Northern Gulf Institute

PROGRESS REPORT

July 01, 2011 through September 30, 2012

NGI Northern Gulf Institute
a NOAA cooperative institute

Mississippi State University

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NGI Progress Report

Award NA06OAR4320264

Reporting Period: July 1, 2011 – September 30, 2012

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INTRODUCTION

This Northern Gulf Institute (NGI) Annual Progress Report reviews and summarizes the research and the education and outreach goals accomplished during the reporting period of July 1, 2011 – September 30, 2012. While NGI had two NOAA awards, NA06OAR4320264 and NA11OAR4320199 during this period, the items in this report cover only award NA06OAR4320264. The report consists of two (2) sections and appendices. The first section provides the General Description of NGI, the NGI Direction, Organization and Operations, NGI Research Focus Areas and Highlights, and Distribution of funding to NGI from NOAA.

The second section is titled Project Reporting. It begins with the list of all of the awards to the NGI of projects currently active. The section describes the project objective and research conducted for each project and other project details, along with contact information and related NOAA sponsor and strategic goal. Appendix A provides the total count of publications for this reporting period, and Appendix B summarizes the total number of employees and students supported by NOAA funding at NGI. Appendix C lists other agency awards NGI received during this reporting period.

NGI General Description and Core Activities

The Northern Gulf Institute (NGI) is a National Oceanic and Atmospheric Administration (NOAA) Cooperative Institute, a partnership of five complementary academic institutions and NOAA addressing important national strategic research and education goals. Mississippi State University leads this collaboration, partnering with the University of Southern Mississippi, Louisiana State University, Florida State University, Alabama's Dauphin Island Sea Lab, and NOAA scientists at various laboratories and operational centers in the northern Gulf of Mexico region.

NGI develops, operates, and maintains an increasingly integrated research and transition program, the results of which raise awareness and understanding of the Gulf region. NGI was recognized by the NOAA Cooperative Institute Science Review Panel in October 2009 for its significant efforts to address important questions related to the NOAA Strategic Goals. NGI has been recognized as critical and well positioned to provide baseline, current, and future science and outreach needs to the region. The necessity of such a role for NGI is acutely demonstrated by northern Gulf of Mexico catastrophes like Hurricane Katrina and the Deepwater Horizon incident.

The Institute contributes to NOAA's priority interests in the four NGI research themes of Ecosystem Management, Geospatial Data Integration and Visualization, Coastal Hazards, and Climate Effects on Regional Ecosystems. Important recent research accomplishments by NGI researchers, in collaboration with multiple NOAA researchers, focus on the issues and resources of the Gulf with many of the tools and protocols transferrable to other coastal environs. Additional details are available in the second section on Project Reporting.

The NGI Education and Outreach Program provides an integrated comprehensive approach to educate the public on NGI priority issues associated with NGI research and to facilitate the transition of NGI research to NOAA operational centers. The program connects universities to

NOAA and works closely with the educational programs at the Gulf of Mexico Alliance, the various Gulf of Mexico Sea Grant programs and the NOAA Gulf of Mexico Regional Collaboration Team. Together we develop communication and significant long term messaging campaigns to address identified priority issues.

NGI hosts an important conference on an annual basis – bringing together NGI researchers and educators with NOAA and other stakeholders in the northern Gulf region. As part outreach and part research planning, NGI participated in or hosted several workshops during this reporting period. The NGI Education and Outreach Program disseminates content and reports of research accomplishments through a multi-media approach including listserv emails, twitter, Facebook, and continual updates to the institution's website with NGI audience relevant news. Content includes recent information about research activities and transitioned results, essential components of the collaboration, operation updates, and other outreach items of interest (*see:* www.NorthernGulfInstitute.org). One of the most exciting outreach accomplishments during this progress reporting period was publicizing establishment of the Exploration Command Center at the Mississippi State University Science and Technology Center at Stennis Space Center and the important research coordination in the Gulf of Mexico that included the Center.

The NGI Education and Outreach Program strives to enhance NOAA workforce development by including students in several aspects of the cooperative institute. They are involved in research project performance and reporting, internships, career fairs, NGI associated volunteer opportunities, and network support. NGI staff is currently exploring the development of distance learning degree and certificate programs targeted at NOAA professionals working on Gulf of Mexico related programs.

NGI Management, Mission, and Vision

The NGI leadership team adopted a ten year NGI Strategic Plan on June 24, 2011 (http://www.northerngulfinstitute.org/about/strategic_plan.php). With input from its university and NOAA partners, the NGI Program Office strives to make the complex collaborations as efficient and easy as possible for the participants with regular teleconferences, semi-annual meetings and annual conferences.

Mission and vision statements

NGI Mission: NGI conducts high-impact research and education programs in the Northern Gulf of Mexico region focused on integration – integration of the land-coast-ocean-atmosphere continuum; integration of research to operations; and integration of individual organizational strengths into a holistic program. The program shall measurably contribute to the recovery and future health, safety, resilience and productivity of the region, through sustained research and applications in a geospatial and ecosystem context.

NGI Vision: NGI will be a regional leader providing integrative research and education to improve the resiliency and conservation of the Northern Gulf of Mexico.

Organizational structure

The NGI Program Office's strategic location at the Stennis Space Center, MS, facilitates close interactions with multiple NOAA activities and key stakeholder groups including the NOAA Gulf of Mexico Regional Collaboration Team, regional Sea Grant programs, the Gulf Coast Ecosystem Restoration Task Force, and the Gulf of Mexico Alliance. With the completion of the Mississippi State University Science and Technology Center at Stennis Space Center, which houses NGI and NOAA activities, NGI has the foundation and the building blocks to maintain and grow its role in northern Gulf of Mexico environmental research and education. MSU employees moved into the MSU Science and Technology Center in December 2011. Employees from NOAA National Marine Fisheries Service and National Coastal Data and Development Center moved into the Center during the summer of 2012. During this period, MSU supported the installation of the NOAA Exploration Command Center in the MSU Science and Technology Center and hosted numerous researchers from around the region and country who participated in the NOAA Okeanos research cruise of the Gulf of Mexico in March and April 2012.

Since its initial award on October 1, 2006, the NGI's leadership has worked diligently to build collaborations between the five academic institutions and NOAA research and education programs. NGI activities during this progress reporting period total $15,705,755 in NOAA support. NGI continues to use this NOAA investment to contribute to the recovery and future health, safety, resilience and productivity of the Northern Gulf of Mexico region, through sustained research and applications in a geospatial and ecosystem context. NOAA cooperative institute metrics summarizing published research and staffing support are provided in the appendices.

In 2006, the NGI Council of Fellows, consisting of a senior investigator from each of the member institutions, established an Executive Office at MSU in Starkville, Mississippi, and a Program Office at Stennis Space Center, Mississippi. Funding for the NOAA led research began in the spring of 2006 and research initiatives at the NGI partner institutions began in February 2007. Significant efforts are being made to address important questions related to NOAA's long-term goals of Climate Adaptation and Mitigation, Weather-Ready Nation, Healthy Oceans, Resilient Coastal Communities and Economics, and NOAA enterprise-wide capabilities.

Figure 1 illustrates the NGI organizational structure and collaborative connections. The top row reflects the oversight role of MSU. The Director of NGI, a tenured professor who reports to the MSU Vice President for Research, has his principal office on the MSU campus, but often visits Stennis Space Center, MS. The Director's responsibilities are to serve as primary liaison to NOAA's Executive Council and as the principal point of contact for the Cooperative Institute Program Manager. At the direction of the Director, the NGI Co-Director assists in this role.

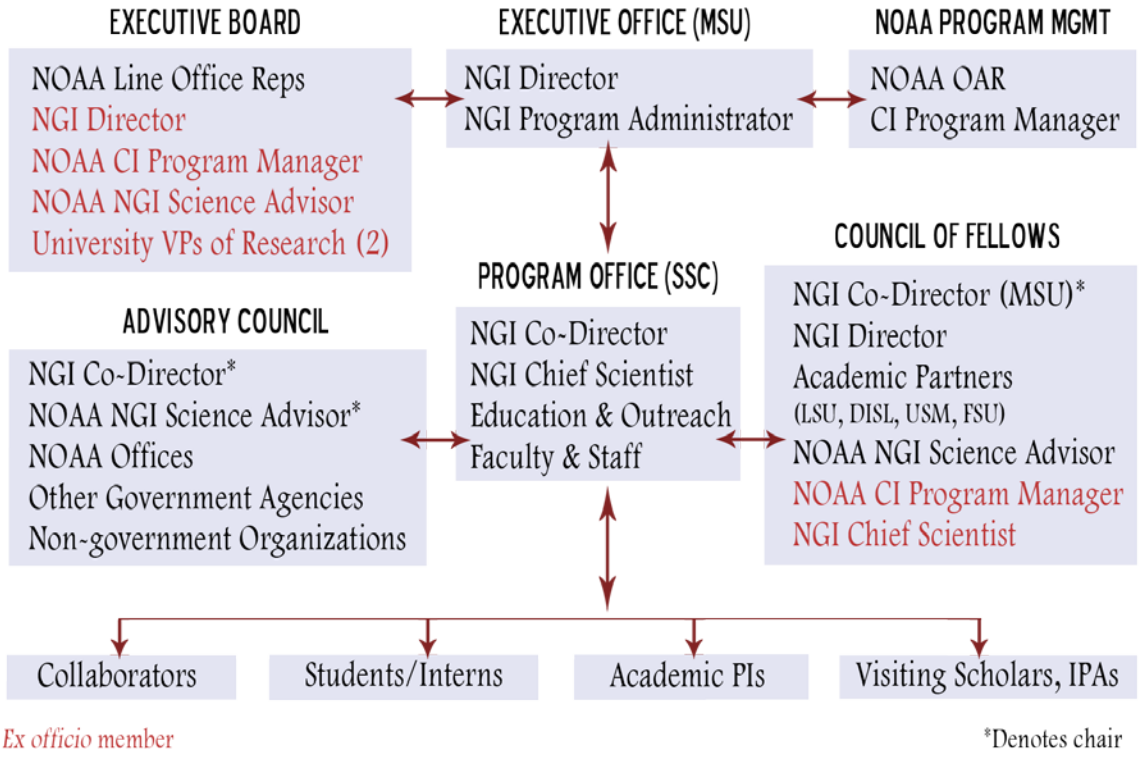

Figure 1. NGI organization diagram

NGI program operations and implementation is guided by the NOAA October 1, 2006 cooperative agreement award, adoption of a Memorandum of Agreement between MSU and NOAA, and compliance with the NOAA Cooperative Institute Interim Handbook. The Executive Office and Program Office staff coordinates with the NOAA Office of Oceanic and Atmospheric Research on amendments to the original award which support research and education by NGI in support of activities of NOAA line offices. These include the Office of Oceanic and Atmospheric Research, National Marine Fisheries Service, National Environmental Satellite Data and Information Service, and the National Ocean Service.

The NGI Program Office located at the Stennis Space Center, Mississippi, is staffed by MSU employees, including the Co-Director, Chief Science Officer, and research and outreach faculty. The Program Office is responsible for maintaining regular interaction with the Council of Fellows, the NGI Advisory Council, and the NOAA NGI Science Coordinator. NGI participates in the NOAA Gulf of Mexico Regional Collaboration Team. It also has prime responsibility for the day-to-day management of the Institute that includes project management, facilitating meetings of the Council of Fellows, the NGI Annual Conference, and NGI students, contractors and visiting scholars on-site at Stennis. The Program Office constantly upgrades services to the research and education affiliates, and applies adaptive management approaches to improve program stewardship.

NGI has 3 councils that make management and advisory contributions to the Institute. The Council of Fellows is composed of senior scientific/ technical representatives from each NGI member academic institution, as well as the NOAA NGI Science Coordinator, and the NOAA

OAR CI Program Manager. The Council is chaired by the NGI Co-Director or designee. The Council of Fellows is the principal vehicle for NGI concept development, program strategy, annual research plans, peer review, resource allocation, research and technology coordination, and achieving the overarching goal of regional and disciplinary integration.

The Council of Fellows

For period of July 1, 2011 – September 30, 2012, the NGI Council of Fellows consisted of:

- William McAnally, Ph.D., Mississippi State University (chair)
- Monty Graham, Ph.D., University of Southern Mississippi
- Eric Chassignet, Ph.D., Florida State University
- Chris D'Elia, Ph.D., Louisiana State University
- John Valentine, Ph.D., Dauphin Island Sea Lab

Meetings of the NGI Council of Fellows for this reporting period were held in Baton Rouge, LA on October 18, 2011 and in conjunction with the NGI Annual Conference on May 23-24, 2012 at Stennis Space Center, MS. At the May meeting, the Council of Fellows and the Advisory Council held a joint session to allow exchange of recommendations from the Advisory Council and updates on progress from the Fellows. The Fellows participate in regular teleconferences to remain up to date between face-to-face meetings.

The NGI Executive Council

The NGI Executive Council consists of six Senior NOAA officials and vice presidents of two NGI academic partner institutions. Dr. Bonnie Ponwith serves as Chair. The NOAA OAR Cooperative Institute Program Manager, the NOAA NGI Science Coordinator, and the NGI Director serve as *ex officio* members of the Executive Council. The Executive Council is primarily responsible for broad policy and program direction for the NGI. The Council plans to meet at least once yearly to review NGI programs and progress and to transmit NOAA strategic plans and priorities to the NGI management in order to ensure program alignment with these priorities. It last met on November 9, 2010. The Executive Council provides information regarding the NGI successes to the NOAA Administrator to justify inclusion of NGI funding in the NOAA core budget. The NGI is committed to transparency, accountability, governance control, and effective integration through the Executive Council. The NGI Executive Council consists of:

- Bonnie Ponwith, Ph.D., Director, NOAA SE Fisheries Science Center (Chair)
- Gary M. Carter, Director, Office of Hydrologic Development
- Margaret Davidson, Director, NOAA Coastal Services Center
- Louisa Koch, Director, NOAA Office of Education
- Al Powell, Ph.D., Director, Center for Satellite Applications and Research
- Alan Leonardi, Ph.D., NOAA Atlantic Oceanographic and Meteorological Laboratory
- David Shaw, Ph.D., VP for Research & Econ. Dev., Mississippi State University
- Denis Wiesenburg, Ph.D., VP for Research, University of Southern Mississippi
- Philip Hoffman, OAR CI Program Manager (Special Advisor, *Ex officio*)
- Julien Lartigue, Ph.D., NOAA NGI Science Coordinator (*Ex officio*)
- Robert Moorhead, Ph.D., NGI Director (*Ex officio*)

The NGI Advisory Council

The NGI Advisory Council serves as the principal interface to the regional stakeholder community of the NGI. It has broad representation from the entities listed in the organizational chart, and meets regularly to identify and prioritize research and educational needs in the Northern Gulf region. The Advisory Council provides input on the current research and education/outreach programs of the NGI. NGI supports the formation and efforts of workgroups around each of the major themes of the NGI and accepts direction from the Advisory Council when they identify the need. The Advisory Council met May 24, 2012 (Stennis Space Center, MS) to assess NGI research directions and advise the Fellows on important issues facing the region. The NGI Advisory Council members are:

- Steven Ashby, Ph.D., MSU/NGI Co-Director (Chair)
- Duane Armstrong, NASA Stennis Space Center
- Russ Beard, NOAA National Coastal Data Development Center
- David Brown, Ph.D., NOAA National Weather Service, Southern Region
- Miles Croom, NOAA National Marine Fisheries Service
- Alyssa Dausman, USGS Gulf Coast & LMV
- Todd Davison, NOAA Gulf Coast Services Center
- Lisa Desfosse, NOAA National Marine Fisheries Service
- Kristen Fletcher, Coastal States Organization
- Judy Haner, The Nature Conservancy
- Karl Havens, Ph.D., Florida Sea Grant College Program
- Matt Johnson, NPS Gulf Coast Network
- Julien Lartigue, Ph.D., NOAA NGI Science Coordinator
- Kristen Laursen, NOAA Fisheries Service
- Larry McKinney, Harte Research Institute
- Helmut Portmann, NOAA National Data Buoy Center
- Matt Romkens, USDA National Sedimentation Lab
- David Ruple, Grand Bay National Estuarine Research Reserve
- Ben Scaggs, EPA Gulf of Mexico Program
- LaDon Swann, Ph.D., MS-AL Sea Grant Consortium
- Robert Twilley, Ph.D., Louisiana Sea Grant
- Suzanne Van Cooten, Ph.D., NOAA National Weather Service LMRFC
- William Walker, Ph.D., MS Department of Marine Resources
- Jeff Waters, US Army Corps of Engineers
- Chuck Wilson, Ph.D., GOMRI Chief Scientist

Executive Summary of Important Research Activities

As NGI research teams complete the first five years of collaborative study, vital pieces of the northern Gulf ecosystem puzzle are falling into place. This final progress report details the accomplishments of their efforts. Significant work is still needed as the conditions change and more is discovered. Here is an introduction to three of the important research activities that have recently concluded.

NGI's Ecosystem Team has just completed Integrated Ecosystem Assessments for four northern Gulf of Mexico estuaries: Galveston Bay, Texas; Barataria Basin, Louisiana; Mississippi Sound in Louisiana, Mississippi, and Alabama; and Perdido Bay, Florida. An integrated ecosystem assessment is a fusion of information about relevant physical, chemical, ecological, and human processes in relation to specified resource management objectives, such as sustainable fisheries and recreation. It assists management with critical decision-making and policy matters. The four estuaries selected represented a variety of northern Gulf of Mexico estuarine ecosystems over a narrow range of latitude, and offered ample opportunities for contrast and comparison in the assessments. The Ecosystem Team found that human-related processes dominated all four of the estuaries. Ecosystem stresses include increased fishing pressures, urban/coastal development, boat traffic, nutrients from runoff, and increased pollution. The results and models created by the Team can be used to evaluate strategies for environmentally and economically-sustainable development and use. The NGI Ecosystem Team is composed of researchers from University of Southern Mississippi; Mississippi State University; Dauphin Island Sea Lab, Alabama; Louisiana State University, Harte Research Institute (Texas A & M), Florida State University, and US EPA Gulf Ecology Division. The team's contributions of the resource management assessments can lead to a sustained vibrant economy and a healthy environment.

Pulsed freshwater diversions on the Lower Mississippi River are increasingly being used to combat coastal land loss. An issue that arises with diversions is their effects on aquatic biota in the area. How do pulsed releases of freshwater affect the spatial distribution and health of ecologically and economically important fish and invertebrate species downstream? NGI research led by LSU provides that it appears that the exchange between deep channels and the wetlands was not improved by the 35 $m^3 s^{-1}$ discharge. In contrast, the 2-week ~ 200 $m^3 s^{-1}$ discharge caused enhanced water exchange between wetlands and adjacent water bodies, substantially increasing water velocities in the narrow bayous and channels of the upper estuary. A noticeable reduction of salinity in the mid-estuary (about 10 to 20 km from the diversion) was also predicted. These effects caused a noticeable increase in down-estuary residual current, with a significant reduction of local estuarine residence times for the whole estuary. The 3-month high discharge scenario was the only scenario that had effects farther than 40 km from the diversion structure.

MSU and USM teamed to gain a comprehensive understanding of the spatial variation and temporal trend of the water quality parameters in the northern Gulf of Mexico. The observing parameters for water quality were water clarity and concentrations of suspended inorganic matter (SIM) and organic matter (SOM). Water clarity is a direct and first order measurement of the status of the health of an ecosystem, while SIM and SOM provide more in-depth evaluation of water constituents. Such information is critical for the evaluation of the health and stress of an

ecosystem that is required to help federal and state agencies on decision making in regulation of nutrient discharges. Some of the parameters studied include patches of inorganic particles suspended in the water column, phytoplankton dynamics, and colored dissolved organic matter, an optically active component that plays an important role in carbon cycling. Each of these puzzle pieces, and the other NGI projects, will help improve our understanding of the whole picture of the northern Gulf of Mexico.

Distribution of NOAA Funding

Total NOAA funding awarded to NGI during the progress reporting period was $15,705,755. This funding spans all three NOAA CI tasks as well as each one of NGI's themes, with several projects having multiple themes.

Task I Activities

Task I funding supports the central management and coordination of the five complementary universities working together with NOAA. This year, Task I funding supported summer interns and education and outreach efforts. Details of these efforts are reported in project reports of 09-NGI-17, 10-NGI-MOD-45, 10-NGI-MOD-49, 11-NGI-MOD-51, and 11-NGI-MOD-52. NGI hosts an annual conference to bring together researchers, students, stakeholders, the NGI Advisory Council, and NOAA to highlight the research progress and help foster collaborations that have led to NGI's position as a leading regional research institution.

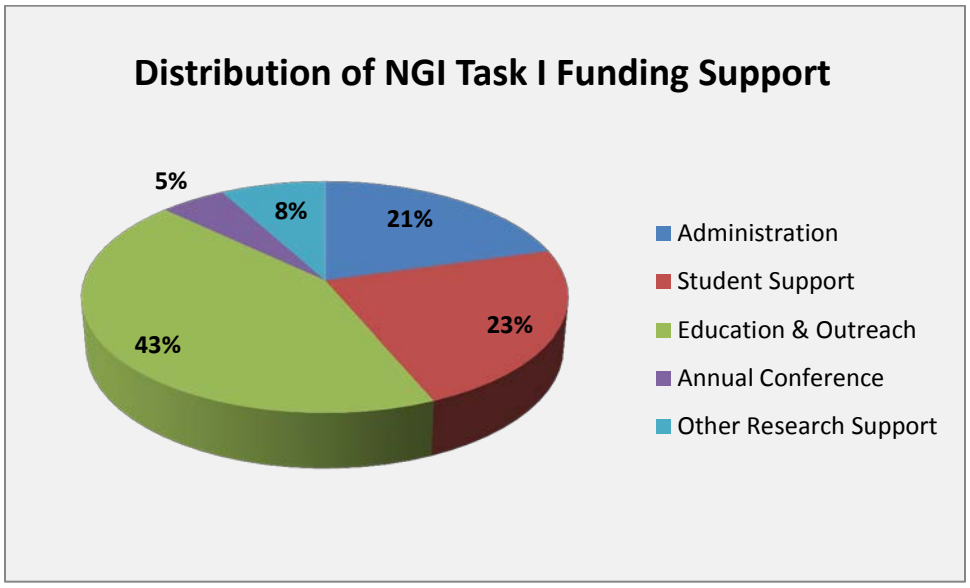

Figure 2. Distribution of NGI Task I funding.

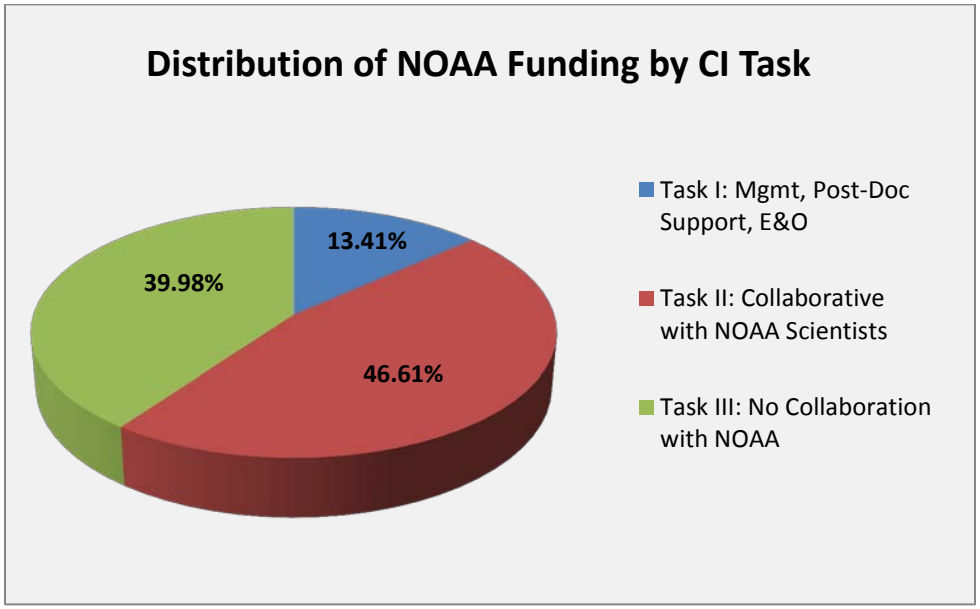

Figure 3. Distribution of NOAA funding by the three cooperative institute task categories.

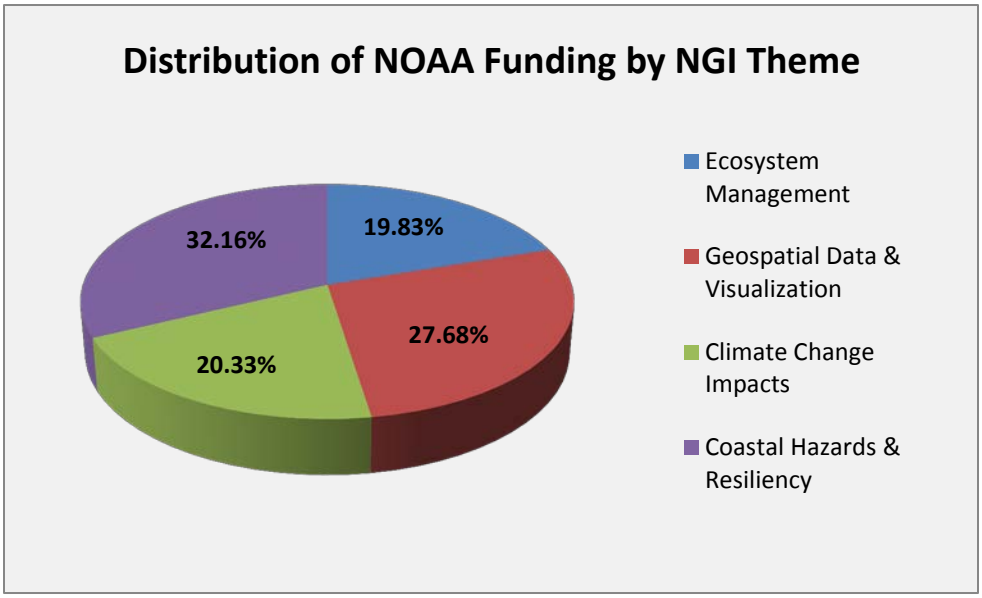

Figure 4. Distribution of NOAA funding by the four NGI themes.

NGI FILE #08-NGI-MOD-12

Project Title: Development of Prototype Integrated Ecosystem Assessments in the Northern Gulf of Mexico

Project Lead (PI) name, affiliation, email address: John Harding, Mississippi State University, jharding@ngi.msstate.edu

Related NOAA strategic goals: Ecosystem Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Buck Sutter, NMFS

Project objectives and goals

NGI is collaborating with the National Marine Fisheries Service, the Gulf Coast Services Center and the National Coastal Data Development Center to host NOAA Integrated Ecosystem Assessment related workshops focused on the development of prototype IEAs in the northern Gulf of Mexico, execute the prototype IEA development, and participate in the standardization of data and meta-data for all IEAs. NGI researchers continue to have significant long range data collection and ecosystem research programs and are developing a network for data sharing and analysis using the NOAA/NGI Ecosystem Data Assembly Center (EDAC) servers at Stennis Space Center.

The goal of this work is to begin the process of generating an Integrated Ecosystem Assessment (IEA) for the Gulf of Mexico and to identify a way forward to complete that IEA. The specific objectives are to:

1. Identify and summarize IEA Drivers and Pressures for three representative systems in the northern Gulf of Mexico thus completing step 1 of the Levin et al (2008) 5-step IEA process.
2. Identify the similarities and differences in Drivers and Pressures among the three systems.
3. Formulate an approach to complete the full 5-step IEA process for the Gulf of Mexico.

Description of research conducted during the reporting period and milestones accomplished and/or completed

Prepared maps of the IEA sites and assembled information on social science methods for evaluating impacts of ecosystem changes relevant to objective 3 above as well as the related, NOAA-sponsored, follow-on project, 10-NGI_Mod-48 Ecosystem Approach to Management for the Northern Gulf.

Description of significant research results, protocols developed, and research transitions

None reported

Information on collaborators / partners:

a. Name of collaborating organization: National Marine Fisheries Service (Buck Sutter)
b. Date collaborating established: 1 July 2008
c. Does partner provide monetary support to project? Yes. Amount of support? 300K

d. Does partner provide non-monetary (in-kind) support? No
e. Short description of collaboration/partnership relationship: Primary funding organization for this project.

a. Name of collaborating organization: NOAA Gulf of Mexico Regional Collaboration Team (Buck Sutter)
b. Date collaborating established: 1 July 2008
c. Does partner provide monetary support to project? No.
d. Does partner provide non-monetary (in-kind) support? Yes.
e. Short description of collaboration/partnership relationship: Workshop Co-sponsor And member of NGI Ecosystem Team

a. Name of collaborating organization: NOAA NCCOS Center for Sponsored Coastal Ocean Research (Alan Lewitus)
b. Date collaborating established: 1 July 2008
c. Does partner provide monetary support to project? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship: Workshop Co-sponsor

a. Name of collaborating organization: NOAA NESDIS National Coastal Data Development Center (Russ Beard)
b. Date collaborating established: 1 July 2008
c. Does partner provide monetary support to project? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship: Workshop Co-sponsor And member of NGI Ecosystem Team

a. Name of collaborating organization: NOAA Coastal Services Center (Todd Davison)
b. Date collaborating established: 1 July 2008
c. Does partner provide monetary support to project? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship: Workshop Co-sponsor And member of NGI Ecosystem Team

Information on any outreach activities: Engagement of NOAA staff cited above provided interaction and communication between the PI and NOAA on applying science-based perspectives to resource management objectives.

NGI File #09-NGI-MOD-23

Project Title: NGI Sustained Operations Alternatives

Project Lead (PI) name, affiliation, email address: Robert Moorhead, Mississippi State University, rjm@ngi.msstate.edu

Related NOAA strategic goals: Weather and Water Mission Goal, Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Robbie Hood, OAR

Project objectives and goals

- Support the operational development of the regional test beds in the NOAA Unmanned Aerial Systems (UAS) Program
- Conduct research and analysis of the capabilities of various UAS and their suitability for achieving selected test bed mission requirements
- Develop multiple operations and logistical support models that will include cost comparisons and full consideration of the environmental conditions of operations that achieve science data acquisition objectives in each region

Description of research conducted during the reporting period and milestones accomplished and/or completed

The majority of the research was done via a subcontract to the Alaska Aerospace Corporation (AAC).

Two reports were prepared. The first one was a 54 page report entitled “Sustained Operations Alternatives Phase III Comprehensive Report.” The second was a 15 page report entitled “Alaska Airfield Potential for Small UAS Operations.”

The first report provided an overview, a description, the beneficial aspects, the detrimental aspects, and a recommendation for basing UAS operations at the following locations. The recommendations for each are:

- Eielson Air Force Base (AFB) – Eielson is an excellent base for high altitude, long endurance (HALE) UAS operations in the Arctic and Pacific regions due to its location near NOAA areas of interest, restricted airspace, numerous available hanger spaces, and a staff that is receptive to UAS operations. Once NOAA formally establishes a UAS acquisition program, formal basing agreements between NOAA and Eielson can be made. Eielson’s low base utilization and supportive staff should enable rapid establishment of UAS operations, and integrate the UAS program into existing base activities. The optimal access to the polar test bed, close proximity to the UAF Geophysical Institute and the Poker Flat Research Range, provides a unique capability for study of the Arctic. Eielson provides a low-medium risk, very high payoff location that a NOAA UAS program can leverage to perform research in Arctic and Pacific regions.
- Edwards AFB – Edwards Air Force Base is an excellent location for the NOAA UAS program. The large quantity of Restricted Airspace and the current UAS programs at Edwards give it significant advantages over other locations. The cruise missile corridor

allows UAS access to the Pacific Ocean operational locations, and potentially to Arctic areas as well. The overlapping capabilities between Air Force and NASA UAS operations can be a strong benefit as well. NASA has a Global Hawk Operations Center at Dryden that could potentially be used for NOAA operations when not in use. The weather allows for year round flight operations as well. For these reasons, Edwards AFB is a strong candidate as a NOAA UAS base.

- Pacific Missile Range Facility (PMRF) – AAC initially recommends PMRF as a temporary / seasonal base for NOAA UAS operations due to its location near NOAA areas of interest and its feasibility as an operating location. Once NOAA formally establishes a UAS acquisition program, the PMRF Commander should be contacted to begin coordination for using PMRF. PMRF's many advantages should allow a rapid establishment of UAS operations to achieve NOAA observing requirements. After conducting operations for a season or two, the potential of making PMRF a permanent base can be more accurately assessed along with input from the base command. The main hurdle in transitioning from a seasonal base to a permanent one will be gaining the support of the community to build basic infrastructure to support the UAS program. A solid public affairs plan that can demonstrate the benefits of NOAA's UAS program to Hawaii, such as providing storm warning and environmental monitoring, will help establish positive relationships and lay the foundation.
- Kennedy Space Center (KSC) – The Shuttle Landing Facility (SLF) at the Kennedy Space Center is an excellent location to operate UAS to achieve NOAA operational objectives in the Gulf of Mexico and the Mid-Atlantic Ocean. The restricted airspace, low utilization, secure facilities, and potential for future expansion greatly facilitates sustained UAS operations. Challenges still remain, to include convincing KSC to host NOAA at the SLF, hanger access, cost-sharing of runway maintenance, and mitigating the thunderstorm and hurricane activity. AAC recommends that NOAA leverages their current relationship with NASA Dryden to gain support for future operations out of KSC. NOAA should also begin a conversation with the KSC Development Manger to stay abreast of proposed SLF utilization, and to show their interest in using the facility. The SLF is a great asset that can support NOAA UAS program objectives throughout the Gulf/Atlantic test bed region.
- Wallops Flight Facility (WFF) – AAC highly recommends WFF as the main base for NOAA UAS operations due to its location near NOAA areas of interest, the restricted airspace, available hanger space, and established UAS support structure. Once NOAA formally establishes a UAS acquisition program, NOAA can begin formal basing agreements with NASA at WFF. WFF's many advantages and proactive UAS program should allow a rapid establishment of UAS operations to achieve NOAA observing requirements. The many resources at WFF can provide direct support to the NOAA UAS program, and the close proximity to NOAA headquarters will give the opportunity for senior leadership to see the program first hand. Use of WFF also expands the opportunities for NOAA and NASA to work together on their UAS programs. Both organizations can operate collaboratively, with NASA developing new payloads and operating concepts while NOAA leverages the NASA development process to improve their routine flight operations. WFF provides a low risk, high payoff location that the

NOAA UAS program can leverage to create quick results that are highly beneficial to the public and the scientific community.

The second report provided an overview of potential Alaskan airfields to use for small UAS operations, focusing on restricted and military use airspace and UAS operations in general. The applicable restricted airspaces include Oliktok Point, Eielson AFB, Delta Junction, Clear Air Force Station, and Fort Richardson. Two appendices showed the location of the public airports in Alaska and the location of military aviation operations.

Alaska provides a wide variety of research opportunities for a small Unmanned Aircraft System (sUAS) program. Alaska can be viewed as an aircraft carrier for UASs being used in the Arctic. Alaska has a very well developed airport infrastructure; with regular commuter flights to over 144 airports across Alaska. There are over 700 registered airports in Alaska with 254 of these owned or operated by the State of Alaska. There are generally five kinds of airport categories within Alaska.

