagues. In conjunction with CSCOR HAB program managers, we continue to add individuals working in the areas of freshwater HABs, socioeconomic impacts of HABs, and endangered species and HABs. We have also been adding state, local and tribal managers who are still not familiar with national HAB efforts. We currently maintain listservers for ISSHA (the International Society for the Study of Harmful Algae), SoundHAB (for HABs in the Puget Sound, WA area), Northeast PSP (for *Alexandrium* blooms in New England), GOMA HABs (for Gulf of Mexico Alliance HABs), NADSP (for North American Diarrhetic Shellfish Poisoning) and the National HAB Committee.

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 are needed, requiring considerable time commitments, but also providing a necessary and valuable service to the public.

International Council for the Exploration of the Seas (ICES) Working Group on HAB Dynamics

The National Office undertakes the unique role of compiling information on HAB events in the U.S. as the ICES *National Coordinating Center for Exchange of Information on Harmful Algal Blooms*. This involves annual efforts 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 HAEDAT database 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 usually updated annually for ICES as well as posting on the Harmful Algae Web site (see <http://www.who.edu/redtide/page.do?pid=14898&tid=542&cid=47893&c=3> for an example). In addition, PI Anderson presented a summary of U.S. events for 2015 at the 2016 WGHABD meeting. Recently the ICES Science and Communications Center in Vigo, Spain opened this database up to the public for browsing (<http://haedat.iode.org/>).

Intergovernmental Panel on Harmful Algal Blooms

Every two years, the IOC convenes the Intergovernmental Panel on Harmful Algal Blooms (IPHAB) to oversee the many aspects of the global HAB program. PI Anderson has attended these panel meetings since their inception, and participates as a scientific advisor and member of the US delegation. He has chaired several IPHAB task teams or activities in the past, and is currently chair of the Task Team on HABs and Desalination. The next IPHAB meeting will be in April, 2017.

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 the 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 this office worked with scientists and managers on the following unexpected or unique HAB events: an extensive and unprecedented bloom of *Alexandrium monilatum* in the lower Chesapeake Bay region; a mass mortality event of more than 100 adult diamondback terrapins in Flanders Bay, Long Island, NY; and the massive and widespread outbreak of domoic acid (DA) along the West Coast, which led to the closures of recreational and commercial fisheries for razor clams, and Dungeness and rock crab, and prompted Governor Brown to request the first-ever federal declaration of a fishery disaster and commercial fishery failure in California due to a HAB event. It is impossible to predict what the next year will bring in terms of HAB events, but the Office will be ready to assist NOAA CSCOR with administering the Rapid Response Program.

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 Conference on Harmful Algae* (Korea) and the *Eighth Symposium on Harmful Algae in the U.S.* (California).

U.S. HAB symposia. Kleindinst served on the Steering Committees for the *8th Symposium on Harmful Algae in the U.S.*, which was held November, 2015 in Long Beach, CA. She worked closely with the organizers to plan the meeting, and to 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 serves on the Steering Committee for the *17th International Conference on Harmful Algal Blooms*, which will be held in Brazil in 2016.

National HAB Committee (NHC)

The National HAB Committee was formed in 2005, and is charged with overseeing coordination and implementation of the revised U.S. National Plan. The National Office provides support to the NHC. Each year we request nominations for the 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, which facilitates communication by this group. Richlen provides administrative support to this group, and both she and Anderson serve as *ex officio* members. Richlen 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.

HIGHLIGHTS

- Assisted with the planning and organization of the *Eighth Symposium on Harmful Algae in the U.S.* (California), including soliciting and processing travel awards for students and managers.
- Soliciting and selecting travel awards for students and managers for the *17th International Conference on Harmful Algae* (Brazil).
- Maintenance of *Harmful Algae* Web Site (www.whoi.edu/redtide) and Harmful Algae Facebook Page (<https://www.facebook.com/pages/Harmful-Algae/210160985681846>).
- Support to National HAB Committee and Event Response Program.

SOCIETAL BENEFITS

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

EDUCATION AND OUTREACH ACTIVITIES

- Anderson, D.M., U.S. Summary of HAB Events – 2015, ICES WGHABD, Brest, France, April, 2016)
- 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/>

In addition to the aforementioned activities, PI Anderson communicates with journalists about HAB issues frequently (estimated 5 or 6 over the past year alone).