- Large Commercial. These airports typically have multiple flights per day, to and from the airport, with generally over 10,000 passengers per year. There are over 28 Primary airports in Alaska. All primary airports are paved and lit. Airplane sizes at primary airports typically vary from turbojet 737's, to smaller turboprop aircraft.
- Non-primary Commercial. These airports typically have daily commercial flights, and generally have over 2500 passengers per year. There are 21 Non-Primary airports around Alaska. All non-primary airports are paved and lit. Airplane sizes at non-primary airports typically vary from medium to small turboprop aircraft to twin engine Navajo-class passenger aircraft.
- General Aviation. Many flights to these airports are by charter only, with regular commuter flights to airports located in larger population centers. Passenger traffic in this category varies from as little as 4 passengers per year to over 40,000 at some seaplane bases; however the average passenger traffic is 500-1000. There are over 160 airports in this category, and this includes seaports, some gravel strips, and paved airports.
- Private-use Airports. These airports generally require prior approval from the owner of the strip before use. Most flights to these airports are "Bush" charter flights with Cessna aircraft or seaplanes the primary traffic. Airports in this category are generally unpaved, or lake based. Passenger traffic data is largely unavailable for these airports, there is over 188 listed in this category.
- Military Airfields. Military airfields are controlled by the Department of Defense (DOD) or the Department of Homeland Security for U.S. Coast Guard bases. Some of the 28 military airfields in Alaska are not in regular use or are decommissioned following the end of the Cold War.

Western Alaska is notable for the lack of road connections between the towns, leaving the only methods of travel to and from these towns by air or sea. Despite the lack of road connections, the supply infrastructure is very well developed, with regular federally subsidized cargo and commuter flights to most towns in western Alaska.

Alaska is an excellent location to accomplish numerous small UAS missions. Specific site selection will depend on a detailed mission analysis of the proposed mission. The flight

objectives, sUAS system, logistical requirements, environmental requirements, and budget all factor into site selection. For test flights in restricted airspace, the areas around Anchorage and Delta Junction are likely the best choices. R-2203 near Anchorage at Joint Base Elmendorf-Richardson is easily accessible and adjacent to Alaska's largest city for logistical support. Use of this airspace must be coordinated through the Army Range Control at Fort Richardson because it is often used for military training. For long term testing, the UAS airstrip in R-2202 outside of Delta Junction is recommended because there are facilities there which can support UAS testing, and this training area is used less than Fort Richardson. Coordination for use must also take place through Fort Wainwright Range Control. Delta Junction has few lodging or maintenance facilities, although it is located about 90 miles away from Fairbanks on the Alaska Highway system. For research driven sUAS flights, the location will depend on the area that requires data collection. Consultation with Alaska-experienced personnel is recommended to understand what areas can meet the required logistical support. These areas will also require coordination with the FAA to get Certificates of Approval for UAS operations.

Alaska has many airfields spread out over the state. The majority of the airfields do not connect to road systems, nor do they have logistical support. When planning sUAS operations in Alaska, it is important to have clearly defined objectives and support requirements in order to select a site that will enable a successful mission.

Description of significant research results, protocols developed, and research transitions

None reported

Information on collaborators / partners: None

Information on any outreach activities: None

NGI FILE #09-NGI-MOD-26

Project Title: Balloon and Payload Acquisition for WISDOM Activities during the 2009 Hurricane Season

Project Lead (PI) name, affiliation, email address: Louis Wasson, Mississippi State University, lwasson@gri.msstate.edu

Co-PI(s) name, affiliation, email address: David Shaw, Mississippi State University, dshaw@research.msstate.edu

Related NOAA strategic goals: Ecosystems Mission Goal, Climate Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Justyna Nicinska, OAR

Project objectives and goals

NOAA has mandated a 50% increase in hurricane track forecast accuracy 3-7 days from possible landfall. More accurate, long range track forecast will give local emergency management agencies more time to better advice local communities in preparations or evacuations if needed. The problem with long range track forecast is the data gap 1000 miles off shore of the United States. Satellite images see the current position of a storm but little synoptic meteorological data for models. With little data from these remote ocean areas forecast models formulate numerous tracks that cover hundreds of miles of coast line making it difficult to manage emergency services.

The challenge will be to develop systems capable of obtaining these important meteorological measurements in an economical manner without placing NOAA personnel at increased risk. One such system involves the instrumented balloons on the WISDOM operation.

A major goal of the WISDOM operation is to use college students in a related field of study to help in the launching operation of the WISDOM balloons. NGI contacted the Department of GeoSciences at MSU for student assistance in launching the balloons. The meteorological discipline in GeoSciences has one of the premier meteorology programs in the country and its students are very active in local, regional and national storm chasing. In national student forecasting competitions MSU routinely finishes 1st or rated very high each year. Over 20 GeoScience students volunteered their time in traveling to the Mississippi gulf coast for WISDOM launches. Their expertise in forecasting was invaluable during the launch operations.

Description of research conducted during the reporting period and milestones accomplished and/or completed

2010 to 2012 no WISDOM launches were conducted. This was due to no hurricane activity in 2010 and 2011 hurricane seasons and lack of funding in NOAA to support the WISDOM launches in 2012. Though no WISDOM launches have been conducted since 2009, WISDOM funds have been used to conduct investigations into different types of balloon configurations. One such balloon was the Cheaper Clipper design that carried the WISDOM meteorological payload and a balloon sail to better catch low level winds. The Cheaper Clipper used a drag line to keep the balloon 100 feet above the ocean surface as the winds drove the balloon out to the vast open oceans.

In November, Hurricane Ida formed in the Gulf of Mexico and headed north. On November 6 several balloons were launched from Waveland, MS and on November 9 a team from NGI headed to the Florida Keys and launched 5 balloons, one every 3 hours to intercept the hurricane. At a later date the WISDOM data from this launch was used in an experiment to test if the WISDOM data could improve the track.

Description of significant research results, protocols developed, and research transitions

No significant research results, protocols or transitions to report.

Information on collaborators / partners:

a. Name of collaborating organization: NOAA ESRL
b. Date collaborating established: May 30, 2008
c. Does partner provide monetary support to project? Amount of support? Yes, $50,000
d. Does partner provide non-monetary (in-kind) support? Yes, ESRL provides technical guidance and analysis, works to incorporate data in to prediction models, recommends changes to hardware and protocols, and participates in training and test launches.
e. Short description of collaboration/partnership relationship. NGI personnel from Mississippi State University and the NGI Program Office work closely with the collaborating organization to ensure that the project goals are coordinated with technical personnel in NOAA responsible for modeling hurricane forecasts of land fall locations, times and intensities. Additionally, NOAA personnel experienced in balloon operations advised NGI during the development, training and deployment of test balloons.

Information on any outreach activities: None

NGI FILE #09-NGI-MOD-29

Project Title: Development of a Northern Gulf of Mexico Operational Forecast System

Project Lead (PI) name, affiliation, email address: John Harding, Mississippi State University, jharding@ngi.msstate.edu

Co-PI(s) name, affiliation, email address: Changsheng Chen, University of Massaschusetts-Darmouth, c1chen@umassd.edu

Related NOAA strategic goals: Ecosystems Mission Goal, Climate Mission Goal, Weather and Water Mission Goal, Commerce and Technology Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Frank Aikman, NOS Coastal Survey Development Lab

Project objectives and goals

The NOAA National Ocean Service's Physical Oceanographic Real-Time Systems (PORTS) along the northern coast of the Gulf of Mexico will provide real-time oceanographic data to promote safe and efficient navigation. NGI, through MSU, will manage and coordinate this Operational Forecast System (OFS) UMASS-Dartmouth project activity in the development of a model to support the PORTS. A global or basin-scale model will provide boundary conditions to a proposed northern Gulf of Mexico Shelf domain model. This will cover the continental shelf from the shoreline seaward to approximately the 200 m isobath and from the southern tip of Texas to between Pensacola and Choctawhatchee Bays, Florida. The nGOM Shelf model will provide boundary conditions to three nested OFSs for the Northeastern Gulf of Mexico (NEGOM), the Northwestern Gulf of Mexico (NWGOM), and the Lower Mississippi River (LMR). The NEGOM regional OFS will include the three PORTS locations for Mobile Bay, Pascagoula, and Gulfport. The NWGOM regional OFS will include the three PORTS locations for Lake Charles, Sabine Neches, and Houston/Galveston. The LMR regional OFS will cover the New Orleans PORTS.

The major role of UMASSD team is to help the NOAA National Ocean Service to define the methodology for the development of the nGOM OFS; to describe the technical approach and timeline; and to provide technical assistance in using FVCOM.

Description of research conducted during the reporting period and milestones accomplished and/or completed

The nGOM Shelf and nested NEGOM, NWGOM and LMR OFSs require a hydrodynamic model capable of accurately representing larger scale features such as meso-scale eddies and the wind-driven coastal circulation as well as the smaller scale coastal and estuarine circulation associated with complex shorelines, topography and tidal dynamics. Therefore, the Finite Volume Coastal Ocean Model (FVCOM: Chen et. al., 2003), developed at UMASSD has been selected to be tested and applied to this region. FVCOM has been successfully applied in several coastal ocean regions to simulate the hydrodynamics using an unstructured grid. The Northeast Coastal Ocean Forecast System (NECOFS) has been implemented by UMASSD in a real-time mode since 2007 (http://fvcom.smast.umassd.edu/research_projects/NECOFS/

index.html) with high-resolution grid nesting functionality. In addition, the application of FVCOM to the Delaware River and Bay, within the context of NOS's Delaware River and Bay Model Evaluation Environment, revealed encouraging FVCOM modeling skills in simulating water levels, currents, salinity and temperature. FVCOM was therefore chosen as the core numerical model for developing an nGOM regional modeling approach.

A key feature in the proposed system is the implementation of a regional model, using the forecasts of a global ocean or basin-scale Gulf of Mexico model to provide open ocean lateral boundary conditions. The regional model is then nested to a series of highly resolved grids to focus in regions of interests, i.e., PORTS. The technique of nesting has made significant advances over the last few years and the NECOFS system has demonstrated high-resolution grid nesting functionality. For prediction accuracy and operational efficiency, a medium grid resolution (5 km to 500 m) model will be set-up to cover the shelf area (nGOM Shelf). nGOM Shelf will use boundary conditions from a global or basin-scale model. The higher resolution (50 m to 500 m) NEGOM, NWGOM and LMR models will then be nested within the nGOM Shelf model to resolve the smaller scale coastal and estuarine circulation features in detail.

NOS has begun the nGOM Shelf domain development. The latest version of FVCOM available from UMASSD was configured for this. The nGOM Shelf model will provide forecasts in Mobile Bay as an initial PORTS demonstration and nesting of the NEGOM OFS will follow. The tasks breakdown for development and implementation of the nGOM Shelf and nested NEGOM OFS model system are: T1. Grid determination; T2. Tidal skill assessment T3. Hindcast skill assessment; T4. Nowcast/forecast system set up; T5. Nowcast/forecast system implementation.

Description of significant research results, protocols developed, and research transitions

The key objective of this project is to provide the technical support to the NOAA/NOS modeling team in developing the nGOM-FVCOM forecast system. The major efforts have been made in the development of protocols for the operational model to meet the NOAA/NOS need and also transferring the FVCOM technology to the NOAA/NOS modeling team. We have successfully reached these two goals.

We have successfully transferred the updated FVCOM technology to the NOAA/NOS modeling team. The nGOM-FVCOM has been able to run on the NOAA IBM supercomputer. We also have built a partnership with NOAA/NOS modeling team in the system development. The model system has been running and now are being validated by the observation.

Information on collaborators / partners:

a. Name of collaborating organization: NOAA/NOS Coast Survey Development Laboratory, NOAA/NOS Center for Operational Oceanographic Products and Service
b. Date collaborating established: 2009
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? No
e. Short description of collaboration/partnership relationship. Drs. Frank Airkman, Eugene Wei and Aijun Zhang are leading the development of nGOM regional and coastal model using FVCOM. This system will be placed into the forecast operation after it is validated

using the field measurement data. We have been working together with them to provide the technical support through this funded project.

Information on any outreach activities: None

NGI FILE #09-NGI-02

Project Title: From Physics to Fish: Modeling the Effects of Pulsed River Diversion on Fish Distribution

Project Lead (PI) name, affiliation, email address: Dubravko Justic, Louisiana State University, djusti1@lsu.edu

Co-PI(s) name, affiliation, email address: Kenneth Rose, Louisiana State University, karose@lsu.edu; Chunyan Li, Louisiana State University, cli@lsu.edu; Haosheng Huang, Louisiana State University, hhuang7@lsu.edu

Related NOAA strategic goals: Ecosystems Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

Pulsed freshwater diversions on the Lower Mississippi River are increasingly being used to combat coastal land loss. An issue that arises with diversions is their effects on aquatic biota in the area. How do pulsed releases of freshwater affect the spatial distribution and health of ecologically and economically important fish and invertebrate species downstream? This is a critical question to address if these diversions are to be used for wide-scale coastal restoration. Our project combines hydrodynamics (physics), water quality, and individual-based fish models into a single integrated “physics to fish” model, and examine how changes in salinity, temperature, and water quality resulting from diversions affect several key fish species. We are formulating a “physics to fish” model based on the Caernarvon River Diversion (CRD) and Breton Sound Estuary. The CRD provides a good test case – it has been operating since 1992 and has been the subject of several large-scale studies (i.e., PULSES, NUMAN, and most recently NGI) designed to monitor how pulsed releases affect water quality and key aquatic biota. There are also existing datasets and models for this system that have been developed from previous projects that will make it easier to develop our models. With prior support of NGI, we have implemented the Finite Volume Coastal Ocean Model (FVCOM) to the coastal northern Gulf of Mexico. As a part of this effort, we have extended the model grid to the upper Breton Sound all the way to the CRD. FVCOM has been coupled with a simple nutrient-phytoplankton-zooplankton (N-P-Z) model of the Breton Sound that was previously developed within the PULSES project. Finally, the individual-based fish model is being developed to simulate the movements of thousands of individuals in the same 3-dimensional spatial grid as used by the hydrodynamics model. Each individual’s position in the grid is tracked in continuous space on an hourly time step, and each fish will experience the water velocity, salinity, temperature, and water quality in the cell within which it is located. Our individual approach is similar to the classical particle tracking approach, except that our particles can exhibit complicated movement behavior. We will examine both the short-term (days) and longer-term (weeks to months) influences of different diversion release scenarios on fish distributions and environmental conditions experienced by exposed fish. Our project will provide a quantitative tool to be added to the toolbox for assessing the effect and utility of river diversions for coastal restoration. Our model addresses the issue of diversions causing significant shifts in the spatial distributions of key fish species, and whether the rapidity of changes in environmental conditions can cause

stress in individual animals. These research endpoints are highly relevant to the Gulf of Mexico ecosystem research and the missions of NOAA, NGI, GOMA and Sea Grant.

Description of research conducted during the reporting period and milestones accomplished and/or completed

We have implemented a high-resolution three-dimensional unstructured-grid Finite Volume Coastal Ocean Model (FVCOM) for the Breton Sound Estuary, including the Caernarvon Freshwater Diversion site and part of the Louisiana continental shelf. The model horizontal grid consists of 77,628 nodes and 145,713 triangular elements, with a variable spatial resolution of 1-10 km over the shelf regions and 10–500 m in the Breton Sound Estuary. The model includes 19 vertical sigma layers. The model grid in the estuary extends to the surrounding wetland areas to allow for wetting and drying of estuarine marshes. Model prognostic variables included sea surface elevation, three-dimensional velocity, salinity and turbulent variables. FVCOM has been coupled to a simple nutrient-phytoplankton-zooplankton (N-P-Z) model and an individual-based fish model in which particles exhibit complicated “smart particle” movement behavior. The codes for simulating behavioral movement using kinesis, fitness, and game theory algorithms have been completed and are currently being tested on an idealized test grid.

Description of significant research results, protocols developed, and research transitions

Four numerical experiments were run to assess the response of current, salinity, water level, and marsh flooding to different diversion discharge scenarios. The four scenarios considered were: a 3-month high discharge scenario of ~ 200 $m^3 s^{-1}$ corresponding to the actual diversion discharge in April-July 2010, a 2-week pulsed scenario of ~ 200 $m^3 s^{-1}$ corresponding to the diversion discharge normally occurred in spring season, an almost constant discharge scenario of ~ 35 $m^3 s^{-1}$ corresponding to the annually averaged discharge, and a scenario with no discharge. Numerical simulation results indicated that 35 $m^3 s^{-1}$ discharge caused little change in wetland inundation and salinity compared to the no discharge case. Thus, it appears that the exchange between deep channels and the wetlands was not improved by the 35 $m^3 s^{-1}$ discharge. In contrast, the 2-week ~ 200 $m^3 s^{-1}$ discharge caused enhanced water exchange between wetlands and adjacent water bodies, substantially increasing water velocities in the narrow bayous and channels of the upper estuary. A noticeable reduction of salinity in the mid-estuary (about 10 to 20 km from the diversion) was also predicted. These effects caused a noticeable increase in down-estuary residual current, with a significant reduction of local estuarine residence times for the whole estuary. The 3-month high discharge scenario was the only scenario that had effects farther than 40 km from the diversion structure.

Oil slick simulations indicated that the 3-month ~ 200 $m^3 s^{-1}$ high diversion discharge drove most of the oil particles, initially located at the entrance of the estuary, out of the estuary and moved them along the coastline to the Mississippi Sound. In contrast, the no discharge scenario allowed most oil particles to travel upstream into the estuary. This difference can be explained by the relatively large contribution of the long diversion freshwater release to the residual currents. Individual-based fish modeling involved assigning complicated movement behaviors to the particles based on salinity as the cue. Movement was simulated using kinesis, restricted-area, and event-based approaches. These alternative movement approaches have been tested

on both an idealized test grid and on the Breton Sound grid for the period from 1 April to 1 July 2010. The analysis of fish movement results is still ongoing.

Information on collaborators / partners:

LSU scientists are collaborating with Dr. Lawrence Rozas, NOAA Fisheries Service, who participates in this project as unfunded collaborator. Over the past decade or more, Dr. Rozas has been investigating how aquatic fauna community structure responds to river pulsing and other perturbations in a variety of locations in coastal Louisiana, including Breton Sound. Our group is also collaborating informally with Dr. Shaye Sable of the Louisiana Department of Wildlife and Fisheries, and with Dr. Brian Piazza, the Atchafalaya Program Manager at the Nature Conservancy. Dr. Sable is involved with developing and using other modeling approaches than the particle tracking proposed here for examining how river pulsing affects fish community composition on marshes, and Dr. Piazza is involved with collecting and analyzing field data on diversion effects on aquatic fauna composition and spatial distributions in the upper portion of Breton Sound.

Information on any outreach activities:

The project advances the educational mission of Louisiana State University by enhancing its land-grant and sea-grant institution status. The Louisiana Sea Grant Program annually sponsors “Ocean Commotion”, which brings more than 3,400 area students and teachers to LSU to learn about our coast and sea (http://www.lsu.edu/university_relations/oceancommotion/). Project results from LSU NGI contribute to this program by demonstrating how high-end computing and information from different disciplines is combined for use in ecosystem management. Participants in our project contribute to community outreach by participating in stakeholder meetings, such as the Caernarvon Interagency Advisory Committee (CIAC), whose members represent all major stakeholders of the region. CIAC members include fishery representatives (oyster, shrimp, and recreational fishers), representatives of local governments, local landowners who care about the environment, and natural resource agencies (LA Depts. of Wildlife and Fisheries, Natural Resources (DNR), Environmental Quality, and Health and Human Resources; and US Fish and Wildlife Service, National Marine Fisheries Service, EPA, and Army Corps of Engineers).

NGI FILE #09-NGI-03

Project Title: Riverine and Estuarine Carbon Export to the Coastal Ocean, Northern Gulf of Mexico

Project Lead (PI) name, affiliation, email address: Brian Fry, Louisiana State University, bfry@lsu.edu

Co-PI(s) name, affiliation, email address: R. Eugene Turner, Louisiana State University, euturne@lsu.edu; Dubravko Justic, Louisiana State University, djusti1@lsu.edu

Related NOAA strategic goals: Climate Mission Goal, Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

2 objectives: 1) compare C lability in the Mississippi River and in a nearby estuary, Barataria Bay, that is heavily influenced by this river and, and 2) clarify carbon source/sink issues involving net autotrophy and net heterotrophy for lower Barataria Bay via coupled pCO_2 and productivity measurements.

Description of research conducted during the reporting period and milestones accomplished and/or completed

We completed this project in the last six months of 2011, and this final report covers those final six months. The field work was extended to the end of 2011 to include a full year of water quality, productivity, respiration and pCO_2 measurements in Barataria Bay. Activities on the publication front for the whole project include publication of two manuscripts, one manuscript in review, and two manuscripts in preparation.

Description of significant research results, protocols developed, and research transitions

Barataria Bay appears similar to other Louisiana bays in terms of P (productivity) and R (respiration) dynamics. Seasonality and winds emerge as quite important aspects of these bay systems, with higher P and R rates in warmer seasons, and winds acting to re-suspend sediments in these shallow bays, thereby decreasing light needed for P. Thus, samples collected in calmer conditions can have 3-6x the P than samples collected in windy conditions. The interplay between season and winds is important for the overall productivity of these bay systems, and, along with nitrate loading, governs whether they act as a source or sink for CO_2. We are using the newly completed annual cycle information to inform our views of 10-20 years of monthly-collected transect data for this bay, to develop an integrated assessment of how P and R dynamics have changed through time in these bay systems.

Information on collaborators / partners: None

Information on any outreach activities: None

NGI FILE #09-NGI-04

Project Title: Spatial Variation and Temporal Trend of Water Quality in the Northern Gulf of Mexico

Project Lead (PI) name, affiliation, email address: Zhongping Lee, Mississippi State University, zplee@ngi.msstate.edu

Co-PI(s) name, affiliation, email address: Laodong Guo, University of Southern Mississippi, laodong.guo@usm.edu

Related NOAA strategic goals: Weather and Water Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

Our overarching objective is to obtain a comprehensive understanding of the spatial variation and temporal trend of the water quality parameters in the northern Gulf of Mexico. The observing parameters for water quality will be water clarity and concentrations of suspended inorganic matter (SIM) and organic matter (SOM). Water clarity is a direct and first order measurement of the status of the health of an ecosystem, while SIM and SOM provide more in-depth evaluation of water constituents. Such information is critical for the evaluation of the health and stress of an ecosystem that are required to help federal and state agencies on decision making in regulation of nutrient discharges.

Description of research conducted during the reporting period and milestones accomplished and/or completed

Lee Lab

a) Field measurements and sample analyses: During the funding period, we either participated or carried out sampling measurements in the northern Gulf of Mexico and Lake Pontchartrain, with samples covering waters from the Mississippi River plume as well as deep blue waters. In addition to the measurement of remote-sensing reflectance (Rrs) using a hand-held spectral radiometer, water samples were corrected to analyze colored-dissolved organic matter (CDOM), dissolved organic carbon, particulate organic matter, total suspended particulate matter (SPM), and other water quality parameters.
b) Buoy and Argofloat measurements: An optical-sensor equipped Argofloat was deployed (April 8 – May 8, 2011) in the northern Gulf of Mexico, with physical and optical properties in the surface layer collected following the currents. Also, optical sensors were installed/integrated with NDBC Buoy (#42040) on June 17, 2011, with water-quality properties measured every 30 minutes for five months (to the end of October).
c) Algorithm refinement: With both numerically simulated and field-measured data, algorithms for the derivation of water's optical properties have been refined. These properties provide key inputs for the estimation of water clarity, and the algorithm is found working well for turbid waters in the northern Gulf of Mexico that including the Lake Pontchartrain.
d) Satellite data processing: Water quality products of the Northern Gulf of Mexico were derived from MODIS and MERIS measurements with refined processing algorithms.

Guo Lab

During this funding period, we coordinated with NGI Principal Investigator, Dr. Zhongping Lee, on field sampling camping and sample analysis. In addition to study areas in the northern Gulf of Mexico, we also used Lake Pontchartrain as a model water body for ground truth observations. We have conducted two field sampling trips to the Lake Pontchartrain, one in winter season and the other in spring 2011. Furthermore, we also participate in two Gulf of Mexico sampling cruises for collecting water samples for the measurements of fluorescent dissolved organic matter, chromophoric dissolved organic matter, other derived optical properties and suspended particulate matter concentration as well as dissolved and particulate organic carbon concentrations. Most sample processing and data acquiring have been done and data synthesis and interpretation is on-going. We expect to have 2-3 collaborative manuscripts for submission to scientific journals for eventual publication.

Description of significant research results, protocols developed, and research transitions

Lee Lab

1) "Whitish" patch of waters: "Whitish" patch of waters in the northern Gulf of Mexico are constantly observed from ocean color satellite imageries. With a newly developed optical index (particle backscattering ratio), we are able to confidently classify these "whitish" waters as that dominant with inorganic particles suspended in the upper water column. Further, with remotely sensed particle optical properties, the concentration of the inorganic portion of matters was estimated.
2) Phytoplankton dynamics in the Northern Gulf of Mexico: The phytoplankton abundance in the Northern Gulf of Mexico is found well correlated with the input of total phosphorus; while the relative amount of suspended inorganic particulates in NGOM waters is found correlated with the input of dissolved SiO_2. As both phosphorus and SiO_2 are routinely measured (and provided) by USGS and EPA over various fixed stations around New Orleans, these results provide a path way to predict the phytoplankton and particle characteristics in NGOM waters.
3) Algorithm to retrieve absorption coefficient of colored dissolved organic matter: Colored dissolved organic matter (CDOM; or gelbstoff), is an optically active component and plays an important role in carbon cycling. Mapping the spatial distribution of CDOM from ocean color satellite measurements and understanding its temporal dynamics are important aspects for characterizing the health of water quality. Unlike traditional empirical approach of deriving CDOM absorption from ocean color data, we have developed a semi-analytical algorithm for this retrieval and found it performed well for both oceanic and coastal waters.
4) Impact of hurricane Katrina on NGOM water quality: Using water-quality products derived from MODIS, we evaluated the temporal (monthly, 2005 – 2010) change of both phytoplankton absorption (a proxy for chlorophyll concentration) and particle backscattering (a proxy for turbidity) before and after Katrina. For the aquatic environments surrounding New Orleans, which suffered significant loss of population right after Katrina and then slowly gains population, there is no apparent change of water quality. For the west portion of Lake Pontchartrain, chlorophyll increased significantly right after Katrina, likely a result from the out flow of flood waters in New Orleans. Since

then, there is no apparent large change of chlorophyll and turbidity compared to before landing of Katrina.

5) Measurement of remote-sensing reflectance from a hand-held radiometer: Remote-sensing reflectance (Rrs) is a key property for ocean color remote sensing, either for algorithm development or for water-quality product generation from satellite measurements. Traditionally Rrs is measured either from above the surface with a hand-held spectral radiometer or from below the surface by vertical profiling. When Rrs is measured from above the surface, inevitably surface reflected skylight will also be collected, and this is a source of error for the derivation of Rrs. We have documented the spectral impact of the surface reflected light on the measurement of Rrs from the above surface platform, and demonstrated an innovative approach to precisely measure Rrs in the field.
6) Distributions and composition of chromophoric dissolved organic matter (CDOM) in Lake Pontchartrain: Distributions and composition of CDOM during spring and winter were investigated using UV-visible and 3D fluorescence spectroscopy techniques. In both seasons, DOC concentration was significantly positively correlated with absorbance, specific UV absorbance (SUVA) values, and humification index, but negatively correlated to biological index and spectral slope values. Three major fluorescent DOM components were identified using parallel factor (PARAFAC) analysis: component C-1 with Ex/Em maxima of 266/460 nm and UV humic-like DOM characteristics; C-2 with Ex/Em maxima of 350/450 nm, a visible terrestrial humic-like DOM; and C-3 having Ex/Em maxima of 295/380 nm and marine humic-like DOM characteristics. The fluorescence intensity ratio of C3/C2, an indicative of the dominance of marine vs. terrestrial humic-like DOM, is positively related with biological index. CDOM in Lake Pontchartrain was mostly derived from terrestrial sources with high aromaticity and high-molecular-weight materials. Large spatial and temporal variations in optical properties indicate heterogeneous distributions and dynamic cycling of CDOM in Lake Pontchartrain.
7) Variations in inorganic and organic nutrient species in Lake Pontchartrain: The abundance, distribution, speciation, and temporal variations of nutrients (N, P and Si) were investigated in Lake Pontchartrain. Dissolved inorganic phosphorus (DIP) was the dominant P species in both winter and spring, with concentrations ranging from 1.0 to 3.7μM and comprising up to 83-99% of the total dissolved phosphorus (TDP). Most of nitrogen was present in the form of DON (ranging from 88% to 98%). During spring, DIP, TDP and $Si(OH)_4$ concentrations in the west part of Lake Pontchartrain, adjacent to main fresh water inputs, were lower than those in the east part. In contrast, higher dissolved organic phosphorus (DOP) concentrations were measured at stations in the west part, likely due to inputs of DOP from small black water rivers in spring. During winter, the distribution of nutrient was mainly controlled by the mixing of fresh-water and salt- water, and terrestrial inputs around the lake. Concentrations of dissolved inorganic nitrogen (DIN), TDP, DIP and $Si(OH)_4$ were lower in spring than those in winter, indicating the influence of biological activities on nutrient abundance in the water column. Both DON and DOP concentration in spring (21.6±2.0 and 0.18±0.04μM, respectively) was higher than that in winter (19.9±0.9 and 0.11±0.08μM), resulting from higher freshwater inputs

and biological activities. Average inorganic N/P ratio were 0.5±0.3 in winter and 0.8±0.5 in spring, indicating a strong N-limitation ecosystem in Lake Pontchartrain. Dissolved organic matter in Lake Pontchartrain had a higher DOC/DOP (2933±993 in winter and 2575±582 in spring) and DON/DOP ratio (139±48 in winter and 123±25 in spring) than those observed for end-member water bodies surrounding the lake (1398±634 for DOC/DOP and 67±25 for DON/DOP), reflecting a diagenically older DOM pool in Lake Pontchartrain, due to its long water resident time.

8) Biogenic silica in the Mississippi River: We found that the annual export flux of biogenic silica from the Mississippi River ranged from 5 to 16×10^9 mole-Si/yr, comprising on average 27% of total Si fluxes to the Gulf of Mexico. Thus, the biogenic silica is a major component in the export flux of Si from the Mississippi River and may play an important role in the biogeochemical cycling of Si in the northern Gulf of Mexico.
9) Dynamics of phosphorus in the Bay of St. Louis: Concentrations of different phosphorus show a large variability during estuarine mixing in the Bay of St. Louis. While dissolved organic phosphorus (DOP) and particulate phosphorus (PP) were the predominated P species in end-member freshwaters entering the bay, dissolved inorganic phosphorus (DIP) become predominated in bay waters resulting from the release of PP and transformation between P species. River export fluxes of phosphate could be significantly underestimated without the quantification of particulate P. Both DIP and DOP behaved non-conservatively during estuarine mixing showing dramatic changes and transformation between different P species. The DOC/DOP ratio decreased rapidly with increasing salinity indicating a diagenetically older DOM from the river and a dynamic change in DOM sources and chemical speciation of P in the estuary. Results from laboratory mixing experiments support our hypothesis that physicochemical processes are the predominant mechanisms controlling the biogeochemical cycling of P species in the Bay of St. Louis.
10) Characterization of chromophoric and fluorescent dissolved organic matter in the lower Mississippi River: Concentrations of dissolved organic carbon (DOC) had a positive correlation with discharge ($P<0.005$), suggesting a hydrological control. High DOC concentrations were accompanied by higher specific UV absorbance (SUVA), lower spectral slope, higher colloidal organic matter, and higher humification index (HIX) values, suggesting the inputs of newly available, less degraded DOM with more optically active and higher molecular weight DOM components during high flow season. In contrast, riverine DOM during low flow season contained less aromatic and less HMW-DOM components, but a higher biological index, due to longer water residence time. Based on fluorescence EEMs and PARAFAC analysis, four major DOM components were identified from Mississippi River waters. The first component, C1, had its Ex/Em maximum at 364/469nm, and can be referred to visible terrestrial humic-like DOM. The second component C2, with Ex/Em 250/447 nm, had typical characteristic of UV humic-like DOM. The third (C3) and fourth (C4) component had Ex/Em maximum at 338/414 nm and 230/460 nm, respectively. C1 was found to be enriched in the >1 kDa colloidal organic matter fraction isolated by ultrafiltration, suggesting its high molecular weight in nature, while C2 was found overwhelmingly in the <1 kDa LMW-DOM fraction. Overall,

DOM abundance, optical properties and fluorescent DOM composition were largely influenced by hydrological cycles in the lower Mississippi River.

Guo Lab

While some of our samples are still under processing /analysis, we have worked on data synthesis and will be combined with PI's satellite data for ground truthing. Based on our available data, we have presented and submitted a number of abstracts to regional and national scientific meetings and conferences. See also publication and presentation list below.

Information on collaborators / partners:

a. Name of collaborating organization: Naval Research Lab at Stennis Space Center
b. Date collaborating established: July 1, 2008
c. Does partner provide monetary support to project? Amount of support? No.
d. Does partner provide non-monetary (in-kind) support? Yes.
e. Short description of collaboration/partnership relationship: Help on satellite data acquisition and processing.

Information on any outreach activities: None

NGI FILE #09-NGI-05

Project Title: Sediment and Mercury Path and Fate Modeling

Project Lead (PI) name, affiliation, email address: William H. McAnally, Mississippi State University, mcanally@ngi.msstate.edu

Co-PI(s) name, affiliation, email address: James Martin, Mississippi State University, jmartin@cee.msstate.edu; Karen McNeal, Mississippi State University, ksm163@msstate.edu; Vladimir Alarcon, Mississippi State University, Alarcon@gri.msstate.edu

Related NOAA strategic goals: Ecosystems Mission Goal, Weather and Water Mission Goal, Commerce and Transportation Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

Sediments are the main repository of mercury in the coastal Gulf of Mexico as well as the site of transformation of inorganic mercury to methylmercury, the more toxic form that is bioaccumulated through food webs. Re-suspended sediments are a major transport vector for total mercury and methylmercury. The redistribution of mercury-containing sediments is a critical determinant of where in the coastal environment mercury will become a problem. Sediment characteristics such as texture and organic matter content help determine the extent to which inorganic mercury is transformed to methylmercury. The goal of this project is to provide a suite of methods to predict the path and fate of sediment and mercury in the Gulf coastal region from entry point to fish stocks.

The specific objectives of this project are to:
(1) Improve sediment and mercury modeling capabilities
(2) Determine potential sulfide accumulation effects on methylmercury production
(3) Establish a method to predict mercury bioaccumulation in fish
(4) Extend the new technologies to other areas of the Gulf of Mexico
(5) Determine the potential of Weeks Bay sediments to promote methylmercury production through measurements of mercury, acid volatile sulfides, total reduced sulfides, reactive iron, and organic carbon.

Description of research conducted during the reporting period and milestones accomplished and/or completed

All work was completed.

A one week sampling trip to Weeks Bay, AL occurred in June, 2011. Samples were collected at twelve sampling locations: including water column and sediment. Water column measurements of conductivity, turbidity, dissolved oxygen, temperature, and salinity were made and samples were analyzed for chlorophyll and total mercury. Sediment porewaters were analyzed for dissolved H_2S, Fe^{2+}, Mn^{2+}, O_2 and sediments were analyzed for reactive iron, total reduced sulfides, acid volatile sulfides, total mercury, and total organic carbon. Laboratory analyses of the above mentioned measured were completed and results are provided in the following section.

A suite of hydrodynamic, sediment, and mercury transport numerical models were developed and tested, including:

- Hydrologic models of the watershed
- Hydrodynamic models of the Bay
- Transport models of the Bay

A series of shoreline profiles were measured prior to the oil spill, but were suspended when the bay inlet was blocked to prevent oil intrusion during the Deepwater Horizon incident. The data were used to develop a shoreline profile algorithm for muddy shores.

Description of significant research results, protocols developed, and research transitions

There is an indirect relationship between pyrite and MeHg. Iron and mercury results confirmed that when pyrite increases the MeHg decreases because pyrite iron is competing for available sulfides to make acid-volatile sulfide (AVS) and total reduced sulphur (TRS) minerals instead of cinnabar. The lack of oxygen within the sediment and presence of organic carbon supported the activity of SRB favoring MeHg and pyrite formation. Hydrogen sulfide accumulated, evidenced by the presence TRS and AVS minerals, and the competition for sulfides between reactive iron and inorganic mercury occurred. The wide concentration gap between the total pyrite and MeHg indicates that reactive iron more strongly competes for sulfides. The reactive iron overwhelmed inorganic mercury decreasing the chances of hydrogen sulfide reacting with inorganic mercury to form cinnabar. With the quantity of iron being greater than MeHg, the probability for cinnabar to form is remote. Therefore, the more iron that is deposited the less likely for cinnabar to form. There is an adequate presence of reactive iron, sulfate, limited carbon, and hypoxia with burial favoring sulfate-reducing bacteria (SRB) productivity and sulfide production. The oxygenated water above the sediment supports biologic activity and the opportunity for MeHg to work its way up the food chain.

A coupled sediment-mercury numerical model was created and tested. Conclusions from that modeling were:

- Weeks Bay, identified by the Environmental Protection Agency as an area of high atmospheric mercury deposition, is home to wildlife – especially fish – with large amounts of mercury bioaccumulated in their systems.
- In the present study a coupled tidally averaged transport and mercury speciation model was implemented for the analysis of the principal processes that affect the fate and transport of mercury and ultimately its toxicity in Weeks Bay, Alabama. The transport module was calibrated and verified using salinity observations collected at different points within the estuary. The results suggest that the model is able to reproduce the long term transport characteristics of the system and therefore can be used to predict the transport of mercury in Weeks Bay. It is important to notice that as the transport module is based on a tidally averaged approach, the model is unable of capturing intratidal changes or short term dynamic transport in the system.
- As historic observations of the different forms of mercury in Weeks Bay are nonexistent, the speciation model has not been properly calibrated or verified for its use as a

predictive tool of the chemical processes that affect the mercury in the estuary. Further monitoring efforts and modeling research is required.

- Despite the current limitations of data availability, a preliminary implementation of the models to evaluate the hypothesis that atmospheric deposition during the last 30 years can explain the current levels of mercury in the area has been presented in the document. The activity was carried out using historic atmospheric deposition records and model parameter values suggested in the literature. The results suggest that atmospheric deposition in fact could potentially be the cause of the levels of methylmercury observed in the area. However, more research is necessary to evaluate the reliability of these results and other potential causes.

Information on collaborators / partners:

a. Name of collaborating organization: David Evans, NOAA Center for Coastal Fisheries and Habitat Research
b. Date collaborating established: 2005
c. Does partner provide monetary support to project? Amount of support? Yes, $76,000
d. Does partner provide non-monetary (in-kind) support? Yes, boat time and sampling help.
e. Short description of collaboration/partnership relationship. Coauthored proposal, co-sampled in Weeks Bay, AL in 2010, analyzed some MSU-collected samples for Mercury and sediment characteristics. We plan on joint publication of results.

Information on any outreach activities: None

NGI FILE #09-NGI-06

Project Title: Toward an Understanding of Gulf Coast Resident Preferences and Perceptions on Risk and Restoration

Project Lead (PI) name, affiliation, email address: Daniel R. Petrolia, Mississippi State University, Petrolia@agecon.msstate.edu

Co-PI(s) name, affiliation, email address: Keith Coble, Mississippi State University; Matthew Interis, Mississippi State University; Craig Landry, East Carolina University; Rex Caffey, Louisiana State University

Related NOAA strategic goals: Ecosystems Mission Goal, Climate Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

The objectives of this work are 1) an economic analysis of risk preferences and perceptions of coastal residents and how these preferences and perceptions affect behavior, and 2) an analysis of public preferences for coastal restoration policies, particularly in Louisiana.

Description of research conducted during the reporting period and milestones accomplished and/or completed

1. Obj 1: Manuscript submitted to *Land Economics* for review. Paper is currently in 3rd round of review.
2. Obj 1: Master's thesis completed (Jihyun Lee) based on Objective 1 data set.
3. Obj 2: Three manuscripts prepared; two in review process, one posted as research report online. Submission of third manuscript is being delayed until feedback from first two manuscripts is received.
4. Obj 2: Master's thesis completed (GwanSeon Kim) based on Objective 2.

Description of significant research results, protocols developed, and research transitions

1. Obj 1: link between risk preferences and risk perceptions shown to be statistically significant in explaining choice to insure against coastal flood among Gulf Coast residents. Also, the role of perceptions of insurer credibility (i.e., "trust" in insurance companies to pay in the case of event) was found to significantly affect the decision to participate in NFIP, while the role of charity hazard (failing to insure under expectations of post-event government handouts) was found not to be significant; in fact, we found the opposite: that those with expectations of post-disaster aid were significantly more likely to participate in NFIP.
2. Obj 1: Master's thesis completed (Jihyun Lee) based on Objective 1 data set.
3. Obj 2: Preferences for wetland restoration significantly affected (positively) by levels of ecosystem service attributes: flood protection, fisheries productivity, and habitat provision. Welfare estimates significantly affected by degree of consequentiality (i.e., the degree to which the respondent perceives the survey to be meaningful and have a real influence of actual policy decisions). Overall, based on our national survey, we find evidence to support the claim that Louisiana is "America's Wetland", i.e., that households beyond the Louisiana state lines are in favor of devoting resources to the restoration of Louisiana wetlands.

4. Obj 2: Master's thesis completed (GwanSeon Kim) based on Objective 2.

Information on collaborators / partners:

a. Name of collaborating organization: Center for Natural Hazards Research, East Carolina University
b. Date collaborating established: May 2008
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship. Co-investigator, co-author

a. Name of collaborating organization: Center for Natural Resource Economics and Policy, Louisiana State University
b. Date collaborating established: Oct 2006
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship. Co-investigator, co-author

a. Name of collaborating organization: Barataria-Terrebonne National Estuary Program
b. Date collaborating established: Jan 2011
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship. Advisory

Information on any outreach activities: None

NGI FILE #09-NGI-07

Project Title: Food Webs Without Borders: A Case for Ecosystem-Based Management in the Northern Gulf of Mexico

Project Lead (PI) name, affiliation, email address: John Valentine, Dauphin Island Sea Lab, jvalentine@disl.org

Co-PI(s) name, affiliation, email address: Behzad Mortazavi, Dauphin Island Sea Lab, bmortazavi@ua.edu; Tina Miller-Way, Dauphin Island Sea Lab, tmiller-way@disl.org

Related NOAA strategic goals: Ecosystems Mission Goal, Climate Mission Goal, Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

The objectives of this project were to: 1) increase formal and informal educators' and students' understanding of the interconnectedness of marine ecosystems as well as the principles and importance of ecosystem-based management, 2) elevate the understanding of future science educators about the importance of research to future members of society and environmental management via the emersion of graduate student education science majors in the research activities of our laboratories as summer interns, 3) elevate resource managers and regulatory authorities understanding about the importance of ecosystems-based management 4) train future scientists about NOAA's research mission via graduate assistantships, and 5) educate the public and management and regulatory community about the need to develop and enforce plans that incorporate the principles of ecosystem-based management in the northern Gulf of Mexico via public presentations and peer-reviewed scientific publications.

Ultimately our goal is to advance our understanding of the importance of food web linkages among habitats and ecosystems to higher order consumers in the northern Gulf of Mexico and to convey this new knowledge to the public, educators, environmental managers, and fellow scientists.

Description of research conducted during the reporting period and milestones accomplished and/or completed

We used sampling conducted primarily in the lower reaches of the Mobile Bay Delta (MBD), and the lower Mobile Bay Estuary. Fauna and flora collected twice a year during these efforts were used for traditional comparisons of ecological community structure and isotopic analyses, because of the seasonally varying influence of temperature and freshwater inflow on ecological community structure in the northern Gulf of Mexico. Samples collected to conduct the traditional community comparisons were collected from the MBD area. Food web sampling for stable isotopic analyses was conducted at two locations (in the lower reaches of MBD, within the lower reaches of Mobile Bay, and its nearshore waters in the northern Gulf of Mexico) along a transect that extended from the northern boundary of the delta on down through the middle of Mobile Bay.

Description of significant research results, protocols developed, and research transitions

Phase one of our study was designed to examine the effects of a highway causeway on ecological community composition and nursery function within a river delta. We compared nekton density, composition, and biomass in fall 2009 and spring 2010 among three locations and three major habitat types (marsh, SAV=submerged aquatic vegetation dominated by *Vallisneria americana*, SNB=shallow nonvegetated bottom) commonly found throughout the Mobile-Tensaw River Delta (MTD) using 1-m2 drop samplers. Sample locations (TR=Tensaw River, CB=Chocolatta Bay, and BC=Below Causeway) were selected based on their degree of tidal connectivity with the wider estuary (BC > TR > CB). Nekton distributional patterns varied among both locations and habitat types. Species richness was greater at BC than CB. The young of most estuarine-dependant fishery species were more abundant, and had more biomass, at BC and TR than CB, whereas estuarine resident species dominated the nekton in CB. Within locations, mean densities and biomass of abundant species were concentrated in vegetated (marsh, SAV) habitat types, and most species associated with vegetation structure were more abundant in SAV than marsh. Delta locations directly connected to Mobile Bay may therefore provide an important nursery for fishery species such as white shrimp, blue crab, gulf menhaden, and southern flounder.

A number of studies have shown that allochthonous inputs of carbon and nutrients can strongly affect food webs in adjacent habitats. In phase two of this effort, we sought to determine if such linkages exist between the Mobile-Tensaw Delta (MTD) and lower Mobile Bay (LMB), carbon, nitrogen, and sulfur stable isotope signatures were used to document relative contributions of terrestrial, freshwater, and marine resources to consumer diets in these two settings. Because freshwater inflow varies greatly temporally, organisms were collected from all trophic levels in spring and fall of 2010 and 2011. Isotopic signatures varied greatly with season. Many organisms from both locations were more enriched in the heavy forms of all three isotopes in fall than in spring; the exceptions were estuarine fishes collected from LMB and terrestrial/freshwater fishes and invertebrates collected from MTD. Lower $\delta^{13}C$ and $\delta^{34}S$ values recorded in marine fish species from LMB reflecting a drop in salinity during spring. Similarly, higher, more marine $\delta^{13}C$ and $\delta^{34}S$ values recorded in plants, invertebrates, and fishes from MTD during fall documenting the strong seasonal influence of the saline waters of lower Mobile Bay and the nearshore Gulf of Mexico on this area. MTD $\delta^{13}C$ data were compared to a longer-term data set to consider climate impacts (e.g., El Nino and La Nina) on resource use by organisms in MTD. Comparisons of $\delta^{13}C$ to multivariate ENSO index values showed a stronger freshwater $\delta^{13}C$ signature in plants, fishes, and invertebrates during La Nina and El Nino conditions than in neutral ENSO conditions. These results show the strong seasonal linkages between MTD and LMB, as well as the significant, though weak, effects of ENSO on these cross-habitat linkages.

Information on collaborators / partners: None

a. Name of collaborating organization: Lawrence Rozas, NOAA Fisheries Service
b. Date collaborating established: Jan 2011
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? No
e. Short description of collaboration/partnership relationship. In this study, investigators independently evaluating the food web dynamics of oligohaline vegetated habitats in the

northern Gulf of Mexico came together to evaluate: 1) the impacts of an ecosystem-wide barrier to natural hydrological exchange between habitats (NOAA scientists) and 2) the strength of trophic linkages between fauna living in these vegetated habitats and those living in the northern Gulf of Mexico (DISL scientists). Together these investigators also sought to determine the extent to which the findings of these two avenues of investigation varied with season. Additionally, our team sought to determine the extent to which meteorological events (El Nino) in the Pacific Ocean may control the strength of trophic relationships between the oligohaline deltas of this region and the open Gulf of Mexico.

Information on any outreach activities:

In the summer of 2011 (June 5-10), a professional development workshop for K-12 teachers and informal educators was held at the Dauphin Island Sea Lab under the auspices of the Discovery Hall Programs. Objectives of this workshop, titled *The Delta*, included a balance of content relevant to K-12 science standards, research results from the research portion of this grant and field experiences in the Mobile-Tensaw Delta (MTD). Specifically, we addressed watersheds, the geology and ecology of deltaic systems, invasive species, the use of stable isotopes for ecological information, the cultural history, major habitats and dominant plants and animals (and their adaptations) of the MTD, a case study of the Alabama red bellied turtle and human impacts on the MTD. During the 4 day workshop, participants visited specific sites in both the upper and lower Delta by boat on 2 successive days and visited Blakeley State Park and 5 Rivers Delta Center by car on the 3rd day. The remaining time was spent in lectures or conducting classroom and laboratory activities that could be used in participants' respective schools or environmental education centers. Discovery Hall educators were assisted at various times by students of Dr. Valentine; Dr. Charlie Martin, post-doctoral research associate and Ms. LaTina Stelle, graduate student as well as Dr. Judy Stout, local botanist and Mobile Co. Public School System board member, Mr. Fred Nation, botanist and state certified expert in invasive species, and Dr. John Dindo, Sea Lab educator and local expert on the ecology and history of the MTD.

A total of 15 teachers participated in the workshop. All participants earned CEUs: 2 individuals earned graduate credit. Most teachers were from inland schools (60%) and most were K-12 teachers (high school 53%, middle school 27%, home school 7%; 2 informal educators). Participants received a resource notebook and flash drive with background information, specific laboratory and classroom activities, relevant brochures, identification keys, maps, and an additional resource document. Pre and post-test assessments indicated that participants significantly increased their content knowledge ($p<0.001$). Workshop evaluations indicated that most participants thought the field trips were valuable or very valuable (87%, 73%, 87% for the Upper Delta, Lower Delta and Blakeley State Park area, respectively). Most teachers indicated that guest speakers added a valuable or very valuable component to the workshop (95%, 93% and 73% for Dr. Martin, Dr. Nelson and Ms Steele, respectively) as well as field experts (100% each for Drs. Martin, Stout and Dindo and Mr. Fred Nation). With the exception of dissecting the lubber grasshopper (a common inhabitant of marshes in the delta), all participants indicated that classroom activities were valuable or very valuable (invasive species activities, reptiles/alligator activities, edible lab, food web game). Content lectures by DHP educators

were also considered valuable or very valuable by workshop participants. Participants were asked to name the 3 most valuable components: field trips to the sites, expert involvement and hands-on activities were mentioned most frequently. When asked how they would use the information and materials in their classroom or center, responses ranged from the general ("share with other teachers", "in my zoology and environmental science classes", "teach students to take care of the environment and take care of watersheds") to the specific ("transition activities between my hydrology and oceanography units", discuss the processes of weathering, erosion, deposition, ocean transgression and regressions and tides"; "build a mock delta on site"). Graduate students were required to write a research paper and complete an exam: both wrote on invasive species. One A and one B were awarded.

NGI FILE #09-NGI-08

Project Title: Understanding Coastal Resiliency from Hurricane Impacts Using Integrated Modeling and Observations

Project Lead (PI) name, affiliation, email address: Q. Jim Chen, Louisiana State University, qchen@lsu.edu

Co-PI(s) name, affiliation, email address: Pat Fitzpatrick, Mississippi State University, fitz@gri.msstate.edu

Related NOAA strategic goals: Climate Mission Goal, Weather and Water Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

A number of river diversion projects designed to restore coastal wetlands have been built in south Louisiana. Among them are the Caernarvon Fresh Water Diversion Project in upper Breton Sound east of the Mississippi River and the Wax Lake Outlet of the Atchafalaya Basin in St. Mary Parish, LA. These diversions represent two scales and types of land building restoration models: One is the nourishment model that puts fresh water and accompanying sediment in existing older marsh landscapes, and; the second is a land creation model that builds new land with vegetation in new deltaic lobes using river sediments. Both systems may have different resiliencies from hurricane impacts, and consequently, they provide an important comparison and contrast for storm surge and wave reduction models.

The long term goal of this study is to improve our understanding of coastal resiliency from hurricane impacts using integrated numerical modeling, in-situ observations and remote sensing techniques. The specific objectives of this two-year project are to 1) Develop a comprehensive dataset of vegetation, soil and salinity characteristics before and after high energy disturbances in Breton Sound and Wax Lake Delta based on in-situ monitoring; 2) Compile geospatial data and analyze wetland changes in Breton Sound and Wax Lake Delta based on satellite imagery and modeling; 3) Improve the wind forcing input for storm surge and wave models; 4) Extend the NOAA ocean wave prediction model to coastal regions with wetlands; 5) Develop and test a coupled wave, surge and sediment transport modeling system for coastal regions using the Breton Sound and Wax Lake Delta as a natural “laboratory”; 6) Conduct numerical simulations to test hypotheses of coastal resiliency.

In order to understand, quantify and predict coastal resiliency from hurricane impacts, we have identified a number of key scientific equations: 1) What are the controlling factors dictating wetland erosion or sedimentation during a hurricane? 2) Can our predictive ability for assessing storm surge damage be improved through the development of coupled wave, surge, and sediment transport models? 3) How does the wetland loss contribute to the increase of storm surge and waves in coastal basins? 4) What is the rate of recovery of a damaged wetland after a storm? 5) Which land building restoration model is more effective and resilient from hurricane impacts?

Description of research conducted during the reporting period and milestones accomplished and/or completed

The following is a list of milestones achieved during this project.

Milestone A: Numerical modeling and wind analysis schemes

Milestone B: A parametric hurricane surface wind model and its application for tropical cyclones in the Gulf of Mexico

Milestone C: Wetland loss patterns near the Caernarvon diversion due to hurricane storm surge

Milestone D: Surge-dependent vegetation effects on hurricane-generated waves

Milestone E: Directional spectra of hurricane waves in the Gulf of Mexico

Milestone F: Field Measurements of Vegetation Biomechanical Characteristics

Milestone G: Facilitating the development of a quasi-stationary version of WAVEWATCH III

Milestone H: Application of Delft3D in the Breton Sound area

Description of significant research results, protocols developed, and research transitions

Milestone A: Numerical modeling and wind analysis schemes

This project advances weather forecast software and utilizes cutting-edge satellite and aircraft data to improve hurricane wind observations, intensity prediction, and wind structure forecasts. Errors in storm intensity and wind structure contribute to incorrect decision-making in DHS risk prognostics; flood insurance costs; and hurricane landfalls. However, wind observations are difficult to obtain, since instruments are often damaged during hurricanes. Moreover, the main analysis scheme, H*WIND, is a subjective algorithm not based on data assimilation science, handles outer-core winds inconsistently, only produces data every three hours, and often provides no data at landfall. We have developed a hurricane wind analysis scheme based on advances in data assimilation science that will produce consistent wind fields at all temporal and spatial scales. Our research is based on data assimilation experiments with Three-Dimensional VARiational analysis (3DVAR), Four-Dimensional VARiational analysis (4DVAR), and Gridpoint Statistical Interpolation (GSI). The modeling work uses the Weather Research and Forecast model (WRF) and two recently released hurricane versions of WRF: the NCAR version (Advanced Research HWRF, or AHW), and the NOAA/NCEP version (Hurricane WRF, or HWRF). Software has been developed to assimilate standard observations, as well as hurricane reconnaissance data (dropsondes, radar winds, and Step Frequency Microwave Radiometer), resulting in two journal articles. This scheme has been applied to Hurricanes Gustav and Katrina.

Diagnostic tools have also been developed to analyze hurricane model wind accuracy. One tool has been implemented in the Automated Tropical Cyclone Forecasting (ATCF) Scheme, used by the Joint Typhoon Warning Center (JTWC), the National Hurricane Center (NHC), and the Naval research Laboratory (NRL) for assessing the accuracy of operational hurricane model winds. A journal article has been published on the motivation and implementation of this software scheme, which allows operational meteorologists to assess whether numerical models

are accurately capturing hurricane wind profiles. This work was performed in collaboration with scientists at NOAA's CIRA (Dr. John Knaff) and NRL-Monterey (Chris Sampson).

Applied research on improving hurricane structure forecasts using COSMIC refractivity (which is the only satellite data not contaminated by heavy rainfall) data and precipitable water was also conducted.

Milestone B: A parametric hurricane surface wind model and its application for tropical cyclones in the Gulf of Mexico

Tropical cyclones often generate storm surges, wind waves and flooding when they approach the coast or make landfall, which is a major threat to human life and property in coastal regions throughout the. It is critically important to make timely and accurate forecasts of hurricane winds, surge and waves. The prediction of hurricane surface winds is of specific importance because it directly forces storm surge and wave models and controls their forecast accuracy. A parametric hurricane wind model has been developed based on the asymmetric Holland-type vortex model. The model creates a two-dimensional surface wind field based on the National Hurricane Center forecast (or observed) hurricane wind and track data. Three improvements have been made to retain consistency between the input parameters and the model output and to better resolve the asymmetric structure of the hurricane. First, in determination of the shape parameter B, the Coriolis Effect is included and the range restriction is removed. It is found that ignoring the Coriolis Effect can lead to an error greater than 20% in the maximum wind speed for weak but large tropical cyclones. Second, the effect of the translational velocity of a hurricane is excluded from the input of specified wind speeds before applying the Holland-type vortex to avoid exaggeration of the wind asymmetry. The translational velocity is added back in at the very end of the procedure. Third, a new method has been introduced to develop a weighted composite wind field that makes full use of all wind parameters, not just the largest available specified wind speed and its 4-quadrant radii. A journal paper has been published (Hu, K., Q. Chen and S.K., Kimball, 2012. Consistency in hurricane surface wind forecasting: an improved parametric model. Nature *Hazards* 61: 1029-1050.)

Ten historical hurricanes were selected to test the performance of this parametric wind model. In-situ measurements of wind speed and wind direction at 12 offshore buoys in the Gulf of Mexico and the hurricane wind hindcasts from the National Hurricane Center are utilized as the reference to evaluate the predictive skills of the parametric model. The overall RMSE for wind speed and wind direction is 2.8 ms^{-1} and 18 degrees for observed winds larger than 10 ms^{-1}. Without those improvements, the two values of RMSE increase to 3.4 ms^{-1} and 19 degrees. By comparing with H*Wind, it is found out that the wind model has the capability to reproduce the H*Wind distribution if the asymmetry of wind structure is not too complicated. The wind swath results produced by the experimental winds showed that the asymmetry in wind structure was exaggerated. The importance of those improvements in the parametric wind model were further demonstrated through the effects on storm surge and hurricane wave modeling by using a fully coupled surge-wave model during Hurricane Gustav. The modeled results gave better agreements with observed surges and waves than the experimental results. Due to the exaggeration of wind asymmetry in experimental winds, the difference in storm surge and hurricane waves was about 10% on both sides of the hurricane track. A book chapter is in press (Hu, K., Q. Chen, P.J. Fitzpatrick, 2012. Assessment of a parametric surface wind model for

tropical cyclones in the Gulf of Mexico, In: K. Hickey (ed.) Hurricane Research, InTech, ISBN 980-953-307-559-9).

Milestone C: Wetland loss patterns near the Caernarvon diversion due to hurricane storm surge

The altered brackish landscape from the diversion may not be resilient to hurricane storm surge and associated wave action. Hurricanes Gustav (2008), Ike (2008), Rita (2005), and Katrina (2005) caused erosion near the diversion which exceeded other erosion rates. This research geographically quantifies the land loss in the Hopedale and Delacroix marsh due to the 2005 and 2008 hurricanes. Specifically, the following regions are contrasted: 1) north of the Mississippi River Gulf Outlet (MRGO) in an area known as the Biloxi marsh (consisting of intermediate and saltwater marsh); 2) the saline outer marsh of Delacroix near Black Bay; and 3) the interior Caernarvon brackish and freshwater marsh in Delacroix. This analysis is performed for pre-Katrina/Rita, post-Katrina/Rita, and post-Gustav/Ike using data from NOAA's Coastal Change Analysis Program (C-CAP) program [distributed by the Coastal Services Center], and from the Landsat 5 Thematic Mapper (TM) satellite sensor.

The following results were found, and have been submitted in a journal paper:

- Before the 2005 hurricanes, wetland erosion occurred at a slow but steady pace throughout the region, from 0-2.4%. The most erosion was near the diversion in the freshwater region.
- After the 2005 hurricanes, land loss is evident throughout the basin. Both C-CAP and Landsat datasets show that, north of the MRGO, water coverage in the intermediate to saline regions increased from 1.5-3.7%. However, the freshwater regions increased as from 12.3-39.0%.The biggest proportional changes are in the diversion area.
- Wilcoxon rank-sum tests show these differences are statistically significant at convincing levels, with the smallest p-values near the diversion.
- The Landsat data for post-Gustav/Ike showed minimal land loss throughout the basin except near the diversion.
- Hypotheses for this poor resiliency are currently being studied. The freshwater vegetation may be unable to withstand the shear stress from hurricane impacts on shallow low salinity root systems. Because of agricultural runoff into the Mississippi River, the Caernarvon's nutrient-rich waters without bringing sediments from the river contribute to "weaker" soils by lowering biomass, below ground production, and organic accumulation. Additionally, the bulk density of freshwater marsh (0.07 g cm^{-3}) is much less than saline marsh (0.24 g cm^{-3}). All these factors suggest freshwater vegetation in the upper Breton Sound is less hardy than its saline counterparts.

A paper has been submitted to the *International Journal of Remote Sensing* on this effort, and is currently being revised based on reviewer comments.

Milestone D: Surge-dependent vegetation effects on hurricane-generated waves

It has long been recognized that vegetation on low-lying wetlands can effectively reduce the flow speed, modify turbulence structure, attenuate surge and wave energy, and affect sediment dynamics. Most of the existing storm surge and wave models utilize the conventional quadratic law for bed shear stresses. An empirical, constant bottom friction

coefficient has been used to represent the increase in the flow resistance due to vegetation, which may not be applicable to storm surges and hurricane waves over salt marsh grass. During a hurricane event, salt mash grass remains emergent at the beginning and ending of the water surge while becomes completely submerged at the peak of the surge. For flows over flooded wetlands, the bottom drag coefficient strongly depends on the vegetation properties as well as the flow depth and speed associated with the storm surge. A large drag force that is able to bend or damage marsh grass may be generated and result in a reduction of the flow resistance. The plant rigidity is a crucial parameter in determining the vegetal friction, which has important implications for surge and waves. The velocities common to surge events are sufficient to bend flexible vegetation, such as *Spartina alterniflora*, the dominant salt marsh vegetation on the Gulf Coast. For the emergent salt marshes, the vegetation drag is explicitly related to the flow depth as the projected area of vegetation increases with the surge height. Field measurements have been conducted to measure the salt marsh properties on the Louisiana coast. We have obtained new results of modeling wave attenuation by salt marshes using the coupled surge-wave-vegetation models and observed vegetation properties.

A sub-model for the surge-dependent vegetation drag described above has been developed and implemented into a three-dimensional (3D) storm surge model coupled with a spectral wave prediction model. The flow resistance and its equivalent Manning's roughness coefficient due to the vegetation were computed every time step as a part of the output from the 3D model, and used as a part of the input to the wave model together with the water level and depth-averaged velocity. The wave attenuation rate as a function of the surge stage and vegetation properties was quantified. It has been found that the time-dependent Manning's roughness coefficient peaks when the water depth is 1~2 times the plant height and gradually decreases as the surge height increases. Because the salt marsh grass bends as the current velocity increases, the Manning's coefficient decreases and so does the wave energy attenuation rate under strong currents. The methodology that we have developed can be implemented into other wave and surge models. The results have been published in the Proceedings of the 33rd International Conference on Coastal Engineering (Chen, Q., Zhao, H., and Liu, D., 2012. Modeling surge-dependent vegetation effects on hurricane-generated waves) and in a journal paper Chen, Q., and Zhao, H. 2012. Theoretical models for wave energy dissipation caused by vegetation, Journal of Engineering Mechanics. doi: 10.1061/(ASCE)EM.1943-7889.0000318)

Milestone E: Directional Spectra of Hurricane Waves in the Gulf of Mexico

The Gulf of Mexico is extremely susceptible to the impact of frequent tropical cyclones. These extreme meteorological events can generate waves larger than 10 m. Many ocean and coastal engineering applications require the information about the directional and frequency distributions of wave energy beyond significant wave heights and peak wave periods. In this study, hurricane-induced directional wave spectra in the Gulf of Mexico are investigated based on the measurements collected at 12 buoys during 7 hurricane events in recent years. Focusing on hurricane-generated wave spectra, we only consider the wave measurements at the buoys within eight times the radius of the hurricane maximum wind speed (Rmax) from the hurricane center. A series of numerical experiments using a

third-generation spectral wave prediction model were carried out to gain insight into the mechanism controlling the directional and frequency distributions of hurricane wave energy. It is found that hurricane wave spectra are almost swell-dominated except for the right-rear quadrant of a hurricane with respect to the forward direction, where the local strong winds control the spectra. Despite the complexity of a hurricane wind field, most of the spectra are mono-modal, similar to those under fetch-limited, unidirectional winds. However, bi-modal spectra were also found in both measurements and model results. Four types of bi-modal spectra have been observed. Type I happens far away (>6 × Rmax) from a hurricane. Type II is bi-modal in frequency with significant differences in direction. It happens in the two left quadrants when the direction of hurricane winds deviates considerably from the swell direction. Type III is bi-modal in frequency in almost the same wave direction with two close peaks. It occurs when the energy of locally-generated wind-sea is only partially transferred to the swell energy by non-linear wave-wave interactions. Type IV was observed in shallow waters owing to coastal effects. The new findings have been published in a journal paper (Hu, K., and Q. Chen (2011), Directional spectra of hurricane-generated waves in the Gulf of Mexico, *Geophysical. Research Letters 38*, L19608, doi:10.1029/2011GL049145.)

Milestone F: Field Measurements of Vegetation Biomechanical Characteristics

Louisiana coastal wetlands are critical for storm surge mitigation during hurricanes and tropical storms. It is known that emergent wetland vegetation exerts some degree of resistance against the flow of overland surface water, but the amount of physical resistance they represent is largely uncertain and challenging to measure in the field. To attempt characterizing this physical resistance by plants, a series of field measurements were conducted in upper Breton Sound Basin just south of New Orleans, LA. Saline, brackish and freshwater vegetation communities were examined for differences in their frictional influence on water flow. Dominant plant species within each site were measured for plant and stem height, stem diameter, and elasticity (e.g. the amount of force required to bend the plant 45° relative to the earth's surface). Additional site conditions were collected, including water depth, overland flow velocity, temperature, salinity, conductivity, and sediment properties. We have obtained an important dataset relevant to the modeling of surge and wave attenuation by wetland vegetation. Furthermore, the field data from different sites, different species, and different seasons allow us to develop empirical relationships between plant elasticity and the ratio of stem height and diameter. Although they are in general agreement with the relationship found in the literature, seasonal and species dependent variations are found for wetland vegetation in southeast Louisiana. The results are being used by the modelers.

Milestone G: Facilitating the development of a quasi-stationary version of WAVEWATCH III

The research team has worked with the research staff led by Dr. Hendrik Tolman with NOAA-NCEP-EMC by providing the bathymetric and wind data, computational grids and ADCIRC simulation results for Hurricane Gustav (2008) to facilitate the extension of NOAA's wave model to coastal areas. WAVEWATCH III has been successfully applied to oceanic and shelf scale wave modeling domains. With the increased frequency and

severity of hurricane and inundation events, it has become important to extend the field of application of this model to the nearshore. Because this model is based on the hyperbolic form of the action balance equation, CFL restrictions apply to the choice of the propagation time step, rendering nearshore simulation with high spatial resolution computationally expensive. In conjunction with the present study, a so-called quasi-stationary version of WAVEWATCH III has been developed by the NOAA collaborators. The resulting quasi-stationary model has been evaluated for idealized swell propagation and wind growth conditions, and field cases including swell propagation and a hurricane event. Computational savings of up to 50% relative to the default non-stationary model are found, depending on the wave condition and domain size, in combination with local errors in significant wave height and mean period of less than 5% and 2%, respectively. The new model developed by our NOAA collaborators in this project has been transferred to researchers at LSU and MSU.

Milestone H: Application of Delft3D in the Breton Sound area

The Delft3D model suite, developed by Deltares, is capable of simulating flows, sediment transports, waves, water quality, morphological developments and ecology. The primary module, Delft-Flow, was open-sourced in 2011. It is a multi-dimensional (2D or 3D) hydrodynamic (and transport) simulation program, and can be fully coupled with waves by Delft-Wave (or SWAN model). We have applied the Delft3D to the Breton Sound area for storm surge and sediment transport. The techniques of nesting and domain decomposition were adopted to get reasonable boundary conditions from the gulf-scale model and to improve local resolutions, respectively. The comparison of high water marks during Hurricane Katrina (2005) showed good agreement.. Cohesive sediment transport was also set up. The critical bottom shear stress was estimated by the observed D_{50} values and the Shields curve. Together with the coupled SWAN-ADCIRC, the Delft3D model is useful tool to quantify the coastal resiliency from hurricane impacts. Numerical experiments have been carried out.

Information on collaborators / partners: None

Information on any outreach activities:

Q. Jim Chen has collaborated with the Dauphin Island Sea Lab Discovery Hall Program on mentoring a high school student who is measuring salt marsh properties on wetlands in Dauphin Island as her research project.

Q. Jim Chen has presented simulations of hurricane winds, waves and surges at the high school summer came held in the Center for Computation and Technology at LSU every summer.

Fitzpatrick taught a class on July 11, 2011 as part of the “Teachers Exploring Coastal Hazards and Resilience” workshop. He briefly gave an overview on hurricanes, but the focus of the talk was on storm surge. An in-class exercise was given.

Fitzpatrick taught a class on July 9, 2012 as part of the “Teachers Exploring Coastal Hazards and Resilience” workshop. He briefly gave an overview on hurricanes, but the focus of the talk was on storm surge. An in-class exercise was given.

Fitzpatrick gave a talk on June 15, 2011 regarding the peer-review publication process to high school students participating in a NRL summer program.

Fitzpatrick is a member of the National Hurricane Conference Hurricane History Committee, the Planning Committee for the National Hurricane Conference, the Coastal Environment subcommittee for the Annual American Meteorological Society Conference, NASA's Hurricane Science Panel review, and Northshore Lake Pontchartrain Flood Protection Committee.