Marine Resource Education Program (MREP): Serving the Needs of Fishing Communities and Fishery Management in the Northeast Region

NOAA Cooperative Agreement No. NA09OAR4320129
July 01, 2009 – June 30, 2016, 2016

CINAR Investigator – Alexa Dayton, GMRI

NOAA Sponsor – Earl Meredith, NEFSC

Related NOAA Strategic Plan Goals: Healthy Oceans

CINAR Theme: Education and Outreach

PROJECT OVERVIEW

For the period April 1, 2015 to March 30, 2016 the MREP Implementation Team proposed to carry out four initiatives:

- Deliver one MREP Science 100 module and one MREP Management 100 module in a Mid-Atlantic location;
- Develop and deliver a new MREP, covering both science and management, tailored to the needs of recreational fishermen;
- Develop and deliver 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:

- January 5-7, 2016 – MREP Science 100 in Norfolk, VA (three days).
- January 19-21, 2016 – MREP for Recreational Anglers in Baltimore, MD (three days).
- February 23-25, 2016 – MREP Management 100 in Norfolk, VA (three days).
- March 15-16, 2016 – MREP Ecosystems 200 at the NOAA/NEFSC Howard Lab at Sandy Hook, NJ and in Long Branch, NJ (two days).

Norfolk, VA was chosen as the venue for the MREP Science and Management 100 modules in an effort to engage communities of fishermen who have become reticent in participation in fishery management, based on input from multiple sources. The standard MREP 100 curricula were adapted to the information needs of these communities; for example, the Science 100 added presentations examining linkages between estuarine/bay environments and the productivity of open-ocean fish stocks, and the Management 100 included added information on the role of

ASMFC and a presentation given by NOAA Office of Law Enforcement.

MREP for Recreational Anglers was a new venture for MREP in the Northeast, added in response to strong demand by that community. We purposely structured it to provide a foundation for further outreach to the recreational community in the Greater Atlantic Region. A small group of management-savvy recreational leaders, enlisted as advisors, adapted the combined science and management curricula to a shortened format, with added emphasis on the MRIP data-reporting system and alternatives to support and augment recreational data in stock assessments.

Both MREP for Recreational Anglers and MREP Management 100 included variations on the Super Fish Case Study, which continues to evolve as a teaching tool.

MREP 200: *Ecosystem-Based Fishery Management*, also new, was an attempt to meet strong demand from graduates of previous MREP workshops and the community at large. The chosen venue showcased NOAA's unique research capability for understanding the contribution of ecosystem function to fishery productivity.

Presentations by NEFMC scientists laid the groundwork for discussion of the directions management might take in the future as models are refined. A general discussion on the theme *What Fishermen Want Scientists to Know About Ecosystems* allowed the 23 fishermen and 13 scientists attending to explore in depth their mutual perspectives.

HIGHLIGHTS

- Underserved communities in NC, VA and MD were the focus of MREP Science and Management 100, with a high percentage of "pier leaders" in attendance.
- MREP for Recreational Anglers successfully established lines of engagement with a large, diverse and poorly-informed community, laying foundations for future outreach.
- Better understanding of MRIP as a recreational data-collection system, which can be adapted and improved by concerted partnership between recreational fishing sectors and NMFS.
- Beginnings of an open-ended dialog by fishermen and scientists working on models of ecosystem-based fishery management, with opportunities for new partnerships.
- Strong participation by NMFS scientists and managers not previously engaged in MREP workshops, including Silver Spring personnel.
- Over 100 individual attendees and presenters participating in one or more of the four workshops, approximately 70% of who are new faces to the program.

EDUCATION AND OUTREACH ACTIVITIES

A general 3000-piece mailing went out to commercial and highly-migratory permit holders in the Mid-Atlantic region, followed by direct one-on-one recruiting through packing houses based in the Newport News area and key fishermen's associations (e.g., NC Fisheries Association and NC Watermen United).

Most of the participants were recruited through word-of-mouth by these advisors and through consultation; priority was placed on engaging members of the recreational fishing community who are prominent, vocal, and positioned to inform other recreational anglers. The result was an

attendee list heavily weighted with fishing association leaders, tackle shop owners, and moderators of recreational blog-sites. Also attending as participants were a NOAA/Sliver Spring expert on MRIP reporting and GARFO Administrator John Bullard. The result was an average of 25 attendees at each module, from ports as far north as MA, but predominantly from NC, VA and MD.

During the past year, an article about the MREP program was written by Steve Cannizzo, graduate of the MREP for Recreational Anglers module. Steve is a blog moderator for *Fishing United*, the premier website for recreational fishermen on the East Coast, with over 10,000 subscribers. The article first appeared online in the *Fishing United* member's page.