NGI FILE #09-NGI-09

Project Title: Visual Analytics for Assessment and Interpretation of Simulated River Flooding

Project Lead (PI) name, affiliation, email address: Phil Amburn, Mississippi State University, amburn@gri.msstate.edu

Co-PI(s) name, affiliation, email address: Jamie Dyer, jdyer@geosci.msstate.edu; Song Zhang, Mississippi State University, szhang@cse.msstate.edu

Related NOAA strategic goals: Weather and Water Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

The goals of this project are the development of visual analytics tools to enable scientists and forecasters to better interpret and distribute hydrologic information. Such a product would be useful in the research community as an interpretation tool for river level and flood data, but would also serve as a useful platform for hydrologic forecasters within the NWS to more quickly and accurately determine areas at risk for flooding. Another potential use is the emergency management community to better visualize areas to be impacted by flooding to support making decisions on evacuations. These tools will allow NOAA river forecasters to better visualize the extent of flooding, increasing their knowledge and understanding of the extent and effects of flooding. These tools will allow forecasters to relay more information to the emergency management community while issuing forecasts to help protect life and property. Images may be provided to the emergency managers and local officials to assist in making the decision to evacuate people.

Description of research conducted during the reporting period and milestones accomplished and/or completed

During this reporting period, the primary focus has been on development and implementation of a beta version of the FloodViz hydrologic analysis software. A small team of software developers at MSU have extended and refined the alpha version of FloodViz, which was released to the LMRFC during the last reporting period, and produced a more stable and versatile version for operational use. Close cooperation with NWS partners has been crucial during this time, notably those from the National Weather Service (NWS) Lower Mississippi River Forecast Center (LMRFC) and the Office of Hydrologic Development (OHD) in Silver Spring, Maryland.

Early in the project, prior to this reporting period, software requirements and a concept of operations were captured in several documents. These documents have been the foundation of the software development during this reporting period. While most of the work during the previous reporting period was focused on the release of an alpha version of the software, work during the current reporting period was focused on generation of a beta version of FloodViz. LMRFC and OHD partners have been actively testing the early software releases and providing feedback, which has led to the current version of the software (FloodViz 1.0).

The primary test case used at MSU is the Pascagoula river region, an area where the LMRFC has responsibility. Since the NWS has standardized on the use of Hydrologic Engineering Center – River Analysis System (HEC-RAS) for flood modeling, the FloodViz team has concentrated on visualizing data from that model. Combining HEC-RAS model output with digital elevation model data and overhead imagery, the development team has been able to develop and test multiple views of the Pascagoula region. The views supported by FloodViz are a cross-section view, a river profile view, a profile view, and a 3D view. In many respects FloodViz is a customized GIS application that supports both 2D and 3D visualization.

One of the most important accomplishments during this reporting period is the successful introduction and implementation of the FloodViz software to interested individuals at OHD. This division of the NWS is directly associated with operational forecasting and analysis of river and lake levels, and oversees the various river forecast centers within the NWS. As such, successful implementation and use of the software at that level is critical for further acceptance and implementation at individual forecast centers (such as the LMRFC).

Description of significant research results, protocols developed, and research transitions

Jibonananda Sanyal, an MSU CS Ph.D. candidate has been involved in this project since the start. His research work on this project has focused on visualization of uncertainty associated with ensemble data. The personnel at LMRFC use a 13-member Qualitative Precipitation Forecast (QPF) ensemble for their day-to-day river forecasting using the HEC-RAS model. Jibo added uncertainty visualization capabilities into FloodViz. He provided four different views for visualization of simulation output. This capability included controls to adjust the colormap, transparency, rendering order, and support for visual queries. While we have received encouraging feedback from domain experts at LMRFC, nevertheless, this research work is in the early stages and more work needs to be done.

Since this is a software development project, the significant results in this reporting period are directly tied to development and testing of the software. The releases listed below are versions of the software that we have compiled and tested at MSU, and then installed at the Lower Mississippi River Forecast Center (LMRFC) and the Office of Hydrologic Development (OHD). Subsequently, LMRFC and OHD personnel have made the time to do testing of the release candidate and provided us with feedback including error reports and recommendations for further enhancements.

Information on collaborators / partners:

Throughout this project collaboration with the LMRFC has been essential. Representatives of the LMRFC have served as subject matter experts from the start of this project. Periodic GoToMeeting sessions and regular email have proven invaluable. Specifically, the LMRFC collaborators are:

1. Dr. Suzanne van Cooten
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3. David Welch
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   e-mail: David.Welch@noaa.gov

Dr. Philip Amburn and Dr. Jamie Dyer traveled to Silver Spring, Maryland on August 2-4, 2011 to visit NOAA headquarters and the Office of Hydrologic Development (OHD). Dr. Jamie Dyer gave a presentation titled "Scientific Visualization and Geosciences pertaining to Floods and Weather" to people at NOAA HQ in Silver Spring, MD and people at various locations using GoToMeeting (the attendance list is given at the end of the document). Victor Hom hosted us, and we had in-depth discussion with both Victor Hom and James Halgren regarding installation and testing of FloodViz at the national lab.

This summary of the meeting is based heavily on an email from David Welch, LMRFC, and the NOAA partner on this project. Main points in the presentation were: 1) AWIPS compatibility on Linux, 2) cross-platform which would allow USACE, USGS, FEMA (other partner NWS agencies) to use it; 3) interaction with CHPS and 4) ensembles. Topics that we could have discussed more if time wasn't limited: 1) output formats and 2) plans for batch mode.

The task ahead of us is to maintain the momentum on this project. Incorporating additional NWS partners for testing is crucial. Possibly the next ties of users for testing and feedback could include Paul McKee at WGRFC and Seann Reed at NOAA HQ. We would like to involve other government agencies, too. For example, one possibility is to contact Dave Ramirez, a former LMRFC employee, who now works for USACE in New Orleans. An additional contact might be the Environmental Model Center where they are interested in the R2O (Research to Operations) concept.

Information on any outreach activities: None

NGI FILE #09-NGI-10

Project Title: Climate-Related Ichthyofaunal Shifts in the Northern Gulf of Mexico: Implications for Estuarine Ecology and Near Shore Fisheries

Project Lead (PI) name, affiliation, email address: Kenneth Heck, Dauphin Island Sea Lab, kheck@disl.org

Co-PI(s) name, affiliation, email address: Joel Fodrie, University of North Carolina, jfodrie@unc.edu

Related NOAA strategic goals: Climate Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

I. Utilize SEAMAP data made available by the NOAA Laboratory in Pascagoula, MS, to examine temporal and spatial trends in offshore, benthic fish species collected during semi-annual surveys over the last 25+ years.
II. Survey seagrass meadows via otter trawling during summer/fall of each project year to extend the dataset begun by Fodrie et al. (2010, Global Change Biology) and further explore/evaluate climate-related, spatial and temporal patterns of seagrass-associated fish communities.
III. Conduct manipulative experiments on growth and survivorship of juvenile *L. griseus*, *L. synagris* and endemics (e.g., *L. rhomboides*, and *C. nebulosus*) to explore how interactions between these species affect local food-web dynamics.
IV. Conduct tests to quantify rates of parrotfish herbivory on local seagrasses and estimate magnitude of altered energy flow through estuarine food webs.

Description of research conducted during the reporting period and milestones accomplished and/or completed

During this reporting year, we continued to direct our efforts towards objectives II, III and IV, with significant progress on each front. We continued the trawling survey within the seagrass meadows across the northern Gulf of Mexico (objective II), conducting 284 trawl samples in 2011. These trawl collections covered a linear distance of ~15 km, and resulted in the collection of over 31,000 individual fishes. As in the previous 4 years, snapper, grouper and parrotfish comprised a significant portion of the catch.

We furthered our investigation of the effects of tropically-associated species, namely *Lutjanus griseus* and *L. sunagris* (the gray and lane snapper) on the growth and abundance of endemic species (objective III) by taking a novel approach using a multiple before-after control-impact (MBACI) design and otolith microstructure analysis. We compared daily growth rings of pinfish (*Lagodon rhomboides*), the most numerically dominant fish species in seagrass beds in the northern GOM, to determine growth rates of pinfish with and without the presence of snapper. As juvenile pinfish and snappers share common prey, predators, and habitat, and the high degree of niche overlap among these species suggests a high potential for competitive interactions. Therefore, it is likely that increased abundances of snappers would have indirect effects on endemic pinfish. To determine the impacts of snapper abundance on pinfish

abundance we compared trawl survey data taken during summer and fall of 2010 from 3 areas with no snapper and 3 areas of high snapper abundance before and after snapper recruitment. Additionally, approximately 30 juvenile pinfish (Standard length ≤ 90mm) were retained from each trawl and fish from the 6 areas of interest were used for the growth analysis conducted during 2011.

Finally, to quantify the grazing intensity of non-native parrotfish (*Nicholsina usta*) and native pinfish (*Lagodon rhomboides*) and filefish (*Stephanolepis hispidus*) (objective IV), we conducted a series of gut clearance experiments. Each experimental trial had 5 fish and was replicated 5 times for a total of 25 fish per species. Each individual was offered 3 shoots of seagrass with 3 leaves each and allowed to feed for 4 hours. Seagrass leaves were disassembled and photographed before and after feeding trials to determine loss of material as a proxy for consumption rates. At the end of the 4 hour feeding period, the remaining seagrass was removed and fecal material was siphoned out. Each hour for the following 6 hours after feeding ceased, and once 20 hours after feeding ceased, fecal material was siphoned out and dried. Amounts of dried fecal material recovered were weighed then converted into a percentage remaining in alimentary tract of each individual.

Description of significant research results, protocols developed, and research transitions

- NGI funding allowed us to continue our seagrass-associated fish surveys in 2011, extending a survey begun in 2006, and ultimately providing invaluable data following the Deepwater Horizon disaster. The ecosystem-level impacts of the Deepwater Horizon disaster have been largely unpredictable due to the unique setting and magnitude of this spill. Our results demonstrated that fisheries catch rates in 2010 after the spill were high relative to the previous four years and further analysis of the fish surveys in 2011 showed that catch rates were similar to those in the years prior to the spill. Thus, the catastrophic loss of fish cohorts was largely avoided immediately after and for the first year following the spill.
- Despite the high degree of overlap in both diet and habitat use between the tropically-associated snappers and the endemic pinfish, there was no significant difference in the magnitude of difference of pinfish CPUE between the control (no snappers present) and impact (snappers present) sites in the summer, before the snapper arrival, compared to the fall, after juvenile snapper recruitment into the seagrass habitats. Similarly, there was no significant difference in the magnitude of the difference of the otolith increment widths between control and impact sites in the summer compared to the fall. Furthermore, although not explored in this study, the increased abundance of the tropically-associated lane and gray snapper may have other indirect impacts. Because of the high degree of the overlap between these species, there may be an indirect positive effect on pinfish, since shared predators may consume snapper, thereby reducing pinfish predation. Overall, we concluded that higher abundances of juvenile gray and lane snapper resulting from recent climate-influenced shift in distribution have had no
  significant effects on the abundance or growth of endemic species in the northern GOM and endemic species may be robust to snapper range-shifts.

- Results from the gut clearance experiment revealed that non-native parrotfish consumed significantly more seagrass than native pinfish and filefish. Parrotfish consumed about 38% of the total grass offered while pinfish consumed approximately16% and filefish consumed approximately 5%. There was also a significant effect of species on the instantaneous gut evacuation rates. Non-native parrotfish cleared their alimentary tract significantly faster than both native pinfish and filefish. Parrotfish mean instantaneous evacuation rate was nearly two times greater than pinfish evacuation rate, and 6 times greater than filefish evacuation rates. This could hold great implications for overall seagrass biomass in the nGoM since seagrass production may be unable to compensate for the increase in herbivory. Future directions will include generating overall seagrass consumption rates for each species as well as combining trawl data with these consumption rates to estimate how much seagrass production may be consumed by parrotfish moving poleward.

Information on collaborators / partners:

a. Name of collaborating organization NOAA/NMFS Pascagoula Laboratory
b. Date collaborating established: Spring 2009
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship. We will examine all data generated throughout the life of the Southeast Monitoring and Assessment Program (SEAMAP) within Region 11, an area stretching E-W from Mobile Bay Inlet, AL, to the Mississippi River Outflow, LA, and N-S from nearshore environments out to the 50-m isobath. This will involve data synthesis and analysis in a collaboration between researchers at the Dauphin Island Sea Lab (DISL), UNC and co-PIs Pellegrin and Johnson at the NOAA Laboratory in Pascagoula, MS.

Information on any outreach activities:

a. Discovery Hall Programs; MS/AL SeaGrant Teacher Workshop
b. Hosted speakers, workshops and/or any training:
    i. Type (speaker, workshop, training): Workshop
    ii. Name of event: Reefs, Rhizomes and Restoration
    iii. Date: July 11-12, 2011
    iv. Location: Dauphin Island Sea Lab with a field trip to Big Lagoon, Florida
    v. Description: This workshop brings teachers from the Gulf region to Dauphin Island to learn what habitat restoration is all about. Teachers gain first-hand experience with oyster reefs, sea grass beds and salt marshes by visiting these habitats locally and learn about the science of restoration ecology and adapt the information to present in your classroom. Dr. Heck and R. Gericke (A MS student in Dr. Heck's lab) gave a presentation on seagrass related issues, with emphasis on this NGI project and conducted a field trip to Big Lagoon to show the importance of seagrass habitats and to demonstrate current sampling techniques.
    vi. Approximate Number of Participants: 19

a. Discovery Day (Dauphin Island Sea Lab)
b. Hosted speakers, workshops and/or any training:

i. Type (speaker, workshop, training): Public Outreach
ii. Name of event: Discovery Day at the Dauphin Island Sea Lab
iii. Date: April 21, 2012
iv. Location: Dauphin Island Sea Lab, Dauphin Island, AL
v. Description: This fun-filled family event includes a variety of environmentally-themed children's activities; an Open House at the Research Facilities of the DISL where the public can interact with marine scientists and graduate students to explore their ongoing research projects; and free children's admission to the Estuarium, the aquarium at the Sea Lab.
vi. Approximate Number of Participants: 1,000+

a. Discovery Hall Programs; MS/AL SeaGrant Teacher Workshop
b. Hosted speakers, workshops and/or any training:
    i. Type (speaker, workshop, training): Workshop
    ii. Name of event: Reefs, Rhizomes and Restoration
    iii. Date: June 18-19, 2012
    iv. Location: Dauphin Island Sea Lab with a field trip to Big Lagoon, Florida
    v. Description: This workshop brings teachers from the Gulf region to Dauphin Island to learn what habitat restoration is all about. Teachers gain first-hand experience with oyster reefs, sea grass beds and salt marshes by visiting these habitats locally and learn about the science of restoration ecology and adapt the information to present in your classroom. Dr. Heck and D. Byron (Dr. Heck's lab manager) gave a presentation on seagrass related issues, with emphasis on this NGI project and conducted a field trip to Big Lagoon to show the importance of seagrass habitats and to demonstrate current sampling techniques.
    vi. Approximate Number of Participants: 23

NGI FILE #09-NGI-11

Project Title: Identifying Linkages between Zooplankton Dynamics, Fishery Resources and Climate Change in the Northern Gulf of Mexico

Project Lead (PI) name, affiliation, email address: Frank Hernandez, Dauphin Island Sea Lab, fhernandez@disl.org; Malinda Sutor, Louisiana State University, msutor1@lsu.edu; Sara LeCroy, University of Southern Mississippi, sara.lecroy@usm.edu

Co-PI(s) name, affiliation, email address: Harriet Perry, University of Southern Mississippi, harriet.perry@usm.edu; William (Monty) Graham, Dauphin Island Sea Lab, mgraham@disl.org; Guillermo Sanchez, University of Southern Mississippi, Gulliermo.Sanchez@usm.edu; Mark Benfield, LSU, mbenfie@lsu.edu

Related NOAA strategic goals: Ecosystems Mission Goal, Climate Mission Goal, Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

The primary goals are to: 1) combine regional zooplankton taxonomic expertise and methodologies to begin to identify the previously neglected invertebrate zooplankton taxa collected during SEAMAP Gulfwide surveys; 2) incorporate zooplankton abundance and distribution data into the recently revamped SEAMAP database; 3) identify relationships between larval fishes and their zooplankton prey and predators using data from historical SEAMAP samples and newly implemented collection methods; 4) examine variability and changes in the composition of both fish and invertebrate taxa over the SEAMAP time series as related to local, regional and global scale climatic events.

Description of research conducted during the reporting period and milestones accomplished and/or completed

1. Complete inventory of SEAMAP plankton samples recovered and lost due to Katrina at the SEAMAP Invertebrate Plankton Archiving Center (SIPAC). (USM/SIPAC, NMFS)

   The post-Katrina inventory of the SIPAC unsorted plankton holdings was completed, revealing that 4,900 of 9,010 pre-Katrina archived samples (54%) were recovered after the storm.

2. Arrange shipment of select SEAMAP plankton samples back to the U.S. from ZSIOP (Sea Fisheries Institute, Gdynia, Poland, Plankton Sorting and Identification Center) in order to fill gaps in SIPAC holdings caused by Katrina. (NMFS)

   Three shipments were scheduled that returned approximately 5,000 samples from Poland to replace SIPAC samples destroyed by Hurricane Katrina. Several of these samples were use directly by a graduate student (Renee Collini) as part of her thesis work.

3. Assemble an electronic image database of archived SEAMAP plankton samples using Zooscan and begin analyses of zooplankton assemblages. (LSU, NMFS, USM/SIPAC)

A total of 1,465 unsorted zooplankton samples collected during the years 1982-1989 were transferred to Louisiana State University for zooscanning. Of these, 678 samples were unaliquoted, whereas 144 of the samples from the years 1982-1985 had been previously aliquoted (1/4 aliquots) as a space-saving measure.

4. Assemble/summarize data on decapod crustacean larvae previously identified from SEAMAP samples at USM. (USM/SIPAC)

   The post-Katrina inventory of the SIPAC identified invertebrate holdings was completed, resulting in the determination that 3,954 of 7,336 pre-Katrina archived samples (54%) were recovered. An additional 193 samples were recovered that had not been recorded in pre-Katrina databases, bringing the total recovered to 4,147 samples. The majority of these samples (3,106) were decapod crustaceans.

5. Verify and improve resolution (as feasible) of larval decapod crustacean identifications. (USM/SIPAC, NMFS)

   A total of 1,404 sorted and partially identified invertebrate zooplankton samples from the 2003 Fall Plankton Cruise (GU 0303) were transferred to the SIPAC from the NMFS Pascagoula Lab. These included 387 larval portunid crab samples, 7 larval menippid crab samples, 285 larval penaeid shrimp samples, and 130 larval sicyoniid shrimp samples. Material from the 2003 fall cruise was chosen for two reasons: first, because of the extensive coverage of Gulf coastal and shelf waters represented by the stations sampled during the cruise and second, because it was conducted during one of the two annual peak periods of portunid larval abundance in the northern Gulf. The diversity and distribution of these portunid larvae form the basis of the masters research conducted by Carley Knight, the USM graduate student working on this project. Further identification of the target taxa of larval decapods that were received identified to the level of family has resulted in the recognition of 34 distinct taxa. These include one genus (three species) of Menippidae, five genera (six species) of Penaeidae, one genus (four species) of Sicyoniidae and four genera (15 species) of Portunidae, plus six portunid species that could not be placed in a genus.

   A total of 36,328 specimens belonging to the four target decapod families (Menippidae, Penaeidae, Portunidae, Sicyoniidae) from 146 SEAMAP stations sampled during cruise GU0303 were identified. This included material from both bongo and neuston net samples. The most abundant and diverse family was the Portunidae (29,404 individuals; 21 taxa), followed by the Penaeidae (5913 individuals; 6 taxa), Sicyoniidae (986 individuals; 4 taxa) and Menippidae (25 individuals; 3 taxa). As expected, zoeal/mysis stages were generally more abundant in the bongo samples, whereas megalopal/postlarval stages were more numerous in the neuston samples. This was true for all families except the Sicyoniidae, for which the mysis stage was more numerous in samples of both gear types. The preponderance of portunids is not unexpected because, as mentioned above, this cruise was selected because it occurred during a peak season for portunid larval abundance.

   Identifications of material from the SEAMAP samples were verified by using previously identified voucher specimens and comparisons with the literature whenever possible. For those species for which there are no published or accessible larval descriptions, we hope to use genetic data to attribute definitive identifications to the larvae, especially for those taxa

designated by letter codes. To that end, additional designated samples were collected and preserved in 95% ethanol during the final leg of the 2011 Spring Plankton Cruise. Specimens from these samples will be used for genetic analysis and morphological comparison with material from previous samples to confirm or improve identifications based on morphology alone. Genetic data for many species of decapods, based on adult samples, is currently available in GenBank.

6. Direct additional zooplankton analysis of SEAMAP plankton samples at ZSIOP from select SEAMAP surveys to complete temporal and spatial survey coverage for decapod crustacean early life stages. (NMFS)

   Zooplankton protocols were developed for sample processing at ZSIOP. Decapod crustaceans from SEAMAP bongo and neuston net are now regularly sorted and identified as part of the US-Poland Joint Studies Agreement.

7. Incorporate invertebrate zooplankton data into the NMFS SEAMAP Oracle database and develop a GIS platform for the visualization and integration of data on the early life stages of both exploited and non-exploited fishes and invertebrates. (NMFS)

   Invertebrate zooplankton and larval decapod data are being incorporated into the Oracle database. This objective is particularly timely and valued as data are already being requested by NRDA for damage assessment related to the oil spill.

8. Assemble a reference series of invertebrate zooplankton specimens from SEAMAP samples for development of zooplankton 'identification' software and subsequent analysis of scanned images of SEAMAP plankton samples. (USML/SIPAC, LSU, NMFS)

   All identified decapod specimens from this project are housed in the SIPAC collection and are available as a reference set to be used in training the zooplankton identification software used by zooscan operations.

9. Undertake analyses of zooplankton and fish eggs in CUFES (continuous underway fish egg sampler) samples taken during recent SEAMAP plankton gulfwide surveys; evaluate results of these collections. (DISL, NMFS)

   A total of 1,863 CUFES samples from four cruises (Fall 2007, Fall 2008, Winter 2009, Fall 2011) were sorted for fish larvae, fish eggs and invertebrates. Invertebrates from these samples were identified and will be included in the SEAMAP database. An additional 2,169 samples from three cruises (Fall 2009, Spring 2010, Fall 2010) were sorted for fish eggs, which were subsampled and identified using molecular analysis in collaboration with another funded project (NOAA MARFIN awarded to Hernandez).

10. Establish observational & sampling protocols for gelatinous zooplankton collection during SEAMAP surveys; implement these and evaluate results of data collected during surveys in 2009 – 2011. (DISL, NMFS)

    An identification field guide with descriptions for 15 gelatinous zooplankton taxa was developed and is currently in use on SEAMAP cruises. Protocols for enumerating and measuring jellfishes were developed, as were datasheets for recording observations.

11. Enhance student participation and involvement in SEAMAP resource surveys while augmenting graduate student training in the field of marine plankton. (DISL, LSU, USM/SIPAC/CFRD, NMFS)

    Carley Knight, the USM graduate student working on the NGI project, participated in Leg 3 of the SEAMAP Spring Plankton Survey in 2011 (Cruise GU1101; May 1-10, 2011). During the cruise, she assisted with SEAMAP plankton sample and data collection and collected additional samples for her own research, which will include the genetic analysis of some of the material. In addition to the cruise, Carley has participated in data management for the NGI project, gained experience using ARC-GIS software to map SEAMAP data for her thesis research, become an expert in the identification of portunid crab megalopae, given four poster presentations on NGI data, and participated in all activities related to the maintenance of the SIPAC collection. As a result of experience gained on this project, she is currently employed part time at the NMFS Pascagoula lab identifying decapod plankton for a NRDA project.

    Sara Conner, a PhD student at the University of Louisiana at Lafayette (ULL) working on *Macrobrachium* reproductive biology, made use of the sorted zooplankton samples received during the NGI project to search for larval *Macrobrachium* material. She found several specimens during her visit to the collection and borrowed additional samples to examine when she returned to ULL.

    Andy Millett completed his MS degree at USA/DISL in 2010. Using CUFES samples, his research delineated zooplankton community structure in the northern Gulf of Mexico in relation to gelatinous predators. Andy now works at the NMFS Pascagoula Lab as a result of the experience and support from this project.

    Renee Collini, a masters student at USA/DISL, borrowed unsorted SIPAC plankton samples to examine for gelatinous zooplankton material pertinent to her research. Renee successfully defended her thesis in May 2012.

    Randi Shiplett, a masters student at USA/DISL, participated on SEAMAP plankton cruises and processed CUFES samples in the lab. Randi defended her thesis in August 2011, and will soon be joining a research team at the University of Miami working on the plankton NRDA effort.

12. Identify sources, assemble and summarize relevant environmental and climate data, and undertake analytical steps to identify linkages between abundance of target species of larval fish, zooplankton abundance and composition, and climatic and physical factors in the northern Gulf of Mexico. (LSU, USM/CFRD, DISL, NMFS)

    A seasonal association was found between worldwide oceanic-atmospheric modes of variability, meteorological and hydrological conditions and displacement volumes of zooplankton in the northern Gulf of Mexico. The combination of Atlantic Multidecadal Oscillation cold, North Atlantic Oscillation positive, and El Nino Southern Oscillation warm phases were associated with the stormy winter (January to March) weather (i.e. strong low pressure system, southern winds, and high moist air) of 1982, while the opposite phases of these modes of variability were related to the calm dry winter of 1999. The wet winter (high

precipitation and surface runoff) of 1982 was further linked to high mean spring (April 24-May 26) displacement volumes of zooplankton, whereas the dry winter of 1999 was associated with low displacement volumes. Several sources of data have been identified (e.g., NOAA Gulf of Mexico Data Atlas), and more are coming on line in response to the spill. To date, a historic (1982-2007) time series of climate (e.g., ENSO, NAO) and environmental (e.g., river discharge, air temperature, water temperate, along/cross-shore wind, etc.) has been compiled for the northcentral Gulf of Mexico (for details, see Carassou et al., 2011. Mar. Coastal Fish., 3:1, 411-427). Other similar efforts are in progress.

Description of significant research results, protocols developed, and research transitions

Two important analyses were completed to provide vital quality control and assurance for the image analysis of the SEAMAP samples. First, the LSU lab participated in a comparative experiment organized by the SCOR 130 working group on plankton image analysis. A set of reference samples analyzed by a taxonomic expert were scanned and re-examined in three different labs by three different technicians to compare rates of error between operators and instruments. The final results are being verified, but initial results demonstrate that the results produced in each lab are very similar thus verifying that using our established techniques, there is a low rate of error between technicians who scan and analyze the image data.

The second experiment was performed exclusively in the LSU lab to determine best procedures for image analysis of SEAMAP samples. Three randomly selected samples were split to 1/4, 1/8, 1/16, and 1/32. Each of these individual splits was scanned with the Zooscan and analyzed using a manual image analysis software package called Digitizer. The splits that were sparse enough (1/32) to separate most individual plankton on the Zooscan were analyzed using the semi-automated software packages Zooprocess and Plankton Identifier. We are completing the verification of these results, but initial results show that a full digital archiving of the sample will be done by splitting to 1/4 and then the sample will be split to 1/32 and three of the 1/32 splits will be scanned and analyzed with the automated software. The initial results show that this provides robust estimates of abundant taxa and the 1/4 split scans can be analyzed manually for rare taxa. This technique will be used on the samples and modified as necessary to continue to achieve the goals of 1) expediting the analysis by using automated techniques and 2) providing a full-digital archival image of the sample and the ability to enumerate rare taxa that may not be encountered in a smaller split of the sample.

The 2003 SEAMAP fall plankton survey sampled the waters of the northern Gulf of Mexico from Texas to the Florida Keys, resulting in the collection of 146 neuston samples. These samples spanned inshore waters to the 200m isobath along the continental shelf, with sampling occurring from late August through September and throughout the 24 hr period. Of these neuston samples 133 contained portunid megalopae, with abundances ranging from 1 to nearly 6300 individuals per sample. Most of the higher density stations are located in the vicinity of riverine discharge or in the western Gulf. Thirteen portunid crab taxa were recognized in the 38 samples analyzed to date. *Callinectes sapidus*, *C. similis*, and *Achelous* spp. A and B were the most common taxa, occurring in nearly all of the samples analyzed. *Arenaeus cribrarius* was also common in samples from offshore Louisiana waters. Dominance of species in these samples appeared to shift slightly from *Callinectes* spp. and *Achelous* A and B on the shelf to other *Achelous* spp. and Portunidae spp. seaward of the coastal shelf break.

The Gulf of Mexico is functionally designated as a single Large Marine Ecosystem (LME) for the purposes of ecosystem-based management. However, the diversity of biogeographic regimes within the Gulf ranges both longitudinally and over coastal-neritic-oceanic transitions. Based on our re-analysis of the Fall 2007 zooplankton community structure (as revealed with CUFES samples), the northern Gulf of Mexico can be further divided into three LME sub-units corresponding to i) west Florida inner shelf, ii) northern River-dominated shelf, and iii) oligotrophic Gulf-wide. These sub-units can be further assessed by underlying drivers influencing productivity regimes across the northern Gulf namely salinity associated with river discharge, chlorophyll distribution and zooplankton biomass. We anticipate characterizing critical LME sub-units based on the differences we find as a means to better parameterize ecosystem models for management within the Gulf.

Gelatinous zooplankton (scyphomedusae, hydrozoans, and ctenophores) in the northern Gulf of Mexico are capable of forming large seasonal blooms, which have the potential to drastically affect coastal fisheries in a variety of ways: by directly preying on fish eggs and larvae; by competing with larval fish for invertebrate zooplankton prey; and by providing critical food and/or habitat for sea turtles and communal fish. The newly developed gelatinous zooplankton sampling protocols developed by DISL and NMFS scientists under this NGI project are now standard SEAMAP plankton survey methodology. These protocols are also being used on NRDA sponsored surveys to assess damage to Gulf planktonic biota caused by the DWH oil spill event. Incorporation of jellyfish data can now be incorporated into spatial and community analysis to determine which, if any, physical factors are driving jellyfish blooms and to assess their impact on ichthyoplankton and other zooplankton in a more quantitative way then was previously possible.

A seasonal association was found between worldwide oceanic-atmospheric modes of variability, meteorological and hydrological conditions and displacement volumes of zooplankton in the northern Gulf of Mexico. The combination of Atlantic Multidecadal Oscillation cold, North Atlantic Oscillation positive, and El Nino Southern Oscillation warm phases were associated with the stormy winter (January to March) weather (i.e. strong low pressure system, southern winds, and high moist air) of 1982, while the opposite phases of these modes of variability were related to the calm dry winter of 1999. The wet winter (high precipitation and surface runoff) of 1982 was further linked to high mean spring (April 24-May 26) displacement volumes of zooplankton, whereas the dry winter of 1999 was associated with low displacement volumes.

Information on collaborators / partners:

Collaborators with Carley Knight on the identification of a previously unknown portunid crab megalopa from Curaçao are James D. Franks (USM GCRL Center for Fisheries Research and Development) and Dr. Eric Saillant (USM GCRL Department of Coastal Sciences, Fisheries Genetics). Chet F. Rakocinski (USM GCRL Department of Coastal Sciences, Benthic Ecology) is also a collaborator, serving as Carley's major professor for her masters research. Keith Bayha (DISL) conducted molecular analysis of fish eggs sorted from CUFES samples as part of a MARFIN funded project awarded to Frank Hernandez. Joanne Lyczkowski-Shultz, NOAA National Marine Fisheries Service, has contributed greatly to this project, and manages work at NMFS.

Information on any outreach activities:

Tours of the SIPAC collection are included as a part the standard GCRL Museum tours conducted for student groups of all ages, as well as members of the public. A brief explanation of some of the research conducted using these samples is mentioned, including the various facets of the NGI project.

NGI FILE #09-NGI-13

Project Title: Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf

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Related NOAA strategic goals: Ecosystems Mission Goal, Climate Mission Goal, Weather and Water Mission Goal, Commerce and Transportation Mission Goal, Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

- What is the seasonal variability of key water quality parameters in the Lower Pearl River Estuary, Bay St. Louis, the western Mississippi Sound and western Mississippi Bight and what are the controlling factors?
    - What is the variability of nutrient speciation and concentration in each of these sub-regions?
    - What is the effect on phytoplankton communities of the low N:P ratios in the Mississippi Sound (this is being done in a collaborative effort led by Dr. Karen Orcutt of USM)?
    - What is the variability of trace metals in each of these subregions?
    - What is the variability of dissolved oxygen in each of these subregions?
- What is the extent of seasonal hypoxia in the western Mississippi Bight and what are the mechanisms controlling its development?
    - What is the seasonality and timing of the onset of hypoxia and what controls this timing?
    - What are the areal and volumetric extents of hypoxia?
    - What are the relative roles in hypoxia formation and maintenance of: vertical stratification due to seasonal heating, local/regional freshwater input, and upwelling/downwelling; nutrient inputs from local/regional rivers, benthic fluxes, and wetland degradation; and carbon dynamics in overlying surface waters?
- What are the effects on the ecosystem due to hypoxia events?
    - How is the species composition of benthic foraminifers in the MSB affected by changes in dissolved oxygen levels in bottom waters?

    - What is the effect of hypoxia events on the benthic macrofauna (this question has been addressed by Dr. Rakocinski in a collaborative project)?
- What are the carbon fluxes within the study region?
    - What is the seasonality of air-sea CO_2 fluxes (this is being addressed in a collaborative effort with NOAA scientists Drs. Rik Wanninkhof and Chris Sabine)?
    - How are these fluxes related to environmental conditions specifically physical properties of water, freshwater discharge, nutrient levels, algal biomass, and winds?
    - How good are satellite-based extrapolations of pCO_2 for the coastal region and can better regional extrapolation algorithms be developed for differing discharge and seasonal conditions?

Description of research conducted during the reporting period and milestones accomplished and/or completed

During the reporting period sampling cruises were conducted along both the BCS and NGI lines. The dates, and stations sampled, are shown in Table 1 and Table 2. Water samples were analyzed for NH4, NOx, NO2, NO3, PO4, SiO3, dissolved oxygen, and salinity. Water column profiles of P, T, C, S, dO, Chlorophyll a fluorescence, optical backscatter, and turbidity. All data were processed and added to our database.

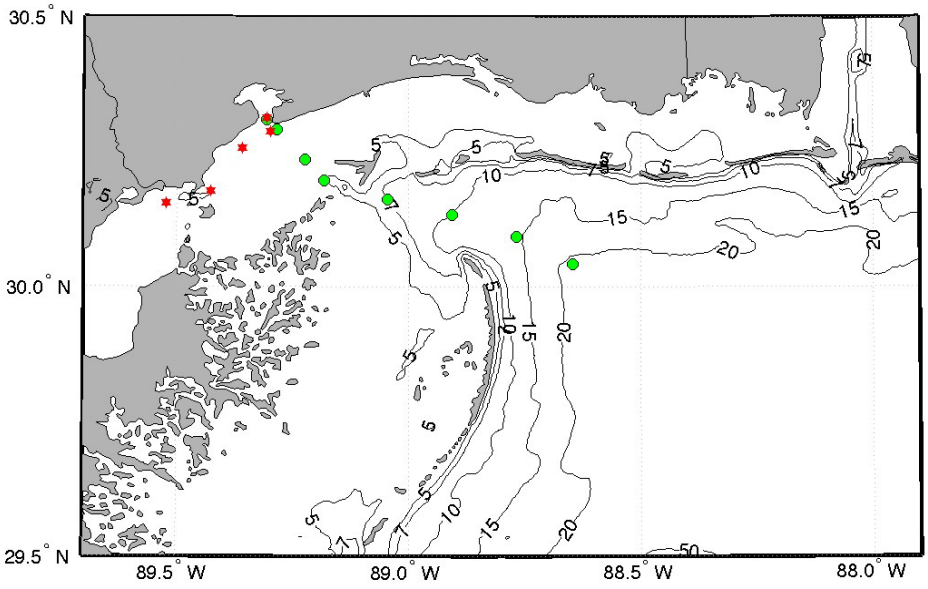

Figure 5. Monthly sampling station locations. The green circles are the stations along the "NGI line". The red stars are the locations of the stations along the "BCS line".

Table 1. Dates stations along the NGI line were sampled during the reporting period. Stations 1-4 had surface water samples taken and station 5-8 had surface, mid-depth and bottom samples taken.

	NGI Stations							
Date	1	2	3	4	5	6	7	8
8/17/11	X	X	X	X	X	X	X	X
9/14/11	X	X	X	X	X	X	X	X
10/03/11	X	X	X	X	X	X	X	X
11/21/11	X	X	X	X	X	X	X	X
12/7/11					X			

Table 2. Dates stations along the BCS line were sampled. Water samples were taken at the surface for each station.

	BCS Stations					
Date	1	2	3	6	7	8
8/15/11	X	X	X	X	X	X
9/12/11	x	x	x	x	x	x
10/03/11	x	x	x	x	x	x
11/14/11	x	x	x	x	x	x
12/5/11	x	x	x	x	x	x

Description of significant research results, protocols developed, and research transitions

Hypoxia in the western Mississippi Bight – Hypoxic bottom waters (dissolved oxygen < 2 mg/l) were detected at one or more stations each year of the program. In 2006, prior to the NGI project, an area of approximately 179 km^2 of bottom hypoxia was mapped by USM in the Mississippi Bight. Through this NGI project USM found extensive regions of hypoxia in 2008 (>2300 km^2) and 2011 (>2300 km^2) which were years when the Bonnet Carre Spillway was opened due to flooding on the Mississippi River.

Pigment and Nutrient Findings (Redalje) Over the course of this project, we have analyzed phytoplankton pigments using HPLC methods. In addition, we have used the pigment data in conjunction with the factor analysis program CHEMTAX to determine what fraction of the total chlorophyll *a* could be attributed to the major phytoplankton taxa found in the Mississippi Sound and the Mississippi Bight. Major findings show that diatoms are always the dominant taxa throughout the year. Cyanobacteria and Prymnesiophytes both became important offshore in summer. Prasinophytes and Chlorophytes were more common at the inshore stations throughout the year. In addition to pigment concentrations, we determined the concentration of the major nutrients in the sound and bight. Concentrations of dissolved orthophosphate (P) were always high relative to expectations suggesting a local source of P that maintained high concentrations throughout the sound, primarily over the course of the project. Ammonium was

the most important of the dissolved inorganic nitrogen (DIN) forms at all stations and at all times. The ratio of DIN:P can be used to assess the state of health of marine waters. In our study, the DIN:P ratio was always (210 out of 213 total determinations) lower than the expected Redfield ration of 16:1, with values often between 1 and 5. This indicates that primary production in the sound and bight was most likely limited by the availability of DIN at all times. We also explored the extent to which variability in our nutrient data could be attributed to larger scale climate patterns as indicated by major climate indices such as the Southern Oscillation Index, the Multivariate ENSO Index, the North Atlantic Oscillation, the Atlantic Multidecadal Oscillation, the North Tropical Atlantic Index, and the Pacific Decadal Oscillation. Of these, the variations in our sound and bight nutrient data were most highly correlated to the anomalies for the Multivariate ENSO Index, the Atlantic Multidecadal Oscillation and the North Tropical Atlantic Index. This indicated that lager scale climate variations in rainfall and subsequent flushing of the local watersheds had a significant impact on coastal nutrient concentrations of the sound and bight.

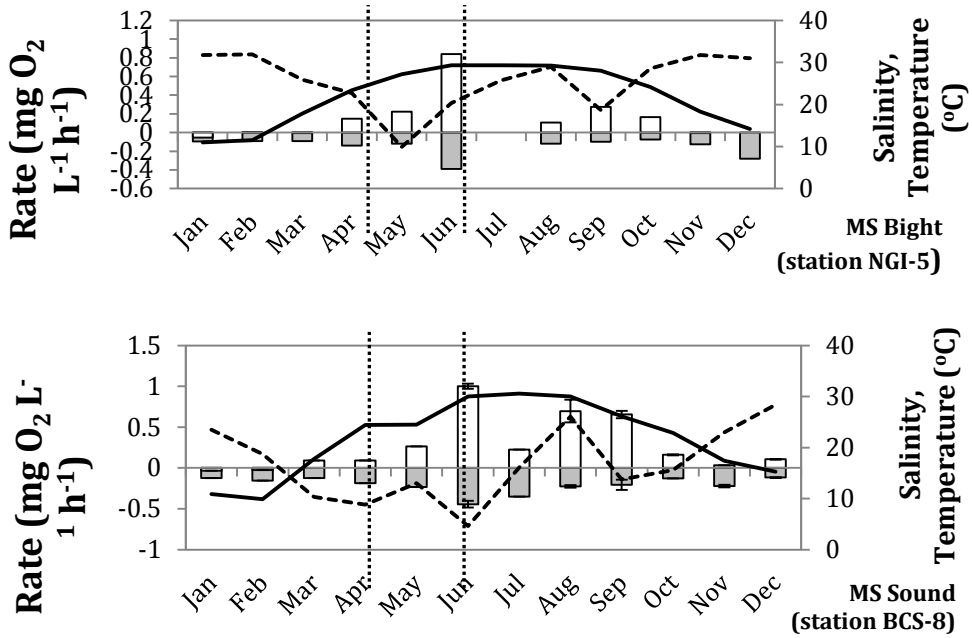

Figure 6. Time-series monitoring of net primary productivity (white bars) and respiration (grey bars), salinity (dotted line) and temperature (whole line) in surface waters off Pass Christian Harbor (station BCS-8) in the Mississippi Sound and south off Cat Island (station NGI-5) in the Mississippi Bight in 2011. There are no net primary productivity and respiration data for July 2011 at station NGI-5. Vertical dotted lines shows the onset and duration of the Bonnet-Carre Spillway opening in 2011.

Net primary productivity (netPP) and microbial respiration (RESP) during the Bonnet-Carre opening in May-June 2011: *(*Gundersen*)* During the course of 2011, additional samples were collected during the monthly NGI-transect and the Bonnet-Carre Spillway (BCS) transects (Figure 5). The spatial and temporal distribution of netPP and RESP was compared to coastal biogeochemistry and hydrography measured in the Mississippi Sound (MS Sound; station BCS-8) and Mississippi Bight (MS Bight; station NGI-5) over the course of one year. Surface *in-situ* measurements of NetPP and RESP were determined each month at the two stations using a novel dissolved oxygen (DO) optode sensor.

Although surface temperatures were strikingly similar at both stations over the course of a year (Figure 6), sea surface salinity in the MS Sound was generally lower than outside the barrier islands in the MS Bight. Maximum rates of netPP and RESP were detected at both stations during the second month of the opening of the BCS (. This peak in production coincided with a chlorophyll-*a* maximum at both stations (Figure 7A, Figure 8A). The fraction of ammonium, to total amount of dissolved nitrogen, remained high throughout the year in surface waters of the MS Sound (Figure 7A) while a sudden shift between and ammonium and nitrate was observed in the MS Bight (Figure 8) following the BCS event. The calculated ratio between dissolved phosphate and total dissolved inorganic nitrogen (the N:P-ratio) was low in the MS Sound (range 05-6.5) and showed a maximum during peak chlorophyll-*a* (Figure 7A). Dissolved N:P was at a peak during spring (Figure 8B), but dropped to levels similar to the MS Sound during the massive BCS outflow and remained low throughout the remainder of the year.

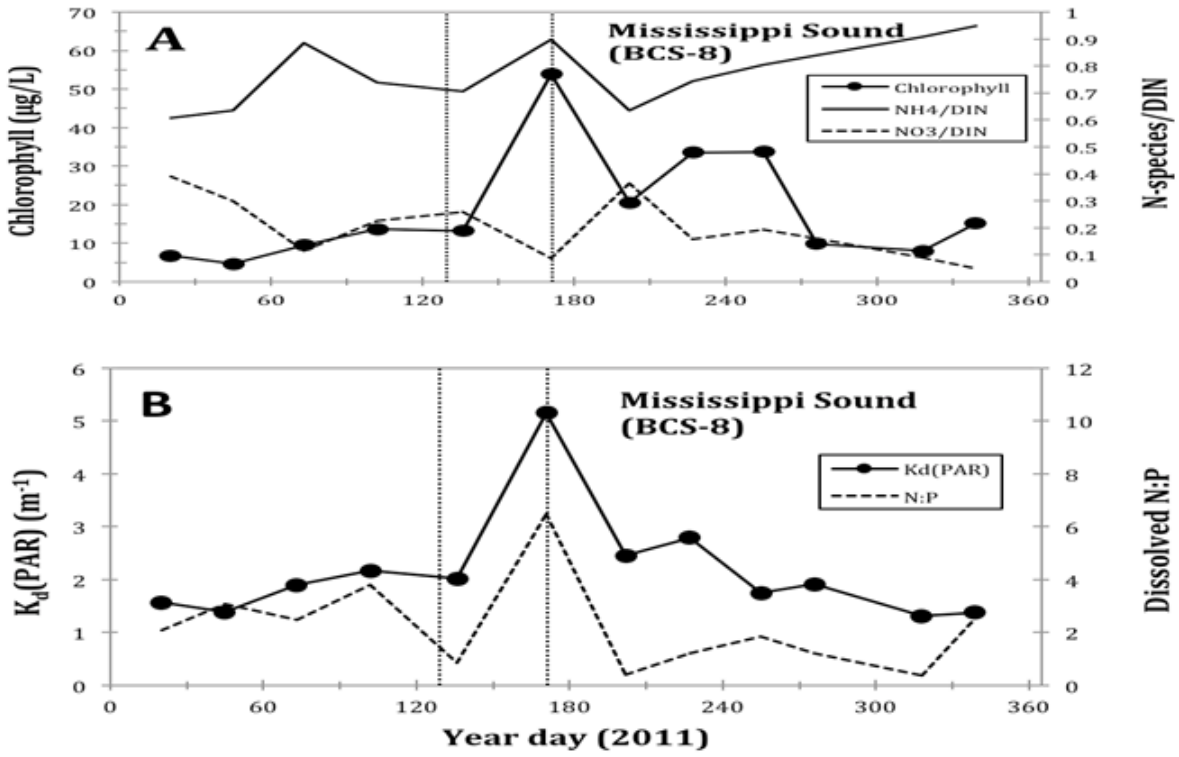

Figure 7. Time-series monitoring of surface waters off Pass Christian Harbor (station BCS-8) in the Mississippi Sound in 2011. A: Chlorophyll-a (Chlorophyll), fraction of ammonium (NH4/DIN) and nitrate (NO3/DIN) of total dissolved inorganic nitrogen as a function of time. **B:** Light penetration [K_d(PAR)] and the molar ratio of dissolved phosphate and total inorganic nitrogen (N:P) as a function of time. Vertical dotted lines shows the onset and duration of the Bonnet-Carre Spillway opening in 2011.

The distribution of photosynthetically available radiance (PAR) is reduced as a log-function with depth and this is significantly amplified due to the high turbidity and sediment resuspension in coastal waters systems. The loss of PAR in the water column is expressed as the downwelling attenuation coefficient [K_d(PAR)]. Calculated K_d(PAR) ranged from 1.2-5.2 in the MS Sound (Figure 7B) while the coefficient never exceeded one in the MS Bight (Figure 8B). The

difference in K_d(PAR) between the two sites may explain some of the difference in netPP during the second month of the BCS outflow (Figure 6).

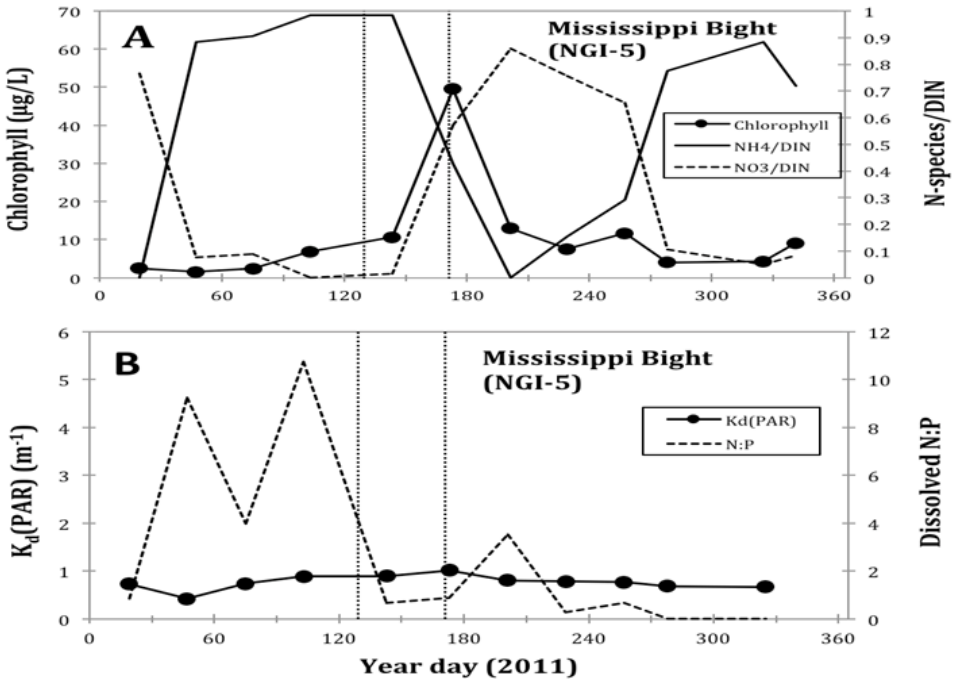

Figure 8. Time-series monitoring of surface waters south of Cat Island (station NGI-5) in the Mississippi Bight in 2011. A: Chlorophyll-a (Chlorophyll), fraction of ammonium (NH4/DIN) and nitrate (NO3/DIN) of total dissolved inorganic nitrogen as a function of time. **B:** Light penetration [K_d(PAR)] and the molar ratio of dissolved phosphate and total inorganic nitrogen (N:P) as a function of time. Vertical dotted lines shows the onset and duration of the Bonnet-Carre Spillway opening in 2011.

Nutrient availability and K_d(PAR) appeared to be the two major factors determining photosynthesis in shallow MS coastal waters. Light plays an important role in regulating daily photosynthesis (netPP) and daily microbial respiration (RESP), and the ratio between the two (netPP:RESP) is frequently below one in coastal waters off Mississippi (data not shown). Downwelling light attenuation is determined by concentrations of suspended particulate matter (SPM), chromophoric dissolved organic matter (CDOM), and chlorophyll-*a*, but our estimates shows that SPM is the dominant contributor to K_d(PAR).

***Isotopic Composition and Export Fluxes of Organic Carbon Species from the Lower Mississippi River*:** (Guo) Monthly water samples were collected from the lower Mississippi River near Baton Rough, Louisiana from 2006 to 2010 for the measurements of dissolved organic carbon (DOC), colloidal organic carbon (COC) and particulate organic carbon (POC) to examine temporal variations in phase speciation and export fluxes of organic carbon species. Selected samples were measured for their stable carbon isotopic and radiocarbon composition to investigate source and transport of organic carbon species from the Mississippi River. Concentrations of DOC ranged from 238 to 344 µM, with an average of 300±28 µM. Colloidal organic carbon (> 1kDa) comprised about 61±3% of the bulk DOC, leaving 39% of DOC in the <1 kDa low-molecular-weight (LMW) DOC. Within the total organic carbon pool, POC made up

about 54%, followed by colloidal organic carbon (28%) and LMW-DOC (18%). Values of d13C were not significantly different among all three organic carbon species, with average values between -26.28‰ for POC and -25.92‰ for DOC, showing a similar terrestrial source. However, radiocarbon composition was distinctly different among DOC, COC and POC, with contemporary COC, young LMW-DOC, but old POC (up to 1,391 yBP, on average), indicating different transport pathways and mechanisms between organic carbon species in the river. Annual export flux of total organic carbon from the Mississippi River varied from 3.0 to 4.1 million tons depending on the water yield.

The distribution, partitioning and seasonal variation of carbohydrate species in the Mississippi Sound and Mississippi Bight**:** (Guo) The concentration of particulate-CHO increased with increasing salinity with a mid-salinity maximum. Biological factor was the main parameter controlling the production of particulate-CHO. There is a good correlation of particulate-CHO with POC, SPM and Chl-a, indicating that phytoplankton biomass is the primary source of particulate-CHO in the water column, while monosaccharides (MCHO) were mainly derived from rivers. High MCHO concentrations were correlated to the flooding event of the Mississippi River and high discharge of the Pearl River, showing a controlling factor for the partitioning of CHO in the Mississippi Sound/ Bight. Results of laboratory mixing experiments show removal of dissolved-CHO in the low salinity area. The dioxin concentration increased from colloidal to particulate organic matter to sediments in both the Mississippi and Pearl rivers. Nevertheless, the dioxin concentration in Mississippi River sediments was higher than the Pearl River sediments

Biogenic silica in the Mississippi River – (Guo) We found that the annual export flux of biogenic silica from the Mississippi River ranged from 5 to 16×10^9 mole-Si/yr, comprising on average 27% of total Si fluxes to the Gulf of Mexico. Thus, the biogenic silica is a major component in the export flux of Si from the Mississippi River and may play an important role in the biogeochemical cycling of Si in the northern Gulf of Mexico.

Dynamics of phosphorus in the Bay of St. Louis: --- (Guo) Concentrations of different phosphorus show a large variability during estuarine mixing in the Bay of St. Louis. While dissolved organic phosphorus (DOP) and particulate phosphorus (PP) were the predominated P species in end-member freshwaters entering the bay, dissolved inorganic phosphorus (DIP) become predominated in bay waters resulting from the release of PP and transformation between P species. River export fluxes of phosphate could be significantly underestimated without the quantification of particulate P. Both DIP and DOP behaved non-conservatively during estuarine mixing showing dramatic changes and transformation between different P species. The DOC/DOP ratio decreased rapidly with increasing salinity indicating a diagenetically older DOM from the river and a dynamic change in DOM sources and chemical speciation of P in the estuary. Results from laboratory mixing experiments support our hypothesis that physicochemical processes are the predominant mechanisms controlling the biogeochemical cycling of P species in the Bay of St. Louis.

Carbohydrate species in the lower Mississippi/Pearl Rivers and the Bay of St Louis**:** (Guo) The abundance of carbohydrate species and their partitioning between dissolved, colloidal and particulate phases were examined in waters from the lower Mississippi River, Pearl River and Bay of St. Louis. Particulate carbohydrates (PCHO) represented only a small fraction

of the particulate organic carbon (POC) pool, with 4.7%, 4.5% and 1.8% in the MR, PR and BSL, respectively. Dissolved carbohydrates (DCHO) were the major component in the bulk dissolved organic carbon (DOC) pool. Within the total carbohydrates, high-molecular-weight carbohydrates were the dominant CHO species, representing 52-71% of the total carbohydrates pool, followed by the low-molecular-weight carbohydrates (<1 kDa), representing 14-44% of the TCHO. The PCHO (>0.7μm) accounted for 4-16% of the bulk TCHO. Variations in the size distribution of carbohydrates among the MR, PR and BSL could be linked to the degradation pathway of organic carbon and the interactions between different size fractions of carbohydrates.

Hurricane effects on water quality – (Shiller) Although water quality can be substantially affected in the short-term due to hurricane impacts, extensive damage to vegetation in the northern Gulf does not lead to associated longer-term changes in water quality because of the slow rate of decomposition. However, multiple impacts over successive years could modify this result.

Assessing macrobenthic indicators of hypoxia and eutrophication – (Rakocinski) Coastal and marine ecosystem goods and services support many societal needs, including the areas of seafood, human health, and commerce. Fulfillment of these needs depends directly and indirectly on proper ecosystem function. Hypoxia has been identified as a major water quality concern in estuaries of the East Coast and Gulf of Mexico regions of the U.S. This NOAA NGI project provided a test case for the use of macrobenthic process indicators in the Mississippi Bight area. Coastal Mississippi experienced exceptionally widespread and sustained hypoxia throughout summer 2008, and intermittent hypoxia since 2008, as documented by the NOAA NGI MAEMP. Thirty-one benthic sampling site-events were completed during this period, in concert with the NOAA NGI Monitoring and Assessment for Ecosystem Management Project. Having experienced intense sustained hypoxia in 2008 and intermittent hypoxic stress between May 2008 and November 2011,two NGI stations located on the Mississippi Bight at the 10 m (Station 6) and 20 m (Station 8) isobaths served as the primary focal sites for examining the effects of hypoxia on the macrobenthic community. Because macrobenthic process metrics reflect ecosystem function, they should be responsive to effects of hypoxia. Basic macrobenthic variables provided information for estimating various process metrics, including production potential, faunal turnover rate (e.g., reciprocal P:B), and normalized biomass size-spectra (NBBS). Bottom hypoxia was most severe in summer 2008, more frequent and severe at site 6 than at site 8, and occurred intermittently during the study period. Macrobenthic metrics varied considerably and reflected apparent effects of hypoxia against the backdrop of seasonal patterns at sites 6 and 8. A mature and productive community at site 6 in May 2008 was evidenced by production potential as high as 200 mg m^2 d^{-1} and a community turnover time of 70+ d. Huge effects of hypoxia on production potential, mean size and abundance were apparent in July 2008. Within one year, production potential returned to about half of what it was in the previous year at site 6. Within one year total abundance returned to about half of what it was initially at site 6. Larger than expected mean body sizes during the worst hypoxia at site 6 suggested that surviving tolerant organisms were not as small as later opportunists. Biomass size spectra proved more informative than just mean size. Biomass was greatly reduced within all size and several large size classes were completely decimated in July 2008.

By November 2008, biomass was rebounding in some mid-size classes, although large size classes were still missing. One year later in May 2009, large size classes were still poorly represented and biomass was still somewhat low within small size classes. The reference site, 9R, sampled in July 2008 clearly exhibited much higher total abundance and production potential than sites 6 and 8 at the same time. However, the macrobenthic community was less well developed at the spatial reference site (9R) in July 2008 than at site 6 in May 2008. In particular, biomass was noticeably lower for medium and large size classes at site 9R. Considering changes in the taxonomic composition of the macrobenthic community in terms of abundance and biomass and in view of the other metrics lends insights into how the community responded to and recovered from hypoxia. For example, looking at dominant constituents at site 6 over the course of one year revealed a dynamic balance among equilibrium, opportunistic and tolerant taxa relative to effects of hypoxia. In conclusion, the macrobenthic process indicators conveyed an informative perspective on changes in the benthic subsystem relative to hypoxic stress. However, a taxonomic perspective in terms of the functional traits of the organisms enhanced the interpretation of macrobenthic responses to hypoxia.

Trace Elements Analysis—(Shiller) Our work focused on trace element fluxes through the coastal transition zone. Trace elements (such as iron, manganese, and copper) are important to study in part because they can be indicators of certain processes such as inputs from oxygen-depleted sources, they can be toxic in high concentrations (as well as indicators of anthropogenic inputs), and they can be limiting nutrients when in short supply. Some of our work examined effects of Hurricane Katrina on metal cycling. In Shim et al. (2012) we analyzed samples that were opportunistically collected in the outflow of the Mississippi River shortly after Katrina. We observed surprisingly little effect of the hurricane on the metal distributions other than what would be expected from aerating the water column. In Shiller et al. (2012), we compared the chemistry of the East Pearl River before and after Katrina caused extensive vegetative damage in the catchment. Here again, there was surprisingly little change, suggesting the resilience of the coastal systems. Shim (2011) also examined metal distributions in St. Louis Bay, the Pearl River floodplain system, and in an offshore transect going from St. Louis Bay to the USM buoy in the Mississippi Bight. Interesting results from this work include the minimal impact of the floodplain on metal chemistry of the Pearl River, seasonal fluctuations of certain trace elements in the offshore transect in response to changes in oxygen, and discovery of a source of anthropogenic cesium in the bay that can be used to track the influence of bay waters offshore.

Nutrients – (Dillon) Seasonal trends of elevated nutrients were observed at NGI transect stations with ammonium and nitrate concentrations being very low in the winter and early spring. During the May 2010 sampling, NH_4 concentrations were less than 2uM in surface and bottom waters and the nitrogen isotope (15N) value for the for this NH_4 at stations NGI 4 and 5 had a light isotopic signatures suggesting N sources such as fertilizers or nitrogen fixation are important for study area. Further offshore, the surface water NH_4 concentrations are still low with higher concentrations in the hypoxic bottom waters. Del ^{15}N values of NH^4 in surface waters were significantly more enriched than samples collected inshore suggesting partial nitrification was occurring which would lead to more enriched NH_4 samples. Surface water nitrate concentrations were below detection at most stations but were elevated at stations 4 and 5

which supports that nitrification was occurring at these stations waters, particularly during the winter and spring. Isotopic N values for this nitrate were also extremely depleted which is also an indication that partial nitrification is occurring in these waters.

Bottom water NO_3 concentrations were typically higher than surface waters once the water column was stratified from May to August 2010. Bottom water ammonium concentrations at the offshore stations were higher than surface water concentrations due to remineralization of organic matter in the bottom waters. Decreased concentrations of dissolved organic carbon and nitrogen observed in hypoxic bottom waters support this notion.

During July 2010, nitrate was the dominant form of inorganic nitrogen in bottom waters while surface waters had undetectable nitrate concentrations and small concentrations of ammonium (<2uM). By September, bottom water concentrations of nitrate were less than 1uM while elevated ammonium concentrations were measured in the furthest offshore bottom water stations (NGI 5 and 6). The nitrate levels in September were too low to be analyzed for ^{15}N however the elevated bottom water ammonium levels were again isotopically heavy as observed during May. Analysis of ammonium and nitrate samples from 2011 is still underway and should be completed during the summer of 2012.

Foraminifera and sediment in the hypoxic area of the Mississippi Bight-- (Brunner)

- NGI-6 at the 10-m isobath is a regional depositional center (depo-center) for fine grained sediment, mostly silt, that thins toward NGI-8 to the southeast on the 20-m isobaths.The NGI-6 site is covered by a layer of coarse silt to 8 cm, and the silt is underlain by sandy mud from 8 to 15 cm that may be sand from the Hurricane Katrina storm layer. The section below the sand returns to coarse silt. The NGI-8 site also is covered by a layer of silt 8-cm thick, and the silt is underlain by two distinct sand-rich layers at 8-14 cm and 16-23 cm that appear to be the Katrina storm layer and a previous storm layer, perhaps Hurricane Camille or the hurricane of 1949. A thin silt layer separates the sandy layers. The depo-center at the NGI-6 site is the most likely area in the inner Mississippi bight to preserve a geologic record of conditions over the past several thousand years.
- The living foraminifer assemblage at the two sites is dominated by species linked with bottom water hypoxia in other locales. The Mississippi assemblage is similar to one of several, reported hypoxia assemblages, but it is not common in the nearby Dead Zone of the Louisiana Bight. The finding that an assemblage dominated by *Bolivina lowmani* and *Nonionella basiloba* thrives during hypoxic events in the Mississippi bight is supported by other indicators, such as low diversity and a shallowing of living depth by one half (from greater than 6 cm to less than 3 cm). However, the density of live specimens is higher in the hypoxic area than in norm-oxic areas, suggesting that the assemblage at NGI-6 and NGI-8 is close to the ecotone, where the community consists of a few hypoxia-tolerant, opportunistic species but with abundance higher than adjacent norm-oxic locales. It is important to note that at no time since 2005 have conditions become severe enough to either reduce the density of living specimens or to entirely eradicate them.

- The persistence of moribund specimens of norm-oxic species suggests that the assemblage recovers to some degree between seasonal hypoxic events. The moribund species are typical of those found at similar depths in norm-oxic conditions.

These results suggest that the dominance of *Bolivina lowmani* (Figure 9) and *Nonionella basiloba* (Figure 10) can be used as a proxy of hypoxia. We have established that the proxy can be applied to sediment cores from the depo-center at NGI-6 to trace a history of the onset of hypoxia in the Mississippi bight.

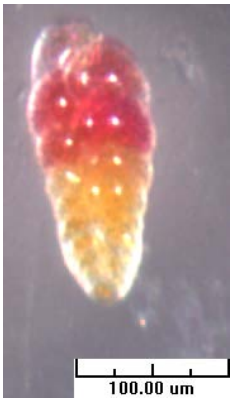

Figure 9. *Bolivina lowmani*

Figure 10. *Nonionella basiloba*

Information on collaborators / partners: None

Information on any outreach activities: None

NGI FILE #09-NGI-14

Project Title: Assessment of Ecosystem Services of Selected Coastal Habitat Types: Towards a Model-Based Toolset for Management Planning

Project Lead (PI) name, affiliation, email address: Mark Peterson, University of Southern Mississippi, mark.peterson@usm.edu

Co-PI(s) name, affiliation, email address: Harriet Perry, University of Southern Mississippi, harriet.perry@usm.edu

Related NOAA strategic goals: Ecosystems Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

Emphasis area 1

a. Collect new data on fish distribution, biomass, and energy content in the Pascagoula River (PR) that is coordinated with similar data collection in Apalachicola Bay (AB, collaborative proposal K. Craig FSU) needed to validate the behavior component of the habitat-production model.
b. Collect new data on habitat quality in PR that is coordinated with similar data collection in AB to provide a regional validation data set for the habitat production model.
c. Use data from (1) and (2) to develop the habitat-production model to quantitatively link loss of salt marsh habitat to fish production and compare results between estuaries.
d. Use data on loss of salt marsh due to sea level rise from SLAMM modeling to examine impacts of sea level rise on fish production (collaborative proposal R. Allee, NOAA)

Emphasis area 2

a. Collect species composition and biomass data on restored oyster reef and use trophic model to compare 2^0 production of natural and restored oyster reefs in western Mississippi Sound (WMS, partnership with The Nature Conservancy)

Description of research conducted during the reporting period and milestones accomplished and/or completed

Emphasis area 1

Field sampling – Field sampling of habitat characteristics and fish distribution and condition was conducted Feb-April each year from 2008-2010. Data collected were for water quality parameters (water temperature, salinity, dissolved oxygen concentration, turbidity, and chlolophyll a concentration), as well as juvenile spot CPUE, mean length, and samples for caloric density determination. These data were assimilated by month and year and used as input data for model development and numerical experiments.

Lab experiments – Lab experiments were conducted at the Gulf Coast Research Laboratory-Marine Environmental Research Laboratory (MERL) to generate empirical measures of movement rates for juvenile spot. These experiments were conducted in spring of 2011. IN addition, samples collected from the field for determination of caloric density were processed and analyzed at MERL.

Model development – Both field-collected and empirical data were used to develop and validate a spatially-explicit individual-based model of movement and growth for juvenile spot. This model was then used to examine the effects of sea level rise on habitat quality and population production in the Pascagoula River distributary.

Emphasis Area 2

Field data collection – Data on benthic secondary production and species composition were collected on two oyster reef sites in western Mississippi Sound between June and August each year from 2008-2010. In addition, fish sampling was conducted during the same period each year over the reef sites to characterize fish species composition, size distribution, relative CPUE, and to collect samples for stable isotope analysis and diet analysis.

Model development – A food web mode has been developed based on the field-collected data and associated data from the literature to describe secondary production export from natural oyster reefs in Mississippi Sound.

Description of significant research results, protocols developed, and research transitions

a. Spatially explicit data collection for incorporation into GIS-based habitat models – We refined and used a technique for collecting water quality data that is amenable to use in combination with remotely-sensed data collected at finer spatial scales. These data provide a base map of habitat quality in the Pascagoula river based on both water quality data and estimates of structural composition derived from satellite imagery.
b. Benthic secondary production estimates for natural oyster reefs in Mississippi Sound – we conducted the first comprehensive assessment of secondary production on oyster reefs in this ecosystem. Total secondary production is about twice that attributable to oysters alone and our modeling activities will attempt to account for this extra ecosystem service of oyster reefs.
c. Model results suggest that the effects of sea level rise on fish populations will be highly dependent on movement behavior and spot appear to be resistant to small levels of SLR, and may even benefit from the change, but displayed a threshold effect at longer time horizons that suggest a reversal of this benefit is likely by the end of the century.
d. Data, models, and procedures from this project are being used to generalize the results to other estuaries and ecosystems. This includes application to Tampa Bay, Barataria Bay, and Perdido Bay. Several papers are anticipated based on these new efforts in the future.

Information on collaborators / partners:

a. Name of collaborating organization: NOAA Gulf Coast Services Center
b. Date collaborating established: 2008
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship. We are working with Dr. Rebecca Allee to convert our model simulation results into habitat –specific visualization tools in line with current work at GCSS.

Information on any outreach activities: None

NGI FILE #09-NGI-15

Project Title: Data Management in Support of NOAA's Integrated Ecosystem Assessment through the NGI Ecosystem Data Assembly Center

Project Lead (PI) name, affiliation, email address: John Harding, Mississippi State University, jharding@ngi.msstate.edu

Co-PI(s) name, affiliation, email address: Ruth Christopher, Dauphin Island Sea Lab, rcarmichael@disl.org; Susan Welsh, Louisiana State University, swelsh@lsu.edu

Related NOAA strategic goals: Ecosystems Mission Goal, Weather and Water Mission Goal, Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

The goals of the EDAC are to demonstrate the utility of integrating broad spectrum ecosystem data, models, and observations for the purpose of determining the health of the ecosystem, identifying the challenges ahead, and developing creative solutions based on sound natural-science criteria. The EDAC concept has been embraced as a core function within NOAA's Integrated Ecosystem Assessments under the Ecosystem Goal Team, and the NOAA Gulf of Mexico Regional Collaboration Team (GoMRT)

DISL (Carmichael): The specific goal was to maintain and expand NGI member institutions internal data management system that links to the existing data management program within the EDAC. Specifically, our objectives were to (a) develop and apply novel approaches to encourage and promote faculty participation in the internal data management process, (b) improve faculty and laboratory personnel participation in creating metadata and archiving past or current datasets, (c) retain datasets in a central database to make them more readily accessible or searchable, and (d) increase awareness that these datasets exist.

LSU (Welsh): The goal of Louisiana State University's Northern Gulf Institute/Shell (NGI) Information Management System (IMS) was to facilitate NGI-LSU's scientific work and to ensure the integrity of the information and databases resulting from NGI-LSU's coastal ecosystem research. Researchers were strongly encouraged to submit new project metadata/data to the Information Manager within 6 months of a project commencement, and thereafter on the quarterly schedule.