FIGURES/PHOTOGRAPHS/ ILLUSTRATIONS



Figure 1. MREP attendees participate in fish dissections.



Figure 2. MREP attendees engage in discussions during one of the workshops.

APPENDIX 1: CINAR Personnel Summary

NA09OAR4320129

July 01, 2009– June 30, 2016

Task 1 Support

Employees

Appt. Dates

Don Anderson, CINAR Director	7/01/09	– present
Judy Kleindinst, CINAR Administrator	7/01/09	– 7/31/2015
Mindy Richlen, CINAR Associate Director	6/01/15	– 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	Ecosystem Monitoring	Fall 2014 (18 Month appt.)	Joel Llopiz

APPENDIX 2: CINAR Personnel Summary Chart

April 1, 2016 – June 30, 2016

Category	Number	B.S	M.S	PhD.
Employees who receive \geq 50% NOAA Funding (not including Students)				
Research Scientist	0	0	0	0
Visiting Scientist	0	0	0	0
Post Doctoral Fellow	0	0	0	0
Research Support Staff	0	0	0	0
Administrative	0	0	0	0
Total	0	0	0	0

Category	Number	B.S	M.S	PhD.
Employees who receive < 50% NOAA Funding (not including Students)				
Research Scientist	11	0	0	11
Visiting Scientist	0	0	0	0
Post Doctoral Fellow	1	0	0	1
Research Support Staff	10	6	3	1
Administrative	11	6	0	0
Total	33	12	3	13

Students	-	-	-	-
Undergraduate Students	0	0	0	0
Graduate Students	0	0	0	0
Total	0	0	0	0

Obtained NOAA employment within the last year	0	0	0	0
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APPENDIX 3: CINAR Publications for Reporting Period

	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
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	2 PR 0 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	1 PR 1 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	3 PR 1 NPR

Czeschel, R., L. Stramma, R.A. Weller, and T. Fischer. 2015. Circulation, eddies, oxygen and nutrient changes in the eastern tropical South Pacific Ocean. *Ocean Sci.*, 11, 455-470, doi:10.5194/os-11-455-2015

DePiper G. 2015. Assessing risk-reward tradeoffs in multispecies modeling frameworks using financial portfolio theory. Presentation at session on: Multispecies Modeling (Including Humans!) for Fisheries Management: Where Are We Now and Where Can We Go? Part 1. *145th Annual Meeting of the American Fisheries Society* in Portland, OR (August 18).

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.

Jin D. 2015. Linking regional economic and marine food web models for ecosystem-based management. Presentation at session on: Multispecies Modeling (Including Humans!) for Fisheries Management: Where Are We Now and Where Can We Go? Part 1. *145th Annual Meeting of the American Fisheries Society* in Portland, OR (August 18).

Jin D, DePiper G, Hoagland P. 2016. An empirical analysis of portfolio management as a tool for implementing ecosystem-based fishery management. *No. Am. J. Fish. Mgmt.* 36:652-669.

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

Munroe D, Wang, J, Haidvogel D, Klinck J, Powell E, Hofmann E, Levin J, Shank B, Hart D. Modeling larval dispersal and connectivity in the Atlantic sea scallop (*Placopecten magellanicus*) in the Middle Atlantic Bight. In Preparation.

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

Pisareva, M.N., Pickart, R.S., Iken, K., Ershova, E.A., Grebmeier, J.M., Cooper, L.W., Bluhm, B.A., Nobre, C., Hopcroft, H.R., Hu, Haoguo, Wang, J., Ashjian, C.J., Kosobokova, K.N.,

Whitledge, T.E. 2015. The relationship between patterns of benthic fauna and zooplankton in the Chukchi Sea and Physical Forcing. *Oceanography* 28(3):69-83. doi:10.5670/oceanog.2015.58.

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

Sutton, A.J., C. L. Sabine, R. A. Feely, W-J Cai, M. F. Cronin, M. J. McPhaden, J. M. Morel, J. A. Newton, J-H Noh, S. R. Olafsdottir, J. E. Salisbury, U. Send, D. C. Vandermark, and R.A. Weller, 2016: Using present-day observations to detect when anthropogenic change forces surface ocean carbonate chemistry outside pre-industrial bounds. *Biogeosciences Discuss.*, doi:10.5194/bg-2106-104.

Weller, R.A., 2015: Variability and Trends in Surface Meteorology and Air–Sea Fluxes at a Site off Northern Chile. *J. Climate*, **28**, 3004–3023. doi: <http://dx.doi.org/10.1175/JCLI-D-14-00591.1>