NGI (via Radiance Sub-Contract): The goal of this effort was to provide system administration for the EDAC Linux systems, maintain the Threads OpenDAP server software and provide web development support for EDAC/ OceanNOMADS data and ocean model access and distribution. (See http://www.northerngulfinstitute.org/edac/)

Description of research conducted during the reporting period and milestones accomplished and/or completed

DISL (Carmichael):

- 13 metadata records completed
- 2 metadata records in progress
- 3 metadata records updated
- All datasets accompanied with metadata were archived on the NJORD server
- 4 MERMAid accounts were created for DISL personnel
- 1 metadata template was created for a newer lab at DISL (Dr. A. Ortmann)
- 3 lab are now independently creating metadata records
- BP-GoMRI metadata records were initiated for Marine Environmental Sciences Consortium (MESC) faculty at other institutions (1 record was completed – Stephen Landers)
- Annual metadata training was conducted for new personnel during the year – 7 attendees in 2011
- Metadata training provided to NGI Diversity Internship participants
- DISL's Metadata Archive was continually updated
- DISL's Data Management Center website was continually updated
- Support was provided to DISL faculty and post-docs who prepared BP-GoMRI proposals to ensure appropriate Data Management approaches were included
- Prepared job posting to replace DISL's Data Management Specialist who left to attend nursing school

LSU (Welsh):

- No new metadata records submitted, updated or in progress
- The IMS servers were continually maintained
- The website was been redesigned to accept metadata independently of the data
- The PI's were informed of the changes and reminded of their obligation to submit
- The PI's were invited to participate in one-on-one tutorials at their convenience

NGI (Radiance Contract): The EDAC servers continued to work at full capacity for the period. With the help of the EDAC intern the old server Pontchartrain was converted into edac.northerngulfinstitute.org. This new server has been set up with THREDDs as well as a copy of Django which works with Apache via Fast-CGI, as opposed to the earlier servers which relied on mod-wsgi. The production version of OceanNomads at NCDDC (see http://www.ncddc.noaa.gov/ocean-nomads/) was established and working with CurvyArrows display program. Additional upgrades were made to CurvyArrows based on user input in order to better facilitate its use as well as to add additional functionality.

Work included updating RTOFS Viz on OceanNOMADS with some new features to add information to the images being created, as well as correct discrepancies that arose when the RTOFS ocean model output converted to GRIB files rather than NetCDF.

Capabilities for CurvyArrows were increased especially with respect to OpenDAP access. A special version of CurvyArrows was created which is able to take files from a primary OpenDAP source as well as any number of additional OpenDAP sources. By comparing time stamps, this allows for an image to be created with a background from one source with arrow and

current overlays from a completely different source. As this is not compatible with the normal NetCDF version, these different versions were merged into one from which any number of either local NetCDF or OpenDap files can be combined to generate the final imagery.

The EDAC-DAP server was rebuilt after a drive failure and the loss of a significant amount of data . All the services running on EDAC-DAP server were subsequently checked to assure they were all functioning correctly after the rebuild. The structure of EDAC-DAP was then reorganized to make things easier access and manage in the future.

Description of significant research results, protocols developed, and research transitions

DISL (Carmichael): The data management program at DISL, consisting of a formal Data Management Center, Senior Data Manager, Data Management Specialist, and Data Management Committee has been extremely successful at incorporating metadata creation, data archiving, and overall data management into the regular process of research at DISL. We are currently in the process of writing a manuscript that describes our approach, successes, and hurdles that we hope will benefit and guide other institutions as they adopt data management practices. Here we briefly summarize major findings from 2011.

As the data management process has expanded at DISL, we have observed a difference in enthusiasm for and willingness to participate in data management activities relative to age or seniority of key personnel (Primary investigators/faculty, post-docs, technicians or graduate students, and interns). We typically found that the younger researchers (graduate students, post-docs) and early career faculty were more receptive to learning about and adopting data management practices. For this reason we found it useful (and recommend to other institutions) a focus on training and working with graduate students, technicians and willing post-docs, with support from core faculty. These early career participants typically had well defined datasets (such as outputs from a single thesis project or dissertation chapter), perceived and valued the training as career development, were more interested in using metadata citations on their CVs, and were more comfortable with learning and using new computer programs and electronic systems. We also hypothesize they represent the future of research and data collection (and a potential investment in the future of data management) with the greatest potential reach beyond DISL as they move forward in their careers. For this reason, in 2011, we dovetailed our Data management program with a relatively newly established NGI Diversity Internship program, operated at DISL (also funded by NGI). Our Data Management Specialist served as the intern program coordinator and provided an introduction to data management and metadata creation training to all interns. In 2012, we plan to extend this reach to participants in DISL's Research Experience for Undergraduates (REU) program to achieve not just an investment in Data Management activities at DISL but also an investment in data management as part of the future of science.

Making data publicly available was a major concern for all participants, particularly primary investigators/ senior faculty. Our ultimate goal is to have metadata records for every spatially identifiable project (bench experiments, for example, may not be appropriate) and accompany each metadata record with archived and searchable datasets that are publicly available. Every year DISL adds more metadata records and a smaller number of archived datasets, most of which are not yet publicly available. One major accomplishment through this project has been

the development and subsequent institutional approval of a Data Management Committee Mission statement and Data Management Policy. The Data Management Committee, represented by each major department at DISL, created the policy and set specific definitions for data suitable for metadata creation and archiving as well as specific timelines for making data available and how data will be managed when personnel leave the institution.

We also noticed a decline in attendance at data management training sessions this year, due to a shift from training core personnel to training new students and colleagues at other institutions, who heard about our program and wished to attend. We are still determining how training outside personnel will affect DISL and have, so far, opted to keep training sessions small and focused on DISL personnel. The DISL metadata website was also a newly available enhancement for training activities and grant writing in 2011; the Data Management Specialist was able to email the link to faculty preparing grants and to training participants before the class to familiarize them with the process and outputs in advance.

Overall, participation is still a hurdle. Metadata is not independently created by all labs. The Data Management Specialist is still highly in demand to help create metadata for busy faculty and to train new students and other personnel who, as part of normal function at an academic/ research institution, turnover on a regular basis.

LSU (Welsh): The NGI-LSU vision of making data publicly available was a major concern for all of the LSU primary investigators (PI's), as it was at DISL. The PI's were encouraged to submit metadata records for every field project and accompany each metadata record with archived and searchable datasets that would be publicly available after specified release date. The NGI-LSU website and the Information Management System (IMS) were fully operational through the life of the grant and the LSU data management team was fully staffed. Early on the NGI-LSU principal investigators were compliant and submitted metadata and data, although the participation greatly waned over the past few years. The lack of participation appeared to be due to two root causes: (1) a general unwillingness to share data and (2) no contractual obligation to submit the data. There are however currently 29 datasets on the LSU IMS and the system will continue to be available for the foreseeable future. The servers will continue to be maintained in the Shell Coastal Environmental Modeling Laboratory in the School for the Coast and Environment and if the original website designer and manager decides to leave LSU, a new manager will be trained to take her place.

NGI (Radiance Contract): We attended meetings and researched the various data sets available on THREDDS to find those best suited for a NOAA NCDDC eddy kinetic energy (EKE) research effort. We subsequently developed protocols for processing and delivering the data for this Ocean Extreme EKE study.

Several scripts were created to download, merge, and perform averages on oceanographic data in the Gulf of Mexico to detect correlations between the various parameters. In particular, we processed chlorophyll, currents, and surface temperature data from the past 10 years and generated 8-day average and anomaly measurements of the data. We also provided sample imagery for chlorophyll concentrations and anomalies in the Gulf of Mexico to help future NCDDC planning and future EDAC applications.

We completed work on CurvyArrows and deployed the latest version at NCDDC, providing the CurvyArrows code and documentation to NCDDC so they could create and edit runs on their own.

Information on collaborators / partners:

a. Name of collaborating organization: Russ Beard, Rost Parsons, and Scott Cross with NOAA NCDDC
b. Date collaborating established: 2006
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship. Information on NOAA data management needs, metadata training

Information on any outreach activities:

Outreach activities included giving presentations at regular NGI meetings, annual personnel training, maintaining our data management website, offering metadata creation support and archiving for BP-GoMRI projects by MESC personnel, training interns as part of the Diversity Program, and planning to train interns as part of the REU program in summer 2012.

NGI FILE #09-NGI-17

Project Title: Northern Gulf Institute Integrated Education and Outreach Program

Project Lead (PI) name, affiliation, email address: Sharon Hodge, Mississippi State University, shodge@ngi.msstate.edu

Co-PI(s) name, affiliation, email address: Tina Miller-Way, Dauphin Island Sea Lab, tmiller-way@disl.org

Related NOAA strategic goals: Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

(1) translate and deliver NGI research results aligned to state and federal science standards to K-12 students in the Northern Gulf region; (2) develop and implement curricular materials based on NGI research results for formal and informal educators along the coast and up the watershed aiming to address the issues throughout the ecosystem; and (3) increase awareness and understanding of the importance of the Northern Gulf region by the public via the Estuarium (the public aquarium located on the campus of Dauphin Island Sea Lab) and other similar institutions; conduct general outreach of NGI accomplishments

Description of research conducted during the reporting period and milestones accomplished and/or completed

Not applicable regarding research conducted, but the Education and Outreach milestone components were completed. One of the goals was modified due to logistical prohibition, and the revised effort (Teacher workshop for Resiliency in July 2012) accomplished the intent of the project.

Description of significant research results, protocols developed, and research transitions

NA – this is an Outreach project. However, this project is instrumental in helping to transition research results to resource management.

Information on collaborators / partners:

a. Name of collaborating organization – NOAA and Gulf of Mexico Alliance
b. Date collaborating established – 2006 and 2007
c. Does partner provide monetary support to project? Amount of Support? NOAA - None other than NGI award defined above. GOMA - None
d. Does partner provide non-monetary (in-kind) support? Yes, supporting materials and venue for dissemination of NGI materials
e. Short description of collaboration/partnership relationship: NGI, NOAA and GOMA have worked together to disseminate science that NGI has reported and included NGI researchers in the priority issues that GOMA is working toward. A particularly successful effort included publicizing the Explorer Command Center, newly housed in the MSU Science and Technology Center, new home to the NGI Program Office.

Information on any outreach activities:

a. General Description: The staff at MSU coordinates dissemination of NGI program materials via website, annual reports, newsletters, listserv, Facebook, Twitter and public outreach events. The staff coordinates the NGI Annual Conference each May. NGI Education and Outreach Program team members at DISL and USM help disseminate the information to their communities. In addition, DISL provides formal education content and delivery of NGI related accomplishments and science.

Teacher workshops

Participated in teacher workshop through Mississippi State University - *Teachers Exploring Coastal Hazards and Resilience* (Had planned to host teacher workshops at FSU and LSU; neither happened could not find local host at LSU to work with on planning logistics, recruiting teachers to participate and arranged one at FSU's marine lab; cancelled ~3 weeks prior to workshop due to insufficient enrollment).

In both years provided content, hands-on activities, field activities and resource notebook on relevant topics (hypoxia, HABS, watersheds, Gulf of Mexico, wetlands, hurricanes & storm surge, data visualization, oil spills)

In 2011 (20 teachers) – teachers were hosted at DISL for part of the workshop, served as instructor

In 2012 (20 teachers) – served as instructor

Conducted a day-long unit (content, hands-on activities) on oil and oil spill activities in *Reefs, Rhizomes and Restoration* at DISL June 2012 (19 teachers); discussed NGI oil spill research and distributed existing fact sheets from NGI Oil spill outreach grant

Conducted a day-long unit (content, hands-on activities) on hurricanes and storm surge in *Climate Change in the Gulf of Mexico* at DISL, July 2012 (18 teachers); discussed data visualization as well as content, distributed lesson plan on storm surge modeling

Conducted a 2/3 day-long unit on models and data visualization in *Marine Applications of Science and Technology* workshop in July 2011;

K-12 Student groups

Worked with the Engaging Youth in Engineering (EYE) program in Mobile County Public School System, July 2011; a enrichment program or middle school students; 3 days, 2 groups/day, ~180 kids; students visited the Estuarium and learned about watersheds, human impacts on watersheds and the oil spill through hands-on activities

Outreach through DISL's traveling marine science classroom, the BayMobile, ongoing; delivered content and conducted hands-on activities about the oil spill; reached approximately 13,000 K-12 students across Alabama in 2011-2012 school year

Activities & Outreach at the Estuarium (learning center)

Boardwalk Talks (informal conversations among scientists and the public) – 56 during this NCE period, 36 different speakers, more than 1200 attendees

Summer excursions (field trips for the public) –18 total trips, 404 participants (turned away folks)

Estuarium visitorship - 95,671 during this NCE period

Science Café – Midtown Kitchen (restaurant) Mobile, AL; speaker – Dr. George Crozier, topic – Climate Change, June 2012, approximate attendance ~50

Hosted Rivers to the Sea kiosk (left August 2011, traveled to Texas State Aquarium)

Short 'cart' activities – 10 implemented and posted on DISL website

Integration of additional information by using QR codes – 10 completed in this time frame

Outreach events

Discovery Day, April 2012 – annual open house at DISL, hosted 2 displays – student activities on plankton, oil spill research, distributed fact sheets; ~2500 attendees

My Two Boots, October 2011 – Pascagoula, MS; event for Pascagoula, MS middle school students focusing on water quality and watersheds; ~250 attendees

Let's Move Outside, November 2011 – Gulf Islands National Seashore; outreach event for the public; ~50 attendees

Celebrate the Gulf, March 2012 – Biloxi, MS; outreach event for the public focusing on issues important in the Gulf of Mexico

EnviroBowl, April 2012 – Mobile, AL; an environmental science themed competition event for high school students

Meetings

Alabama Science Teachers Association, October 2011; oral presentation, "Gulf of Mexico Literacy Project"

Northern Gulf Institute Annual Conference, May 24-26, 2012, approximately 120 in attendance at Stennis Space Center, MS

"The NGI Teacher Workshop Series: An Outlet for NGI Research"; poster presentation

"The NOAA-NGI Diversity Internship Program: A Successful Multi-state, Multi-agency Workforce Development Program"; poster presentation

"Outreach of Oil Spill Projects"; oral presentation

Coastal Estuarine Research Federation (CERF), Daytona Beach, November 2011; oral presentation "Efficacy of video-conferencing to deliver professional development to K-12 teachers on the Deepwater Horizon event at multiple locations across the Gulf of Mexico"

Collaborations

NOAA funded video conferencing workshop for K-12 teachers about the Deepwater Horizon event (~90 teachers), 2 dates, content delivery and hands-on activities

CELC Gulf of Mexico regional network – 2 existing grants; climate change community outreach and GOMA Priority Issue kiosk

Mobile Bay National Estuary Program – video series highlighting water quality and watershed issues; *A Redfish Tale* is done and is being distributed through interested schools; working with the Alabama Math and Science Technology Initiative (AMSTI) to adopt video as part of watershed curriculum unit; finishing work on 2nd video in series, *Redfish Slap*

Gulf Alliance Partnership program – DHP educators talked about oil spill impacts on habitats middle school students visited as part of the program (river delta, salt marsh, estuary)

NOAA - NGI Diversity Internship program – continued support and administration of annual program (2011 – 9 interns; 2012 - 10 interns)

Northern Gulf Coastal Hazards Collaboratory grant – part of E&O team, continued work on integration of models, modeling and data visualizations into lesson plans for 9-14 students

Alabama Dept. Environmental Management (Ms. Patty Hurley) provided professional development for DISL educators on water quality, water quality management and current methodology

Project Wetkids – worked with Dr. Julie Cwikla, Director of the Project WetKids program to develop a proposal to extend the program to Mobile County public schools

NGI FILE #09-NGI-19

Project Title: Integrated Research for the Northeast Gulf of Mexico Big Bend Region

Project Lead (PI) name, affiliation, email address: Eric Chassignet, Florida State University, echassignet@coaps.fsu.edu

Co-PI(s) name, affiliation, email address: William Dewar, Florida State University, dewar@ocean.fsu.edu

Related NOAA strategic goals: Ecosystems Mission Goal, Climate Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Julian Lartigue, OAR

Project objectives and goals

The project is an integrated study of the marine ecosystem of the northern West Florida Shelf (WFS) (including the Big Bend Region (BBR) using an interdisciplinary observational, experimental, and modeling approach. This represents a natural progression in our understanding of this ecosystem based on FSU's current NOAA NGI projects and involves direct collaborations between FSU, NOAA (NMFS and AOML), and USM. The objectives of the research are:

1) To understand the physical processes responsible for distributing water within the BBR, including cross-shelf transport of riverine-influenced seawater, transport of biological material, and the natural and anthropogenic variability of the system;
2) To understand the nutrient cycling, resource connectivity, and trophic interactions between BBR river-dominated coastal areas, nearshore seagrass habitats, estuaries and offshore reef fish communities.
3) To study the processes supporting regional productivity of a number of reef fish species important to both commercial and recreational fisheries, using gag (*Mycteroperca microlepis),* as a primary model.

The goals of this program are motivated by the four research themes of the Cooperative Institute—ecosystem management, geospatial data integration, regional climate effects, and coastal hazards. Those goals include (1) quantifying the onshore and offshore transport mechanisms of the Big Bend Region (BBR), (2) documenting the basic regional physical oceanography, and (3) clarifying key aspects of the ecosystem that contribute to reef fish productivity. All three goals will be integrated within an overarching BBR modeling framework. The observations, experiments, and modeling foci are directed at ecosystem-based management, coastal hazards, and the impacts of climate variability.

Description of research conducted during the reporting period and milestones accomplished and/or completed

We use a combination of physical monitoring, field studies of key habitat features, trophic analyses of a suite of reef fish species, and integrative modeling of all components. This approach is supported by an observational array established with NGI support, with regular sampling along a transect extending from an offshore observational platform (K-tower, ~32 km offshore) to the FSU Coastal and Marine Laboratory (FSUCML) and by characterizing habitat

and predator-prey interactions of key species, conducted by the NMFS and the FSUCML. The platform supports bottom moorings at 3 depths (5-20 m), each housing multisensor probes that measure in real time water depth, temperature, salinity, light, pH, chlorophyll a, turbidity, and oxygen; a suite of meteorological instruments that sample the atmospheric boundary layer to determine air-sea fluxes. The data from K-tower are telemetered in real-time to the FSUCML and to FSU. These studies define the variability and connectivity among critical habitats and the relationship to fisheries productivity. The integrated modeling system will provide near-real time monitoring and prediction of the marine and coastal ocean and atmospheric environment that will direct research activities. The system couples a 1.3 km resolution Weather Research and Forecasting model (WRF) with a 30 arcsec (~ 800 m) resolution Regional Ocean Modeling System simulation over the BBR, nested within larger scale (3-4 km) WRF and HYbrid Coordinate Ocean Model system for the Gulf of Mexico-Western Atlantic. This system complements the observing activities and facilitates interdisciplinary research objectives while enabling ecosystem-level quantification and assessment of the impacts of natural and anthropogenic disturbances at various temporal and spatial scales.

Contrasting High and Low Relief Fishery Habitats of the Northeastern Gulf: Habitat Delineation, Food Web Components, and Spatial Demographics: PIs and Co-PIs: Doug DeVries, Chris Gardner, Robert Allman, and Gary Fitzhugh. Non-Student Personnel funded through FSU subcontract to IAP and based at NOAA Fisheries, SEFSC, Panama City Lab: Chris Gardner - Fishery Biologist II, Patrick Raley - Fishery Biologist II.

The objectives are to 1) examine temporal and spatial patterns in fish community structure, abundance and demographics in an area of high relief (up to 10 m) rocky habitat known as the 3 by 5's; and compare to low relief sites first studied on a prior NGI study, 2) delineate and quantify reef habitats in the 3 by 5's and in cross-shelf (10-30 m) transects in Apalachee Bay off Florida's Big Bend using side scan sonar, 3) collect geo-referenced habitat video and still images for ground-truthing side scan data, 4) characterize diets, predator-prey interactions, resource overlap and habitat-associated differences in diet of reef fish communities in the 3 by 5's within and across depths and habitats; and compare those findings with those from previously-studied low relief sites, and 5) compare growth and condition of fishes between high- and low-relief habitats, and examine effects of scale of a species' movements (or site fidelity) on these parameters.

Biological and environmental data were collected in fall of 2011 at the low relief sites that have been sampled since 2007, and in spring of 2011 and 2012 at the 3 by 5's high and low relief sites. A total of 20 ROV dives were made at the 3 by 5's and 9 dives at the long-term low relief sites. Video analysis has been completed on all but the spring 2012 samples and all data entered. A total of 293 specimens for demographic, trophic, and condition (BIA) analyses have been caught and processed since fall 2011(Table 3).

Post processing, habitat quantification, and habitat classification of the side scan data was completed for 329 reefs at the 3 by 5's and 1388 in Apalachee Bay. That information was incorporated into the sample site universe of the 2012 NMFS Panama City fishery independent reef fish survey and used in weighting schemes in the random site selection process for the survey. These habitat data will be invaluable for post-stratification and will eventually facilitate

intelligent selection of appropriate strata for this stratified random design survey, in turn leading to increasing precision, more statistical power, and increased cost-effectiveness.

Table 3. Fishes collected from high and low-relief reefs since fall 2011 by hook & line sampling for demographic, trophic, and condition analyses.

Species	No.	Species	No.	Species	No.
Red snapper	71	Littlehead porgy	7	Knobbed porgy	2
Vermilion snapper	61	Gray snapper	5	Tattler	2
Red porgy	55	Scamp	5	Whitebone porgy	2
Gray triggerfish	36	Spotfin hogfish	4	Lane snapper	1
Red grouper	15	Bigeye	3	Sand tilefish	1
Creolefish	10	Spanish hogfish	3	Squirrelfish	1
Gag	7	Greater amberjack	2	Total	293

N7 tower instrumentation: During the past year, the COAPS data center assumed management responsibility for all aspects of the meteorological instrumentation on tower N7. The first task undertaken was a complete inventory of available instrumentation purchased through the NGI project. The next task was the reinstallation of meteorological sensors in the fall of 2011. Working in close partnership with the Marine Field Group (MFG), Jeremy Rolph installed wind, temperature, and humidity sensors at 30 meters and pressure, wind, temperature and humidity sensors at 19 m on the tower. Mr. Rolph also expanded the solar panel array and installed a second sonic anemometer at 19 m. The atmospheric observations at N7 were further augmented with shortwave and longwave radiation measurements. These measurements were collected using a new radiation translator purchased from RMRco in Seattle.

The MFG also restored a suite of ocean observational capabilities. Sea temperature and salinity sensors are deployed at 3, 9, and 18 m depth, with the latter sensor also recording dissolved oxygen. A bottom mounted AWAC provides currents and surface wave observations. These sensors are all cabled to the data loggers in the tower to support real-time data acquisition.

Restoration of meteorological and oceanographic observations included reestablishing line of sight radio communication between N7 and the FSU Coastal and Marine Laboratory (FSUCML). Communications were restored in fall 2011; however, performance was not up to the desired standards for real-time data transfer to support GCOOS. Personnel from the MFG and COAPS determined that the best solution was to purchase and install directional antennas at the tower and the FSUCML. The installation of the directional antennas in the spring of 2012 increased the reliability of the tower to shore data transfer with no major radio frequency outages occurring since the installation. The new system supported extensive data collection during Tropical Storm Debbie with winds reaching 55 knots and seas of 12-15 feet.

Description of significant research results, protocols developed, and research transitions

Contrasting High and Low Relief Fishery Habitats of the Northeastern Gulf: Habitat Delineation, Food Web Components, and Spatial Demographics: An atlas of side scan waterfall images and associated ground truth visual images for all sites which had both was completed (123 sites in Apalachee Bay, 6 from the 3 by 5's, and 34 from other locations east of Cape San Blas). This

atlas will greatly facilitate interpretation of raw side scan images and habitat classification, and will be made available to other researchers conducting side scan and habitat classification work in the Gulf of Mexico and Atlantic waters off the S.E. United States. Initially, copies will be sent colleagues at the NMFS Pascagoula lab, the state of Florida's Fish and Wildlife Research Institute, University of Florida, Florida State University, University of South Alabama's Dauphin Island Sea Lab, and the Gulf States Marine Fisheries Commission.

N7 tower instrumentation: Following the restoration of the instrumentation on tower N7, programmers at COAPS ensured that all the meteorological and oceanographic data received in real-time at the FSUCML were displayed on the NGI web page and disseminated to GCOOS. Nkem Dockery at COAPS updated existing data processing and web code to extract the real-time meteorology, sea temperature, and salinity data and displayed it on the web. Mr. Dockery also wrote software to translate the 18 m sea temperature, salinity, and oxygen data from the SeaBird 16plus hex format into physical units. Mr. Dockery added code to our web site to display real-time wave height and period from the AWAC. Finally, Mr. Dockery developed code to support user downloads of comma-separated-value files for the real-time meteorological and oceanographic data. The download tools will allow GCOOS to routinely harvest the N7 tower data for display in the GCOOS web portal. Routine display of N7 data at GCOOS is anticipated in July 2012. COAPS continued to maintain code to translate all real-time meteorological observations into network common data form (netCDF) files. These data all undergo automated scientific quality control prior to dissemination on the NGI web site.

Information on collaborators / partners:

a. Name of collaborating organization: NOAA National Marine Fisheries Service, NOAA/AOML, the NOAA National Weather Service in Tallahassee, the NOAA National Estuarine Research Reserve in Apalachicola Bay, IAP Worldwide Services, and colleagues not directly involved in the NGI
b. Date collaborating established: Oct 1, 2006
c. Does partner provide monetary support to project? Amount of support? Yes, to IAP Worldwide Services in the amount of $118,000 to support research activities in collaboration with NOAA National Marine Fisheries Service.
d. Does partner provide non-monetary (in-kind) support? Yes, ship time to NOAA National Marine Fisheries Service
e. Short description of collaboration/partnership relationship. 1) Examination of temporal and spatial patterns in fish community structure, abundance and demographics and 2) characterization of diets, predator-prey interactions, resource overlap and habitat-associated differences.

Information on any outreach activities:

Various exhibits at the Coastal Marine Laboratory, Oceans Day at the Capitol, FSU Campus, etc**.**

NGI FILE #10-NGI-MOD-34

Project Title: Advanced Data Assimilation Experiments for GOES-R Series Applications

Project Lead (PI) name, affiliation, email address: Xiaolei Zou, Florida State University, xzou@fsu.edu

Related NOAA strategic goals: Weather and Water Mission Goal, Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Fuzhong Weng, NESDIS

Project objectives and goals

This project will refine the assimilation process of GOES-11/12/13 imager radiance assimilation in National Centers for Environmental Prediction (NCEP) global forecast systems. The goal is to incorporate these data into NCEP operational forecast systems and to use them as preparation for the GOES-R data.

Description of research conducted during the reporting period and milestones accomplished and/or completed

In the past two years, we mainly focused on assimilation of GOES imager radiances in ARW model. The Geostationary Operational Environmental Satellites (GOES) provide high-resolution, temporally continuous imager radiance data over the West Coast (GOES-West, also known as GOES-11) and East Coast (GOES-East or GOES-12) of the United States. It was first demonstrated that a direct assimilation of GOES imager radiances from GOES 11/12 improved quantitative precipitation forecasts (QPFs) for three coastal storms over the northern Gulf of Mexico and the east coast (Zou et al., 2011). This study further evaluates the benefits of adding GOES 11/12 imager radiances to the satellite data streams in NWP systems for improved coastal precipitation forecasts. The Community Radiative Transfer Model (CRTM) is employed for GOES imager radiance simulations in the National Centers for Environmental Prediction (NCEP) Gridpoint Statistical Interpolation (GSI) analysis system. The GOES imager radiances are added to conventional data for coastal QPF experiments near the northern Gulf of Mexico and the derived precipitation thread score was compared with those from six other satellite instruments. It is found that the GOES imager radiance produced better precipitation forecasts than those from any other satellite instrument. However, when GOES imager radiance and six different types of satellite instruments are all assimilated, the score become much lower than the individual combination of GOES and any other instrument. Our analysis shows that an elimination of MHS data over areas where GOES detects clouds significantly improved the forecast scores from MHS data assimilation.

In particular, we have

- Developed data assimilation technique for ingesting GOES imager radiance data in NOAA data assimilation system and usethe GOES data for coastal QPF.
- Developed a new testing and refining cloud detection algorithms for NOAA applications.

Description of significant research results, protocols developed, and research transitions

None reported

Information on collaborators / partners:

a. Name of collaborating organization: NOAA NESDIS
b. Date collaborating established: Aug 2010
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship. Help mentoring graduate students and postdoctoral fellows; provide data support.

Information on any outreach activities: None

NGI FILE #10-NGI-MOD-37

Project Title: WISDOM Launch and Coordination Activities during Hurricane Season 2010

Project Lead (PI) name, affiliation, email address: Louis Wasson, Mississippi State University, lwasson@gri.msstate.edu

Co-PI(s) name, affiliation, email address: William H. Cooke III, Mississippi State University, bcooke@gri.msstate.edu

Related NOAA strategic goals: Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Justyna Nicinska, OAR

Project objectives and goals

Availability of reasonably accurate forecast information for potential damage from expected landfalling hurricanes can aid emergency managers as they prepare for potential impacts. MSU developed probabilistic geographic models that predict general damage likelihood and location and two types of forest debris damage, hardwood blowdown and pine shear (stem breakage). The current implementation of the MSU hurricane modeling system relies on static input data including landscape roughness, DEM, slope, and other variables, and two dynamic input variables, H*Wind and NWS Stage IV Daily Precipitation products. Since these dynamic variables are only available after the storm has passed a given location, the models are a post-hurricane analysis tool only.

For this project we tested viability of using satellite-based information that is assimilated into the Weather Research and Forecasting (WRF) model to create simulated hurricane wind and rain fields for initiation of a forecast version of the MSU debris models. Other methods of hurricane simulation were developed to meet the following objectives:

1. Test the viability of ingestion of satellite-based data to create a forecast version of the MSU models.
2. Compare the output model results of the MSU debris forecast models using simulated hurricane wind/rain data with the post-hurricane versions of the models that ingest actual wind/rain data

Description of research conducted during the reporting period and milestones accomplished and/or completed

An effort was undertaken to produce a typical hurricane with wind and rain characteristics suitable for use as inputs to the probability of damage models. The simulated hurricane would be based on previous tropical cyclone activity but not representative of any particular event. By using a principal component analysis of North American Regional Reanalysis climate data on a series of 10 Louisiana landfalling tropical cyclone events, three leading modes of variability were obtained, essentially providing idealized tropical cyclone events. These events all made landfall in Louisiana, one near New Orleans, one near Lake Charles, and one on the south-central coast. These composite events were used to initialize the WRF model to determine whether WRF would produce a hurricane that would impact coastal Louisiana.

A regression analysis-based approach hurricane simulation approach was tested with historic wind and rain data to develop a generalized multiple linear prediction equation to predict storm characteristics for subsequent wind grids using storm characteristics including wind, rain, azimuth and distance from eye, forward speed, and forward direction. A key component of the approach relied on estimates of the forward speed and forecast information associated with the hurricane error cone to determine the location of the subsequent grids.

A mechanistic hurricane simulation approach was developed and implemented with the MSU models using the following methods. The storm radii information available from each NHC advisory provides a measure of distances at which hurricane force winds (64 knots), tropical storm force winds (50 knots), and tropical depression winds (34 knots) are experienced (HURNET). Winds are measured as vectors in four different directions: NE, SE, SW, and NW. Using the vector locations as a starting point, linear interpolation methods are used to determine the strength of the wind at any point at a given distance from the eye of the storm. Once a hurricane begins to impact land, winds are perturbated by the vegetation and landform. These landscape components create a significant amount of drag that results in reduction of wind speed. This effect is accounted for by multiplying the predicted wind values by a drag coefficient value of 0.83. Using the NHC forecast advisories, the advisory closest in time to the time of the simulated product is used to determine the storm strength and radii. The QPF files (NOAA 2011) forecast rainfall values in isopleths, effectively polygon shapes of different rainfall amounts. The polygon coordinates for the isopleths were downloaded from the plain-text QPF files, converted into GIS point files, transformed into Albers Equal Area Conic projection, and then rasterized for use in the models. Each day's values were added together to create the cumulative rainfall grid for the duration of the storm. Forecasted wind values were compared with the closest (temporal) H*WIND grid using a 'Goodness of Fit' statistic for wind speed validation. This statistic is calculated as the normalized Mean Square Error (MSE) with values that range from minus infinity (bad fit) to 1 (perfect fit).

Description of significant research results, protocols developed, and research transitions

The satellite-based composite simulations that were designed to produce landfalling tropical cyclones did not result in storms that intensified to hurricane strength. It is possible that a dampening effect originated from the statistical methods employed. Further experimentation is needed for development of idealized tropical cyclone scenarios for testing with the debris models. While the research team believes that further efforts could result in successful simulation of tropical cyclones, two alternative methods were tested for development of algorithms to simulate wind-field and rainfall based on historic storm data. The two methods tested were, 1) a regression analysis approach and, 2) a mechanistic analysis approach.

Low r^2 values for predictions based on the regression approach were too low to explain a significant amount of variation in the model fitting data sets. The team concluded that this approach was not likely to yield accurate predictions for hurricane wind and rain grids needed for the forecast version of the MSU debris models.

Overall, the results of the mechanistic modeling approach were very good for wind speed forecasts with some normalized MSE values as high as 0.93. In most cases, normalized MSE values were between 0.75 and 0.90 for well-formed storms. When storms do not have a well-

defined eye and circular pattern, the simulations are not as good. Prediction accuracy also diminishes at lower wind speeds. The obvious result of the combination of these factors on simulation accuracy is poorer predictions too far inland or too far in advance of landfall. Simulated Katrina wind and rain grids were used as dynamic input variables for implementation of the potential forest damage models. Results were similar to those produced for the actual data.

Currently, the forecasted products that are used in the mechanistic hurricane simulation products are developed but not integrated into the MSU thin-client debris modeling tool. The research team believes that further experimentation is needed for development of idealized tropical cyclone scenarios from satellite-based information for testing with the debris models. While the research team believes that further efforts could result in successful simulation of tropical cyclones, the alternative methods tested yielded positive outcomes, particularly for the mechanistic approach. Some additional work is needed to integrate the simulation products into the MSU modeling tool.

Information on collaborators / partners: None

Information on any outreach activities: None

NGI FILE #10-NGI-MOD-39

Project Title: Development and Demonstration of a Single-Point-of-Access to Satellite Wind and Wave Products

Project Lead (PI) name, affiliation, email address: Mark Bourassa, Florida State University, mbourassa@fsu.edu

Co-PI(s) name, affiliation, email address: Shawn Smith, Florida State University, ssmith@coaps.fsu.edu

Related NOAA strategic goals: Climate Mission Goal, Weather and Water Mission Goal, Commerce and Transportation Mission Goal, Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Stan Wilson, NESDIS

Project objectives and goals

Develop a website that will provide a single-point-of-access for global satellite altimeter-derived significant wave height (SWH) and wind speed (WS) and scatterometer-derived ocean vector wind (OVW) products. This website is to provide a capability for one-stop-shopping enabling a user to easily access OVW, WS and SWH products from multiple satellites corresponding to a user-specified region and time frame (typically collected within the past three hours for operational use) of interest. The web site is to simplify access to these satellite products for the non-specialist users, thereby potentially broadening the impact that timely access to such products can have, but frequently is not realized due to lack or practical access to the data.

Such a single-point-of-access means, in effect, one-stop shopping, so that a prospective user does not have to go to multiple international sites, to obtain multiple products in multiple formats according to multiple procedures. It also means that the delivery of these products will require less communication bandwidth and computing power to access the data products, and that the retrieved data will be in a format practical for selected end users.

This web site would:

- Provide access to current altimeter and scatterometer products are initially made available in near real time.
- Build a global data base of these products as they are made available.
- Output data with minimal, easy-to-understand flagging based on the L2 flags
- OVW products would be Level 2B, where 2B = swath-oriented, vector wind cells
- 24/7 support will not be provided – this is a best effort demonstration product

User to be able to:

- Specify the geographic area and time period of interest for accessing OVW, SWH and WS products.
- Be able to look at a low-res image of the products of interest before obtaining the full digital files.
- Access those data products in an easy-to-use format like NetCDF (or equivalent)

Current satellites (see that two attached constellation schedules for more detail)

- Altimeters are on:
  - NASA/CNES Jason-1
  - NASA/CNES Jason-2 (with NOAA & EUMETSAT operating the ground system)
  - ESA ENVISAT
  - ESA Cryosat-2 (launched in April) - still in 'commissioning phase'
- Scatterometers:
  - ASCAT on MetOp
  - OSCAT on Oceansat-2 - still in 'commissioning phase'

Description of research conducted during the reporting period and milestones accomplished and/or completed

The PI attended a meeting in Brazil to develop a training workshop (Professional Development) for South American forecasters and researchers. He developed materials to be used for training including data access (one option of which was the website we developed, as well as an alternative approach (still using most of the tools we developed) that proved to be more effective for some South American nations.

The PI planned to attend the training workshop, but did not do so due to health problems. The teaching information has given to other instructors. The student and teacher feedback on the workshop was extremely positive. The demonstration using our tool was very successful.

Description of significant research results, protocols developed, and research transitions

The website (http://coaps.fsu.edu/satellite_download/) described in the goals was developed and tested. This web site does:

- Provide access to current altimeter and scatterometer products in near real time,
- Builds a global data base of these products as they are made available,
- Outputs data with minimal, easy-to-understand flagging based on the L2 flags,
- OVW products are provided from the L2B streams,

Users are able to:

- Specify the geographic area and time period of interest for accessing OVW, SWH and WS products.
- Not able to look at images. The lack of support from UNIDATA on working with GEMPAK/QWIPS format consumed more than half the programmer time.
- Access those data products in an easy-to-use format like NetCDF (or equivalent)

Current satellites (see that two attached constellation schedules for more detail)

- Altimeters are on:
  - NASA/CNES Jason-1 (when available)
  - NASA/CNES Jason-2 (with NOAA & EUMETSAT operating the ground system)
  - ESA ENVISAT (when available)
  - ESA Cryosat-2 (launched in April) - still in 'commissioning phase'(not working at present)

- Scatterometers:
    - ASCAT on MetOp
    - OSCAT on Oceansat-2 - still in 'commissioning phase' (not working at present)

We also collaborated with NOAA in putting the data on the GEONETCast Americas (GNC-A) broadcast system. This approach proved very easy and effective. NOAA has expressed interest in continuing the process. We are considering doing so using other funding.

Information on collaborators / partners:

a. Name of collaborating organization: UNIDATA
b. Date collaborating established: Sep 2011
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? No
e. Short description of collaboration/partnership relationship. UNIDATA continually promised the support that they are supposed to provide for their products. We were strung along with bad suggestions. However, we later discovered that they had no expertise to give this support. Based on this experience, we recommend that any future collaboration with UNIDATA be very carefully explored prior to working that commitment into plans.

a. Name of collaborating organization: NOAA NESDIS
b. Date collaborating established: Jun 2011
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? No
e. Short description of collaboration/partnership relationship. NOAA/NESDIS provides some of the near real time data used in the project. They also helped in attempting to convert the data to AWIPS/GEMPAK format. NOAA/NESDIS/STAR also helped demonstrate the near real time data through a GEONETCast Americas (GNC-A) broadcast.

a. Name of collaborating organization: Brazil's Centro de Previsão de Tempo e Estudos Climáticos (CPTEC, Center for Weather Prediction and Climate Studies)
b. Date collaborating established: Jun 2011
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? No
Short description of collaboration/partnership relationship. CPTEC provided technical support on translating data files into AWIPS/GEMPAK format, as well as reading other satellite data sets. CPTEC also hosted the NASA sponsored workshop that made use of our work on this project

a. Name of collaborating organization: NCAR
b. Date collaborating established: Jun 2011
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? No
Short description of collaboration/partnership relationship. Provided organization and logistics for the NASA workshop.

Information on any outreach activities:

a. General Description. Interaction with forecasters and researchers from five South America Countries
b. Hosted speakers, workshops and/or any training:
    i. Type (speaker, workshop, training): NASA-sponsored workshop at CPTEC
    ii. Name of event: Marine Training Workshop on the Use of Satellite Wind and Wave Products in South American Waters
    iii. Date: May 14 – 19, 2012
    iv. Location: Cachoeira Paulista, about 200 km northeast of São Paolo, Brazil
    v. Description: Provided training for approximately 25 forecasters and researchers from 5 South American countries
    vi. Approximate Number of Participants: 35

NGI FILE #10-NGI-MOD-40

Project Title: Inundation Mapping Strategies Workshop and Support

Project Lead (PI) name, affiliation, email address: John Harding, Mississippi State University, jharding@ngi.msstate.edu

Co-PI(s) name, affiliation, email address: Kathleen Sherman-Morris, Mississippi State University, kms5@msstate.edu

Related NOAA strategic goals: Weather and Water Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Doug Marcy, NOS Coastal Services Center

Project objectives and goals

One of the NOAA Storm Surge Roadmap Phase 1 priorities is computed operational inundation depth maps using high resolution data. However, a gap exists in the understanding of available techniques: what are the advantages and disadvantages, validity of mapping from coarse models to higher resolution models, the relationship between modeling uncertainty and mapping, cost of creating, etc. This project developed a Gulf Coast workshop to bring together experts to discuss the issue and provide input for a white paper of proposed actions and recommended practices required to address this need.

The goal of this project was to identify the issues associated with the creation of operational inundation depth maps using high resolution data. The project held a workshop to address these issues and provide input for a NOAA developed plan of action and milestones.

Subsequent to this workshop, with NOAA sponsor concurrence, a follow-on task addressing one of the needs arising from this workshop was addressed. The purpose of this follow-on task was to help NHC evaluate use of cartographic expertise in surge graphics. The goal was to: (1) test risk perception by different audiences with different storm surge graphic styles and (2) test the storm surge graphics' effectiveness as measured by efficiency and accuracy in eye-tracking lab

Description of research conducted during the reporting period and milestones accomplished and/or completed

Online survey of Gulf coast residents: Surveyed Harrison, Jackson Counties in Mississippi and Baldwin and Mobile Counties in Alabama to determine how risk perception and accuracy varies among different graphics. Only Baldwin and Mobile Counties' response rate was high enough for statistical analysis.

Eye tracking experiment: Conducted eye tracking experiment with 40 participants in eye tracking lab. Goals were to measure which image was most effective in terms of accuracy and efficiency.

Description of significant research results, protocols developed, and research transitions

At least one consistent pattern was detected in both methods (eye tracking experiment and online survey) and across in multiple hurricane scenarios. The green to red scale led to improved accuracy values among participants in both methods. The differences, although

consistent across different tests, were not statistically significant in most cases. Qualitative categories (i.e. low, med, high and extreme) led to greater accuracy than quantitative categories measured in feet (i.e. <3, 3-6, 6-9, and 12+) in the online survey. This pattern was not repeated across all conditions in the eye tracking experiment. In that method, the scale in feet led to greater accuracy in the green-to-red scale but lower accuracy in the yellow-to-purple scale. Participants in the eye tracking experiment spent more time examining the maps when the legend was presented in feet rather than in text categories. The blue colored maps also led to increased examination times for all questions except one comparing two points to determine which was the most severe. The accuracy results from eye tracking were not significant for either color or legend type.

Information on collaborators / partners:

a. Name of collaborating organization: Mississippi State University Department of Psychology
b. Date collaborating established: Mar 2012
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship. Personnel at Department of Psychology ran the eye tracking experiments and helped to recruit participants.

Information on any outreach activities: None

NGI FILE #10-NGI-MOD-41

Project Title: Developments of Global Bias Monitoring System

Project Lead (PI) name, affiliation, email address: Xiaolei Zou, Florida State University, xzou@fsu.edu

Related NOAA strategic goals: Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Fuzhong Weng, NESDIS

Project objectives and goals

- Generate climate-quality of observations to better our understanding of the climate variations at global and regional scales.
- Transition of existing algorithms and products to the operational centers.

Description of research conducted during the reporting period and milestones accomplished and/or completed

In the past two years our major focus was to characterize the bias of the radiance bias from two microwave sounding instrument onboard FengYun satellites which will be used in NOAA NWP systems. Following the successful launch of the first polar-orbiting morning-configured satellite, FY-3A, on May 27, 2008 in a new Fengyun three (FY-3) series, the second afternoon-configured polar-orbiting satellite (FY-3B) was launched on November 5, 2010. The four-channel MicroWave Temperature Sounder (MWTS) was onboard both FY-3A/B satellites, with designed channel frequency similar to channels 3, 5, 7 and 9 of Advanced Microwave Sounding Unit-A (AMSU-A). This study assesses the quality of the brightness temperature measurements from FY-3B MWTS by comparing them with NWP model simulations and NOAA-18 AMSU-A measurements with the same frequencies. A strong latitudinal-dependent bias is found for both MWTS channel 3 and AMSU-A channel 7. At channel 4, the brightness temperatures are contaminated within a small latitudinal zone of Northern Hemisphere, which is believed due to the lunar intrusion into the MWTS space view. It is also found that the bias is strongly asymmetric across the scan and is the largest in the 4^{th} field-of-view (FOV4) of channel 4. This anomalous bias may arise from an interference of the signal transmitted from some unknown sources. A quality control algorithm is developed to removes the anomalous data at MWTS channel 4 before a physically-based algorithm is applied to correct the lunar contamination on space view counts. The measurements from FY-3 MicroWave Humidity Sounder (MWHS) are compared with the data from NOAA-18 Microwave Humidity Sounder (MHS) under various atmospheric and surface conditions. A quality control (QC) procedure is applied to allow the comparison be conducted separately for outliers and non-outliers. The QC algorithm includes a gross error check, instrument noise spikes through noise equivalent differential temperature ($\mathrm{NE}\Delta\mathrm{T}$), and an O-B bi-weighting check, where O represents satellite observations, and B is model-simulated brightness temperature by Radiative Transfer for TIROS-N Operational Vertical Sounder (RTTOV) based on the 6-h forecast fields of the National Centers for Environmental Prediction (NCEP) Global Forecast System (GFS). It is found that (i) the global bias and standard deviation of O-B from MWHS brightness temperatures are comparable in magnitudes to those of MHS measurements; (ii) positive O-A outliers prevail in channel 3 for

both MWHS and MHS instruments; and (iii) biases of channels 4 and 5 are predominantly negative over land for both MWHS onboard FY-3A and MHS onboard NOAA-18 satellites. A series of sensitivity experiments are carried out to demonstrate that the large positive O-A biases could be due to the errors in the atmospheric water vapor profiles from the analysis fields being too wet, and that the negative biases over land arise mostly from errors in surface emissivity, but smooth model terrain also contributes negative biases over land.

To summarize, we have completed:

- Quality assessment of microwave measurements from FY-3A/B.
- Published two papers on FengYun-3 MW sounding channels biases at IEEE Transaction of Geoscience and Remote Sensing
- Quality assessment of advanced satellite microwave products from AMSU and SSMIS

Description of significant research results, protocols developed, and research transitions

None reported

Information on collaborators / partners:

a. Name of collaborating organization: NOAA NESDIS
b. Date collaborating established: Aug 2010
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship. Help mentoring graduate students and postdoctoral fellows; provide data support.

Information on any outreach activities: None

NGI FILE #10-NGI-MOD-42

Project Title: Mississippi Digital Earth Model

Project Lead (PI) name, affiliation, email address: Scott Samson, Mississippi State University, ssamson@gri.msstate.edu

Co-PI(s) name, affiliation, email address: Robert Moorhead, Mississippi State University, rjm@gri.mstate.edu

Related NOAA strategic goals: Ecosystems Mission Goal, Weather and Water Mission Goal, Commerce and Transportation Mission Goal, Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Nicholas Schmidt, NOS Coastal Services Center

Project objectives and goals

The objective of the Mississippi Digital Earth Model (MDEM) is to enhance the resource base in both GIS proficient personnel and the development of state-wide GIS databases. This objective is reached through (1) an extensive education and outreach effort for state and local government employees and (2) the development of a state-wide GIS database addressing the data layers as specified in the National Spatial Data Infrastructure guidelines.

Description of research conducted during the reporting period and milestones accomplished and/or completed

Mississippi legislation created in 2003 allocates public sector responsibilities for (1) research and education and (2) implementation in remote sensing and geographic information systems. The law's coordination has uniquely positioned Mississippi to leverage federal, state, and local funds to become the national leader in this rapidly evolving technology. The law created the Mississippi Coordinating Council for Remote Sensing and Geographic Information Systems to "set and assure enforcement of policies and standards to make it easier for remote sensing and geographic information system users around the state to share information and to facilitate cost-sharing arrangements to reduce the costs of acquiring remote sensing and geographic information system data." The law requires the Mississippi Department of Environmental Quality (MDEQ) to develop seven base data layers of geographic information for the state, referred to as the Mississippi Digital Earth Model (MDEM). The Mississippi Digital Earth Model is composed of seven framework layers as defined by the Federal Geographic Data Community's National Spatial Data Infrastructure. Data for the MDEM is acquired and managed through joint operations between the Mississippi Department of Environmental Quality and the Mississippi Department of Information Technology Services. The on-going program will be largely self-funded in the long term because of coordinating regular governmental and agency data acquisition plans and efficiencies in coordinating statewide data purchases. In the near term, however, federal funding to help transition research results into an operational implementation in developing the initial data layers and an efficient data delivery system will be necessary. The GEO (Geospatial Education and Outreach) Project was charged with the development and implementation of educational programs throughout local and state government agencies in Mississippi. The government workforce is becoming increasingly technologically competent in

the utilization of the geospatial applications derived from NGI research activities. The Geospatial Education and Outreach (GEO) Project was developed in response to the limited availability of geospatial data needed by first responders immediately following Hurricane Katrina of August 29, 2005. An assessment was conducted of the educational needs of Mississippi's local governments, especially the localities in the southern portions of the state most susceptible to the effects of hurricanes. A series of intensive 2, 3 and 5 day workshops were compiled that would provide a strong foundation in the fundamentals and applications of GIS. Courses offered range from basic concepts of GIS to advanced, enterprise database management systems. Technical assistance is provided to local governments following classroom preparation as a means to increase the success rate of implementation of GIS in the work place.

Milestones Accomplished:

a. The Mississippi Department of Environmental Quality is currently acquiring, processing and assessing the QA/QC of 9,880 miles of road centerlines for 9 counties in southeastern Mississippi. The data will be delivered to the public in the 1st quarter of 2013. The new road databases will complement 37 counties where road centerlines have been previously developed.
b. High-resolution (6-inch) imagery was acquired for the six Coastal Counties during the spring of 2012. MDEM funds were leveraged with funds originating from the Mississippi Department of Transportation.
c. Between July 1, 2011 and September 30, 2012 31 workshops were delivered to 290 participants.
d. A 1-day GIS workshop for "users of geographic information" was developed for a new demographic unfamiliar with conventional GIS technology. Examples of this demographic are county emergency management employees and personnel in MSU Extension Service in county offices.
e. The GEO Project developed a prototype of a smartphone application to warn users of immediate natural hazard threats around their present location. A public version is anticipated for release during the late summer of 2012.
f. A 1-1/2 day workshop was held in Biloxi on April 26 and 27 to solicit input from various agencies having a role in hazard mitigation along the Mississippi Gulf Coast. Results from the workshop are under review by the Digital Coast Partners.

Description of significant research results, protocols developed, and research transitions

This project is focused on outreach, education and data acquisition. There is not a research component. The Extension Service model of the land-grant university is used to assist in technology transfer. Workshops, presentations and on-site assistance have been proven to be effective in educating the citizens of Mississippi. A network of county extension offices and state-level specialists provide efficient support in a wide range of areas, such as crop production, youth development through 4-H and geospatial technologies.

Information on collaborators / partners:

a. Name of collaborating organization: Mississippi Department of Environmental Quality
b. Date collaborating established: Jul 1, 2009
c. Does partner provide monetary support to project? Amount of support? No

d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship. The Mississippi Department of Environmental Quality (MDEQ) has been given the charge by the State of Mississippi to develop the 7 National Spatial Data Infrastructure (NSDI) layers for the Mississippi Digital Earth Model (MDEM). A subcontract was issued from this project to support MDEQ with their tasks.

Information on any outreach activities:

Workshops and training: The GEO Project curriculum consists of 8 courses in GIS applications and geospatial database management. Thirty-one 2 and 3 day workshops with 290 participants at various locations across the state. A detailed description of the courses offered, location of workshops and the number of participants is presented in Figure 11. The "Mississippi Coast Workshop: Digital Tools for Community Resiliency" was presented in Biloxi on April 26 and 27, 2012 to solicit feedback on access to geospatial resources as they relate to the Mississippi Gulf Coast. Fifty-eight participants discussed geospatial resource needs for coastal community resiliency. Feedback from attendees will be used in the identification and delivery of the requested resources during the fall and winter of 2012-2013.

Course Name	Date	Location	Participants
ArcGIS Dekstop I: Getting Started with ArcGIS (10)	July 21, 2011	Greenwood City Hall	10
ArcGIS Dekstop I: Getting Started with ArcGIS	July 27, 2011	Mississippi Gulf Coast Community College	10
ArcGIS Dekstop I: Getting Started with ArcGIS	July 28, 2011	Copiah-Lincoln Community College	6
ArcGIS Desktop II: Tools and Functionality (10)	August 25, 2011	Copiah-Lincoln Community College	8
ArcGIS Desktop II: Tools and Functionality	September 1, 2011	Mississippi Gulf Coast Community College	11
ArcGIS Desktop II: Tools and Functionality	September 1, 2011	Mississippi Gulf Coast Community College	11
ArcGIS Desktop II: Tools and Functionality (10)	September 23, 2011	Greenwood City Hall	8
ArcGIS Desktop II: Tools and Functionality (10)	October 19, 2011	Copiah-Lincoln Community College	10
ArcGIS Dekstop I: Getting Started with ArcGIS	November 9, 2011	U.S. Army Corps of Engineers Grenada	12
ArcGIS Desktop II: Tools and Functionality	November 17, 2011	U.S. Army Corps of Engineers Grenada	12
Introduction to Geoprocessing Scripts Using Python	December 7, 2011	Pearl River Community College	11
Working with ArcGIS Spatial Analyst	December 15, 2011	Pearl River Community College	4
ArcGIS Dekstop I: Getting Started with ArcGIS (10)	January 26, 2012	Mississippi Emergency Management Agency	12
ArcGIS Desktop I: Getting Started with ArcGIS	February 9, 2012	Copiah-Lincoln Community College	5
ArcGIS Desktop II: Tools and Functionality (10)	March 1, 2012	Mississippi Emergency Management Agency	10
ArcGIS III: GIS Workflows & Analysis (10)	March 28, 2012	Pearl River Community College	14
ArcGIS III: GIS Workflows & Analysis (10)	April 11, 2012	Mississippi Emergency Management Agency	9
ArcGIS Desktop II: Tools and Functionality (10)	April 18, 2012	Holmes Community College	11
Introduction to ArcGIS Server	April 18, 2012	Pearl River Community College	12
Working with ArcGIS Spatial Analyst	May 3, 2012	Pearl River Community College	11
ArcGIS Desktop II: Tools and Functionality (10)	May 10, 2012	Holmes Community College	10
ArcGIS Dekstop I: Getting Started with ArcGIS (10)	May 17, 2012	Mississippi Forestry Commission	8
ArcGIS Dekstop I: Getting Started with ArcGIS (10)	May 24, 2012	Mississippi Emergency Management Agency	7
Introduction to Geoprocessing Scripts Using Python	May 31, 2012	Pearl River Community College	10
Building Geodatabases	June 7, 2012	Pearl River Community College	12
Introduction to ArcGIS Server	June 14, 2012	Mississippi Emergency Management Agency	6
ArcGIS III: GIS Workflows & Analysis (10)	June 20, 2012	Holmes Community College	8
Building Geodatabases	June 28, 2012	Holmes Community College	5
ArcGIS Desktop II: Tools and Functionality (10)	July 12, 2012	Mississippi Emergency Management Agency	6
ArcGIS Dekstop I: Getting Started with ArcGIS (10)	August 1, 2012	Mississippi Museum of Naural Science	9
ArcGIS Dekstop I: Getting Started with ArcGIS (10)	August 15, 2012	Tupelo City Hall	12

Figure 11. Workshop Agenda

NGI FILE #10-NGI-MOD-43

Project Title: Developments of Advanced Satellite Microwave Products

Project Lead (PI) name, affiliation, email address: Xiaolei Zou

Related NOAA strategic goals: Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Fuzhong Weng, NESDIS

Project objectives and goals

- Develop advanced satellite microwave products for improving typhoon and hurricane predictions.
- Transition of existing algorithms and products to the operational centers.
- Generate climate-quality of observations to better our understanding of the climate variations at global and regional scales.

Description of research conducted during the reporting period and milestones accomplished and/or completed

We focused on improving microwave imager data from EOS, Windsat and FY3 platforms and developed a generalized algorithm for global radio frequency interference. A detection of Radio Frequency Interference (RFI) in the space-borne microwave radiometer data is difficult under snow and sea ice covered conditions. The existing methods such as a spectral difference technique or a principal component analysis (PCA) of RFI indices produce many false RFI signals near the boundary of Greenland and Antarctic. In this paper, a double PCA (DPCA) method is developed for RFI detection over Greenland and Antarctic regions. It is shown that the new DPCA method is effective in detecting RFI signals in the C- and X-band radiometer channels of WindSat while removing the false RFI signals over Greenland and Antarctic. It also worked well in other snow-free regions in the United States. The proposed DPCA can be applied to satellite radiometer data orbit-by-orbit or granule-by-granule and is thus applicable in an operational environment for fast processing and data dissemination.

In particular, we have

- Developed an RFI algorithm for detecting all the contamination of RFI in the microwave imager data.
- Delivered the algorithm sciences to NOAA for operational implementation
- Applications of advanced satellite microwave brightness temperature data for establishing level-2 temperature climate data records using 1D-Var approach.

Description of significant research results, protocols developed, and research transitions

None reported

Information on collaborators / partners:

a. Name of collaborating organization: NOAA NESDIS
b. Date collaborating established: Aug 2010
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship. Help mentoring graduate students and postdoctoral fellows; provide data support.

Information on any outreach activities: None

NGI FILE #10-NGI-MOD-44

Project Title: Time-Series and Underway Assessments of Ocean Acid CO_2

Project Lead (PI) name, affiliation, email address: Stephan Howden, USM, Stephan.Howden@usm.edu

Co-PI(s) name(s), affiliation, email address: Robert Byrne, University of South Florida, byrne@marine.usf.edu; Wei-jun Cai, University of Georgia, wcai@uga.edu; Joseph Salisbury, University of New Hampshire, joe.salisbury@unh.edu

Related NOAA strategic goals: Ecosystems Mission Goal, Climate Mission Goal, Weather and Water Mission Goal, Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Richard Feely, PMEL

Project objectives and goals

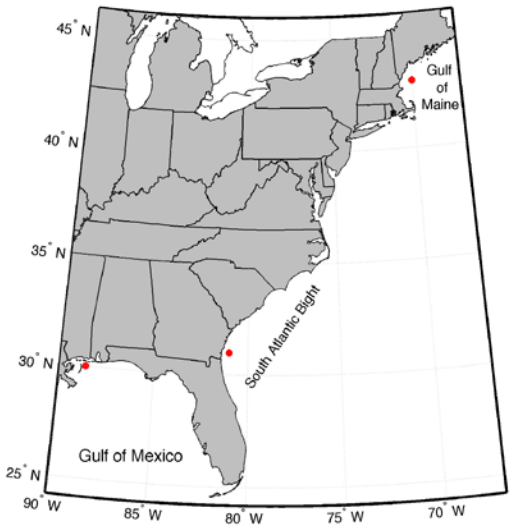

Figure 12. Locations of buoys with NOAA/PMEL MAPCO2 systems. USM operates a buoy in the GoM, UGA collaborates with the NOAA/NDBC buoy in the SAB, and UNH and NOAA/PMEL operate a buoy in the GoME

This project involves a close collaboration with NOAA scientists to provide information critical to NOAA's mission and global concerns regarding ocean acidification and its impacts on ecosystems. Time-series observations of coastal ocean pH and carbon system properties in the Gulf of Mexico (GoM), the South Atlantic Bight (SAB) and Gulf of Maine (GoME) are being conducted by partnerships between NOAA and the University of Southern Mississippi (USM), University of Georgia (UGA), and the University of New Hampshire (UNH), respectively (Figure 12), augmented by a more extensive mapping of pCO_2 in the GoM and the southeastern U.S. coast via underway measurements using ships of opportunity by the University of South Florida (USF).

Description of research conducted during the reporting period and milestones accomplished and/or completed

In order to eliminate down-time of the CenGOOS buoy, the second 3-m discus buoy hull was modified by the NOAA/National Data Buoy Center to house the NOAA/PMEL MAPCO2 system (Figure 13). Three water-tight aluminum cylinders were welded into the hull to house the electronics, reference gas cylinder, and battery, respectively. The hull is being painted and is scheduled to be deployed in July, 2012 with a replacement MAPCO2 system, including a SeaBird Microcat,

Figure 13. Sandblasted hull of 3-m discus buoy modified by the National Data Buoy Center to house the PMEL MAPC02 system

SAMI pH sensor and Wetlabs fluorometer. The PMEL system has a completely separate power and telemetry system from the rest of the buoy.

During the reporting period, the buoys in the northern Gulf of Mexico, the South Atlantic Bight, and the Gulf of Maine extended the time series of coastal ocean pH and carbon system processes in these three different regions. The preliminary full time-series of the mole fraction of CO2 in the near surface atmosphere and ocean are shown in Figure 14, Figure 15, and Figure 16, along with the difference and percent of oxygen saturation in the surface ocean. The most recent thirty-day time-series (unverified) are shown in Figure 17, Figure 18, and Figure 19.

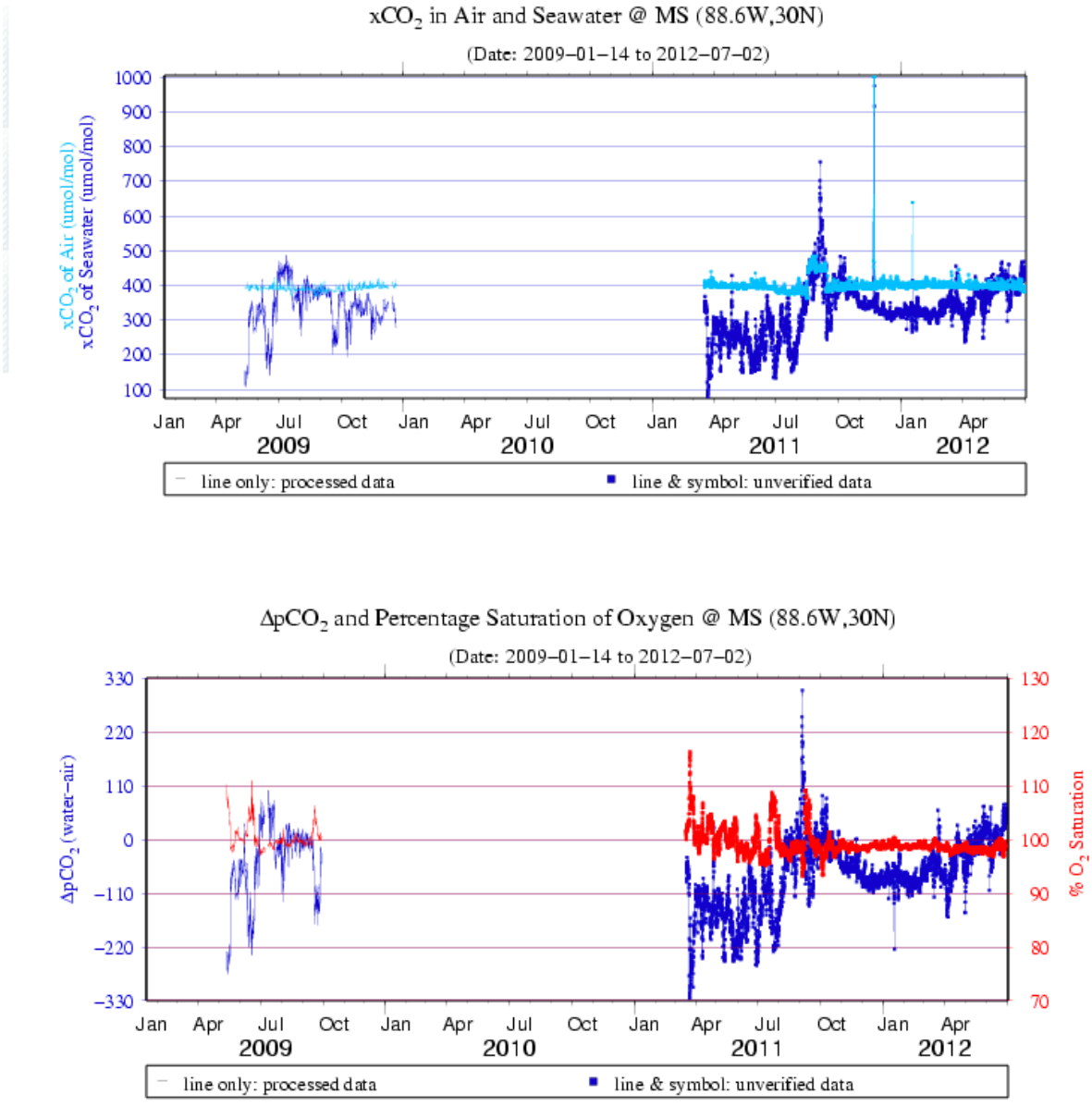

Figure 14. Complete MAPCO2 time series for CenGOOS buoy

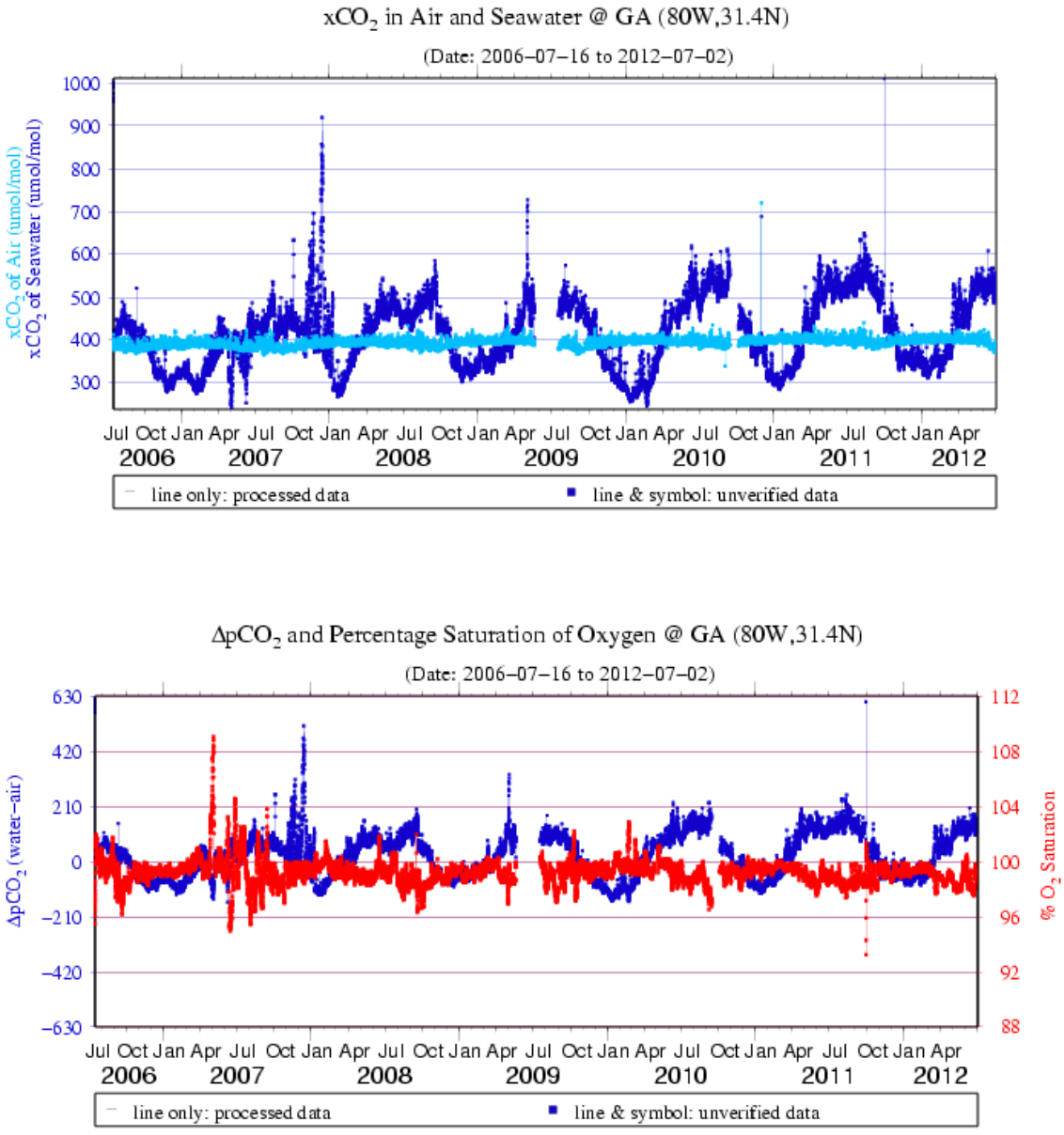

Figure 15. Complete MPACO2 time-series for Gray's Reef NDBC buoy

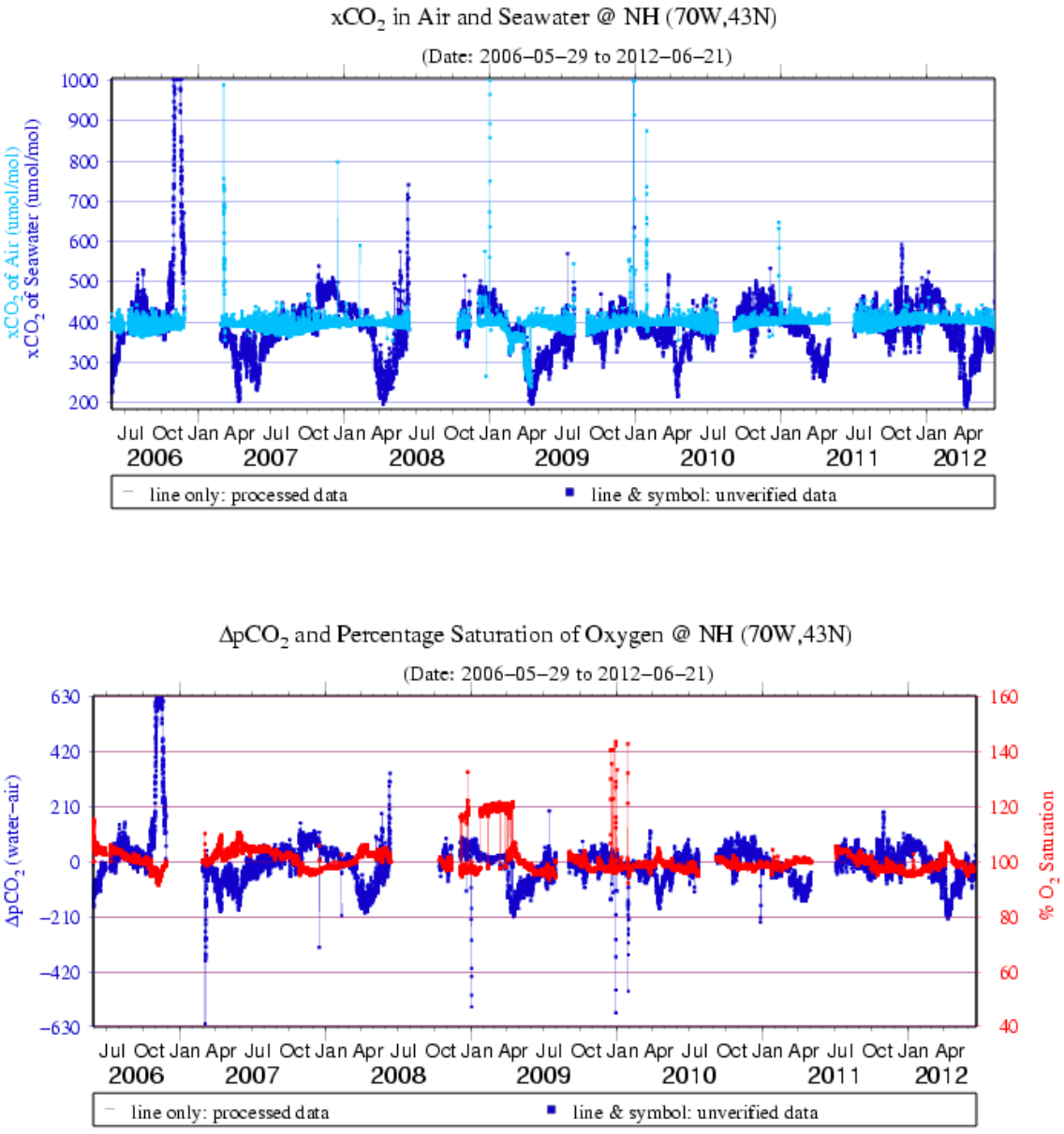

Figure 16. Complete MPACO2 time-series for UNH buoy

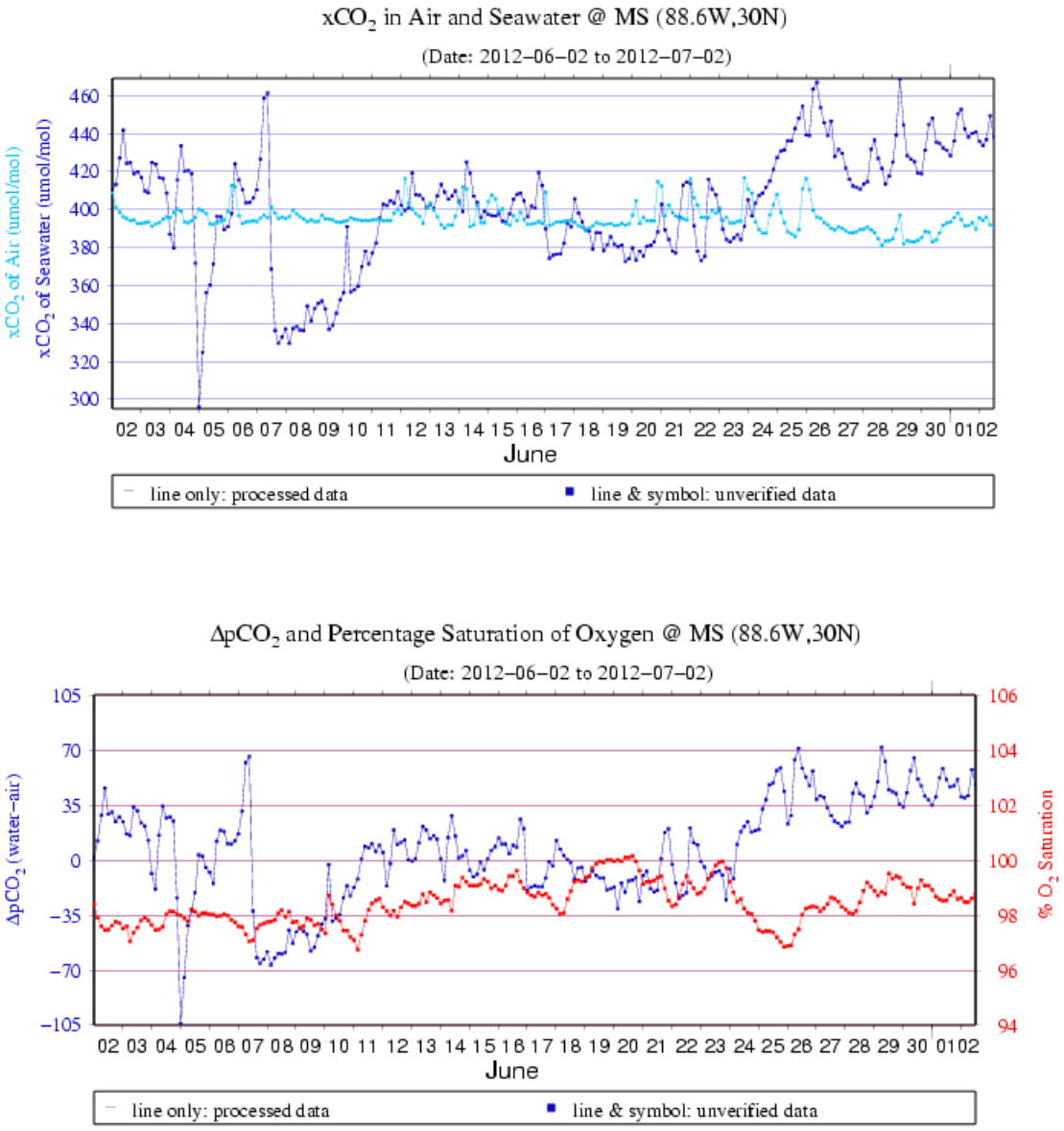

Figure 17. 30-day MAPCO2 time series for CenGOOS buoy

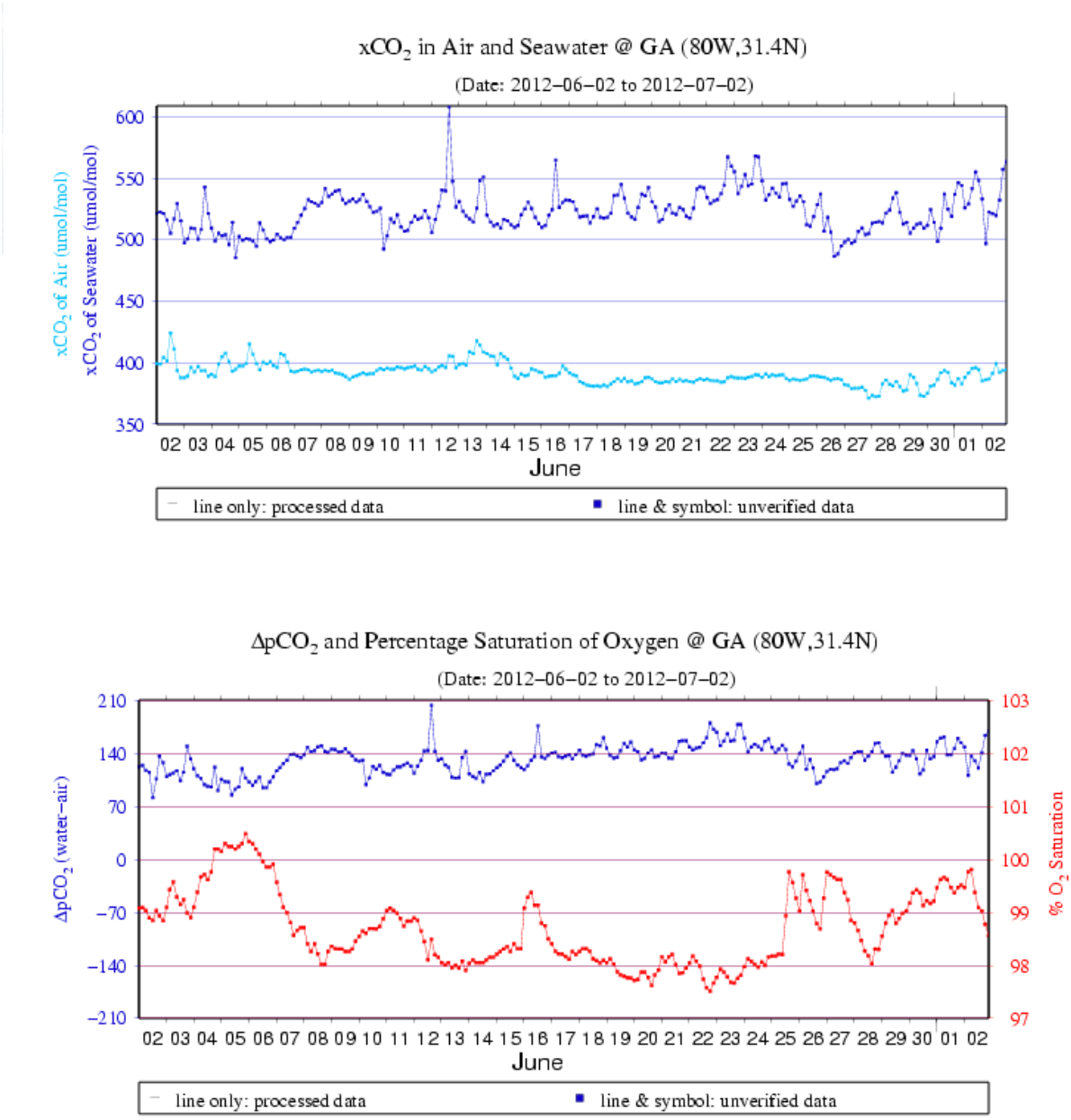

Figure 18. 30-day MPACO2 time-series for Gray's Reef NDBC buoy

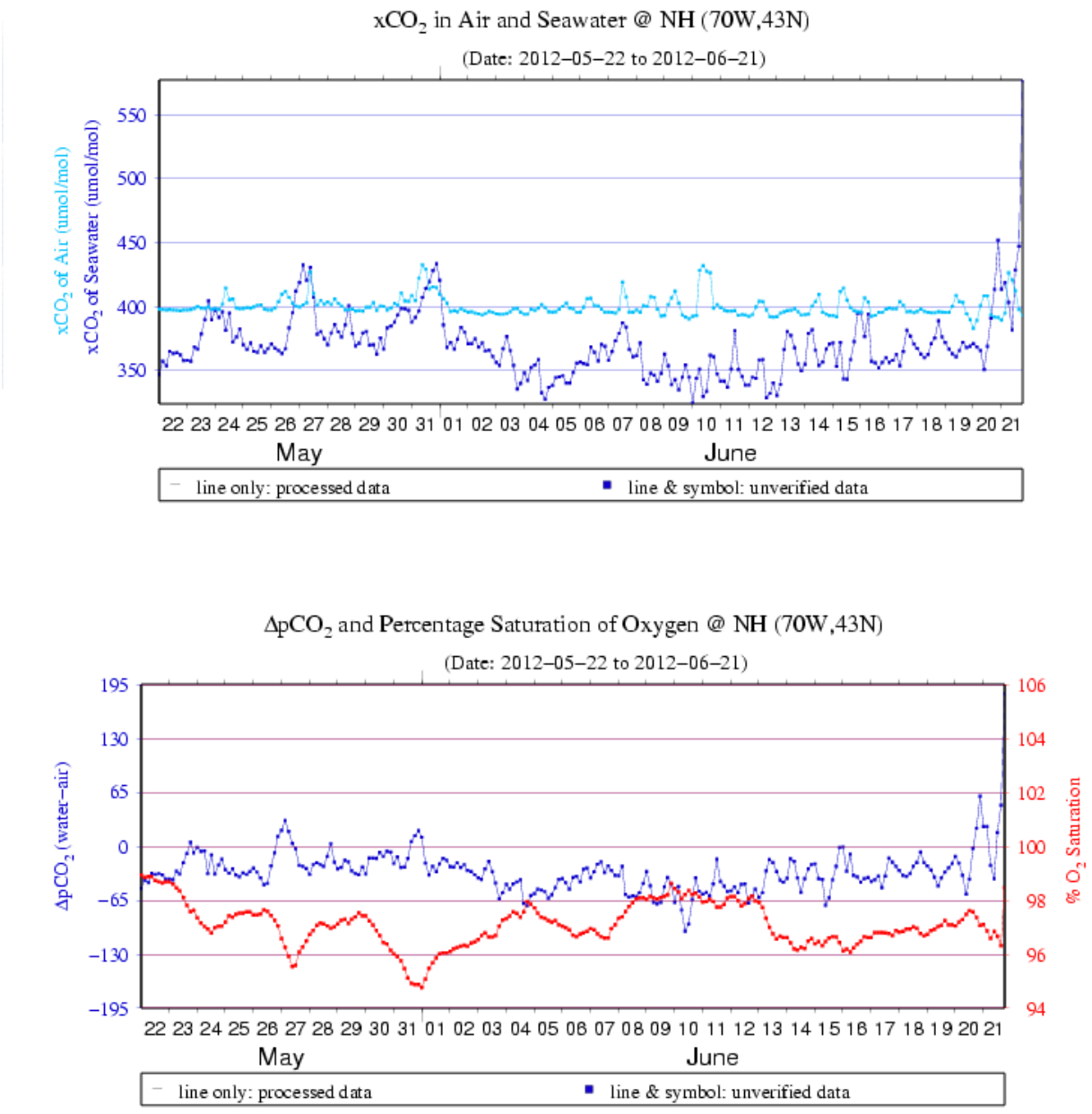

Figure 19. 30-day MPACO2 time-series for UNH buoy

In previous years, the ocean at the buoy location has been a net source of CO_2 only for the month of July. The June 2012 ΔpCO_2 for the CenGOOS site is positive, in contrast to June 2009 and June 2011. SST anomalies for early to mid-June 2012 are greater than those for 2009 and 2011 and may have tipped the balance between increasing seawater pCO_2 due to temperature driven solubility decreases, and reduced pCO_2 due to productivity.

Description of significant research results, protocols developed, and research transitions

Time-series of T, S, pCO_2 and pH in the GoME are shown in Figure 20. A manuscript dealing with seasonal controls on ΔpCO_2 and aragonite saturation state is in preparation. Ten UNH cruises supported by NOAA, NASA and NSF have been used to take ancillary measurements and data for validation. Quality control efforts comparing the continuous data stream to discrete samples are being conducted.

The Gray's Reef National Marine Sanctuary site, which lies in the middle of the SAB, sits near the boundary of the inner shelf and mid-shelf where substantial spatial and seasonal variation in CO_2 and pH dynamics occur. A recent study has illustrated that the SAB mid- to outer shelf is often a sink of atmospheric CO_2 and most likely of net autotrophic on an annual basis, while the inner shelf is more frequently net heterotrophic, i.e., releasing CO_2 to the atmosphere and ocean interior. A MAPCO2 has been deployed on the NDBC buoy 41008 and has been working nearly continuously since July 2006. Data collected so far suggest that pCO_2 at this site follows the general cycle of seasonal temperature; however, there are clear signals that cannot be explained by temperature change alone (Figure 20).

Previous studies in the northern GoM have demonstrated high seasonal variability in CO_2 fluxes and the episodic existence of localized oceanic sinks. However, during a 2009 deployment of the USM buoy from May through December, the northern GoM was primarily a sink for CO_2 (Figure 21) with only July being a mean source. Water samples for ancillary measurements and validation data have been taken on a monthly basis through December 2011, as part of a USM project funded by the Northern Gulf Institute.

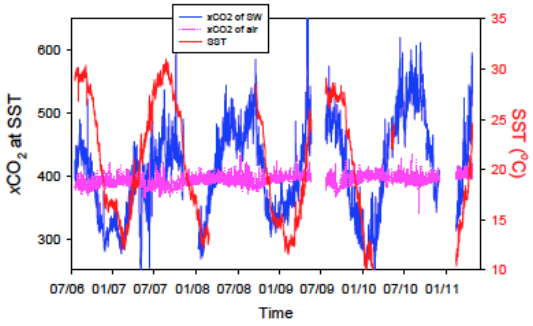

Figure 20. Mole fraction of CO_2 (χCO_2 , ppm) of seawater and cCO_2 of air and SST recorded by the Autonomous pCO_2 Monitoring System deployed on NDBC buoy 41008

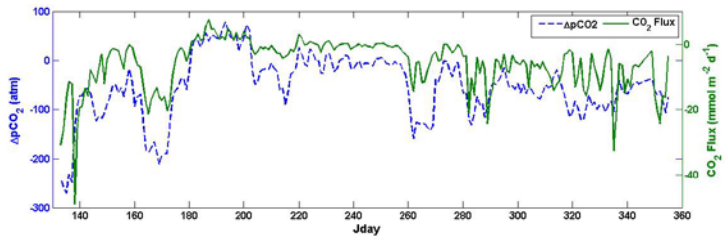

Figure 21. Time series of mean daily ΔpCO2 with mean daily air-sea CO2 flux from May through December, 2009

USF has collected water samples for analysis of TA and DIC to depths of 1,000 m in the GoM. Novel methods were developed that will allow shipboard TA and DIC measurements, in addition to measurements of pH on discrete samples. The SEAS II systems are being modified to allow long term monitoring of pH on moorings and the MICA II systems have been refined for shipboard CO2 system measurements of underway pH, TA and DIC.

Information on collaborators / partners:

The USM/NGI project *Monitoring and Assessment of Coastal and Marine Ecosystems* (PI Stephan Howden) was leveraged by this project to provide monthly sampling at the USM/CenGOOS buoy location. The support of this project provided free boat use and an enhanced set of ancillary data. The monitoring project ended on December 31, 2011, and this project had to shift to quarterly sampling. The next sampling is scheduled for the buoy turnaround cruise in July 2012.

The USM/NOAA/GCOOS project *Central Gulf of Mexico Ocean Observing System* (PI Stephan Howden) provides buoy platforms for the NOAA/PMEL MAPCO2 systems in the Mississippi Bight. That project paid NOAA/NDBC to modify a 3-m discus buoy aluminum hull to house the MAPCO2 system.

Oceanic, Coastal and Estuarine Observing Networks: North Atlantic Ocean, East and Gulf Coasts. PI: Dr. Rik Wanninkhof (NOAA/AOML). Co-I's: Dr. Anne Michelle Wood (NOAA/AOML), Dr. Christopher Sabine (NOAA/PMEL), Dr. Richard Feely (NOAA/PMEL) and Dr. Jon Hare (NOAA/NMFS/NEFSC).

Information on any outreach activities:

Howden, S. D. *CO_2 and Ocean Acidification*. Climate Change Community Outreach Initiative (CCCOI) "Ocean Acidification" September 29, 2011 Gulfport Mississippi. This CCCOI Workshop was sponsored by the National Oceanic Atmospheric Administration (NOAA)-Office of Education through the FL Aquarium, in cooperation with the IMMS-CMER off Lorraine Rd. in Gulfport, MS. The educational program is for middle-school science teachers, and approximately 20 teachers participated in this workshop.

NGI FILE #10-NGI-MOD-46

Project Title: Ecosystem Services Valuation Workshop Support

Project Lead (PI) name, affiliation, email address: Jay Ritchie, Mississippi State University, jritchie@ngi.msstate.edu

Related NOAA strategic goals: Ecosystems Mission Goal, Climate Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Becky Allee, NOS Coastal Services Center

Project objectives and goals

This project supported the Gulf of Mexico Alliance's Ecosystem Integration and Assessment Priority Issue Team in hosting Ecosystem Services Valuation workshops. The goals of these workshops were to build consensus on a common definition of ecosystem services and to identify and prioritize the ecosystem services most relevant to coastal and marine ecosystems in the Gulf of Mexico.

Description of research conducted during the reporting period and milestones accomplished and/or completed

As a result of remaining money and delays associated with the Deepwater Horizon Oil Spill, a 3rd meeting of this group was scheduled for early in 2012.

Description of significant research results, protocols developed, and research transitions

The results of the workshops will be incorporated into Gulf of Mexico Alliance activities in the area of ecosystem services as well as informing the needs identified in the Roadmap. One product is the incorporation of the workshop outcomes into a suggested "best practices" document that will be publically available to practitioners of ecosystem services valuation. These workshops also developed a definition of ecosystem services for the Gulf of Mexico that was endorsed by GOMA and identified and prioritized the ecosystem services most relevant to coastal and marine ecosystems in the Gulf of Mexico.

Information on collaborators / partners:

a. Name of collaborating organization: Harte Research Institute
b. Date collaborating established: May 2010
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship. Co-host of the Ecosystem Valuation workshop and lead organization for the Ecosystem Valuation Ecollarboratory

Information on any outreach activities:

a. General Description
b. Hosted speakers, workshops and/or any training:
    i. Type (speaker, workshop, training): Workshop
    ii. Name of event: Ecosystem Services Valuation workshop
    iii. Date: Jan 24-26, 2012
    iv. Location: Corpus Christi, TX
    v. Description: Workshop identified and prioritized the ecosystem services most relevant to coastal and marine ecosystems in the Gulf of Mexico
    vi. Approximate Number of Participants: 35

NGI FILE #10-NGI-MOD-48

Project Title: Ecosystem Approach to Management for the Northern Gulf

Project Lead (PI) name, affiliation, email address: William H. McAnally, Mississippi State University, mcanally@ngi.msstate.edu

Co-PI(s) name, affiliation, email address: Just Cebrian, Dauphin Island Sea Lab; Scott Milroy, University of Southern Mississippi; Susan Welsh, Louisiana State University; Erick Swenson, Louisiana State University; Cristina Carollo, Harte Research Institute; Richard Fulford, EPA Gulf Breeze Laboratory

Related NOAA strategic goals: Ecosystems Mission Goal, Climate Mission Goal, Commerce and Transportation Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Buck Sutter, NMFS

Project objectives and goals

The overall goal of this effort was to contribute toward the NOAA goal of an Ecosystem Approach to Management (EAM) and Coastal and Marine Spatial Planning (CMSP) concepts to systems and regions throughout the northern Gulf of Mexico.

The work had the following objectives: (1) develop indicators that will define ecosystem "States" for previously initiated Integrated Ecosystem Assessments (IEA) of Perdido Bay, Florida; Mississippi Sound, Mississippi; and Barataria Basin, Louisiana; and look toward the Texas coast for other ecosystems; (2) produce a model framework to link State indicators to Drivers and Pressures; and (3) create a prototype system for the northern Gulf that incorporates findings of these IEA.

Description of research conducted during the reporting period and milestones accomplished and/or completed

The following Phase 1 Tasks were completed:

1-1. Apply the Drivers and Pressures analysis to the entire Perdido Bay and to sub-estuaries in Mississippi Sound and Barataria Basin, in order to separate the effects of scale from the effects of geographical location*. (DISL, LSU, USM)*

1-2. Use the stakeholder groups already assembled plus upstream (watershed) groups to validate the work reported earlier and to continue the IEA definition of States, Impacts, and Responses for these three systems. *(DISL, LSU, USM)*

1-3. Continue development of the Sulis toolkit, with an emphasis on tools supporting incorporating EAM into CMSP and involving GOMA Nutrients PIT. This task will produce a prototype user interface that will serve as an example of what a CMSP plan will look like, displaying existing maps (e.g. MarineMap) and IEA findings to be used in planning evaluations and consultations. *(MSU)*

1-4. Select one new system to complement the three described here. We will select a coastal area in mid- to southern Texas (with low freshwater flows) in consultation with NGI MOA signatory Harte Research Institute, Corpus Cristi, TX, who will also provide related guidance in ecosystem valuation for task 1-3. *(HRI)*

1-5. Prepare site-specific reports. *(DISL, LSU, USM)*

The following Phase 2 Tasks were completed:

2-1. Develop an initial assessment of Drivers and Pressures for the new site identified in Phase 1 *(DISL, LSU, MSU, USM)*
2-2. Identify a suitable model and risk analysis framework as described in Step 3 of the IEA process for the index systems. *(DISL, LSU, MSU, USM)*
2-3. Generate roll-up report on all work to date. *(MSU)*

The following Milestones were completed:

3rd Qtr 2010	Work initiated on Tasks Sulis User workshop held
4th Qtr 2011	Draft Reports on system-subsystems and scale User Test of Sulis Interface
1st Qtr 2012	Draft summary report
3rd Qtr 2012	Final Report Demo of Sulis Interface

Description of significant research results, protocols developed, and research transitions

The work employed conceptual and numerical models of physical and ecosystem processes and establishes a risk framework of interpreting findings. Ecosystem Risk is defined as a measure of the probability and the magnitude of ecosystem effects. The effects can be ecosystem services preserved, gained, or lost. It also employs Sulis, a natural resource assessment system, as an architecture and a software framework. Development of an ecosystem model with food web and fisheries components was begun.

Four systems were examined– Galveston Bay, Texas; Barataria Basin, Louisiana; Mississippi Sound in Louisiana, Mississippi, and Alabama, and Perdido Bay, Florida. They represent a variety of northern Gulf of Mexico estuarine ecosystems over a rather narrow range of latitude, thus offering ample opportunities for contrast and comparison.

Three Driver categories – Hydrologic Modification, Climate, and Human-Related Processes – and 13 Pressures have been identified that are pertinent to at least one of the four systems. Salient commonalities are that (1) Human-Related Processes dominate Drivers for the region, with Local Population Size and Tourism/Recreation cited for all systems and (2) five Pressures manifest those drivers: increased fishing effort, increased urban/coastal development, increased boat traffic, increased nutrients, and increased pollution.

Nearly equal distributions of Pressures were identified at different scales, ranging from individual lagoons to entire estuaries, but substantial dissimilarities in at least some physical processes suggests that while management measures may be similar at multiple scales, evaluation of the system's behavior in response to those measures may not be. For example, total dissolved nitrogen (TDN) concentrations were always higher within each of the individual Perdido Bay lagoons than in the surrounding Bay. These results suggest that the assessment step should include both the smaller scale features and the overall system.

Human-Related Processes is the most prevalent IEA Driver category, affecting all four systems. Five related Pressures – *Increased Fishing Effort, Urban/Coastal Development, Boat Traffic, Nutrients,* and *Pollution* are common to all four systems. Human-related pressures are *fishing effort, urban and coastal development, boat traffic, eutrophication* and *chemical pollution.*

Habitat modification or loss is the most common Impact associated with the four-system Drivers-Pressures-States, followed by *Lack of support for responses* and *Change/loss of native species*. Other impacts, such as *Increased storm surge* and *Eutrophication*, tended to be applicable to one or two systems instead of all four.

Primary Ecosystem Services affected by the impacts, in decreasing order of occurrence, for the four systems are *Habitat Formation, Food,* and *Educational*.

As the size of coastal systems increase (for instance when we move from small lagoons to large estuaries), or as we move from the coastal environment to offshore pelagic environments, the relative importance of human-generated stressors is reduced, with natural stressors (climate processes) becoming more important.

The work demonstrated that:

- The IEA/EAM framework based on the DPSIR/DPSER process is a valid approach to identify, prioritize and manage natural and human-induced stressors in Gulf of Mexico systems. Application of this approach to four systems in the Gulf of Mexico that range widely in environmental, societal and economic characteristics shows that this approach is comprehensive and adaptable to the whole suite of natural-human systems in the Gulf of Mexico.
- The Sulis Community Ecosystem Models and Informatics Services can be used for performing Integrated Ecosystem Assessments, including the framework for evaluation of management responses including risk assessment. Uncertainty and risk can be successfully addressed by extending well-established practices from the physical sciences to ecosystem sciences and modeling.
- The TroSim ecosystem model will provide a management assessment tool for Mississippi Sound.
- The Gulf of Mexico offers an excellent domain in which to develop, evaluate and validate strategies for environmentally and economically-sustainable development and exploitation. These resource management strategies can then be applied to allow for a vibrant economy combined with sustained environmental health. Completing the IEA/EAM framework in the Gulf of Mexico will allow this management strategy development to be accomplished.

Information on collaborators / partners (if applicable):

NOAA contributors: Julien Lartigue, Chris Kelble, Becky Allee, Russ Beard, Michael Schirripa

Corps of Engineers R&D Center participated in workshops

Richard Fulford of EPA Gulf Breeze lab actively participated at his own cost.

Information on any outreach activities: NOAA participants listed above were continuously engaged with the team's efforts, including testing of new tools as applied to resource management challenges.

NGI FILE #10-NGI-MOD-49

Project Title: SeaGrant Peer Listening Network Support Project

Project Lead (PI) name, affiliation, email address: Jay Ritchie, Mississippi State University, jritchie@ngi.msstate.edu

Related NOAA strategic goals: Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Todd Davison, NOS Coastal Services Center

Project objectives and goals

The application of the peer-listening concept to communities impacted by oil spills was pioneered in Alaska following the Exxon Valdez oil spill. The peer-listening approach trains residents of impacted communities how to listen and informally counsel others. This project provided coordination, management and funding supporting the publication and distribution of a Gulf of Mexico specific Peer-Listening Training manual in support of Sea Grant's efforts to enable communities to establish Peer-Listening networks.

Description of research conducted during the reporting period and milestones accomplished and/or completed

The Peer Listener Training Program has trained 7,645 people from 7-14-10 to present with the assistance of partner organizations such as the Gulf Sea Grant programs, Coastal Family Health Center, Auburn University Extension Program, AltaPointe Health Systems, Baldwin County Mental Health Center, and the National Oceanic and Atmospheric Administration.

An online community of Peer Listener Trainers was created on the StormSmart Coasts Network (stormsmart.org)_to allow Peer Listener Trainers to communicate with one another, share information (articles, new research) that may be helpful to the group, and post any upcoming trainings.

The Peer Listener Training Manual is now available online at: http://masgc.org/peerlistening along with referral resources for peer listeners, contact forms, and online registration for future trainings.

Description of significant research results, protocols developed, and research transitions

The majority of the planned trainings were held just after the Deepwater Horizon Oil Spill. We have used the funds from NGI to purchase printed copies of the Gulf of Mexico Peer Listener Training Manual for the many training sessions conducted across the coast. We have been able to leverage these funds with a grant that Coastal Family Health received to provide PLT to Mississippi residents during the same time period.

The Peer Listener Training Manual was used to assist Tornado Survivors in Tuscaloosa, Alabama shortly after the April 2011 storms. The program was offered at the University of Alabama in a modified form to meet the needs of university staff and students who are building a peer listener network to assist university students and their families.

We have partnered with the Prince William Sound Regional Citizens Advisory Council to travel to Cordova or Anchorage and jointly conduct a training during the Fall 2012-Spring 2013 time period. This will allow us to share our update of the manual and newly created PowerPoint presentation for facilitators.

Information on collaborators / partners:

a. Name of collaborating organization: Mississippi Alabama Sea Grant
b. Date collaborating established: Sep 2010
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? Yes
e. Short description of collaboration/partnership relationship. This project directly supports MS/AL Sea Grant's Peer Listening program

Information on any outreach activities:

a. General Description
b. Hosted speakers, workshops and/or any training:
    i. Type (speaker, workshop, training). Training.
    ii. Name of event: Tuscaloosa Tornado Survivors
    iii. Date: Jun 27, 2011
    iv. Location: Tuscaloosa, AL
    v. Description: The Peer Listener Training Manual was used to assist Tornado Survivors in Tuscaloosa, Alabama shortly after the April 2011 storms. The program was offered at the University of Alabama in a modified form to meet the needs of university staff and students who are building a peer listener network to assist university students and their families.
    vi. Approximate Number of Participants: 17

NGI FILE #11-NGI-MOD-50

Project Title: Social Impact and Resiliency in the Wake of Deepwater Horizon Industrial-Environmental Disaster: Development of Well-Being Indicators and collection of Oral Histories: Component Two – Oral Histories

Project Lead (PI) name, affiliation, email address: Louis Kyriakoudes, University of Southern Mississippi, Louis.Kryriakoudes@usm.edu

Related NOAA strategic goals: Ecosystems Mission Goal

NOAA sponsor and NOAA office of primary technical contact: Susan Abbott-Jamieson, NMFS

Project objectives and goals

Document the experience of people directly and indirectly affected by the DWH oil disaster in GOM fishing communities and related coastal locations affected by the DWH oil spill, ensuring representation of the affected regions, the many ethnic communities that comprise the Gulf coast marine fishing and harvesting industry, e.g., Acadians, African-Americans, Croatians, Isleños, Native Americans, and Vietnamese; and all marine fishing and harvesting sectors.

Additionally provide narrative data to complement other social and economic data being collected to update existing baseline data, which is now inaccurate because of the major social and economic perturbations caused by the DWH oil disaster. Oral history data will help NOAA social scientists determine the factors and conditions that affect sub-populations ability to adapt to the DWH oil-disaster-induced changes to Gulf of Mexico (GOM) ecosystems.

Description of research conducted during the reporting period and milestones accomplished and/or completed

Center for Oral History and Cultural Heritage (USM) staff conducted in-depth oral history interviews with 80 subjects involved in all aspects of commercial and recreation fishing/seafood harvesting activity, ranging from commercial finfish fishers, shrimpers, seafood dealers and processors, oyster harvesters, and seafood processing facility workers. All interviews were digitally recorded and professionally transcribed. Preliminary content analysis has been performed through abstracts and detailed content descriptions of each interview. Interviews are being uploaded to the Voices from the Fisheries online oral history database http://www.st.nmfs.noaa.gov/voicesfromthefisheries/ for easy access by researchers and the general public.

Description of significant research results, protocols developed, and research transitions

During the course of this project, our researchers conducted multi-lingual interviews with twenty-one Vietnamese-American marine harvesters and seafood processing workers. Center for Oral History and cultural heritage researchers employed translators to conduct interviews in Vietnamese. The resulting audio recordings were then transcribed in English and Vietnamese, as spoken on the recording. The Vietnamese-language sections of the transcript were then translated into English.

Project researchers also attended and recorded public meetings where fisherfolk expressed frustrations with the Gulf Claims reimbursement process.

Information on collaborators / partners:

a. Name of collaborating organization: National Alliance of Vietnamese American Service Agencies (NAVASA)
b. Date collaborating established: Sep 2006
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? No
e. Short description of collaboration/partnership relationship. Working with NAVASA, BPSOS and MQVCDC, we were able to interview NGO staff and leadership working with Vietnamese-American marine harvesters and seafood workers about the effects of the oil disaster on their community's economic and social well-being. Staff also helped identify potential interviewees among the Vietnamese immigrant community and supplied some assistance in translation and transcription.

a. Name of collaborating organization: Boat People SOS (BPSOS)
b. Date collaborating established: Sep 2006
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? No
e. Short description of collaboration/partnership relationship. Working with NAVASA, BPSOS and MQVCDC, we were able to interview NGO staff and leadership working with Vietnamese-American marine harvesters and seafood workers about the effects of the oil disaster on their community's economic and social well-being. Staff also helped identify potential interviewees among the Vietnamese immigrant community and supplied some assistance in translation and transcription.

a. Name of collaborating organization: Mary Queen of Vietnam Community Development Corporation, New Orleans – East (MQVCDC)
b. Date collaborating established: 2008
c. Does partner provide monetary support to project? Amount of support? No
d. Does partner provide non-monetary (in-kind) support? No
e. Short description of collaboration/partnership relationship. Working with NAVASA, BPSOS and MQVCDC, we were able to interview NGO staff and leadership working with Vietnamese-American marine harvesters and seafood workers about the effects of the oil disaster on their community's economic and social well-being. Staff also helped identify potential interviewees among the Vietnamese immigrant community and supplied some assistance in translation and transcription.

Information on any outreach activities:

Press and Media Coverage: The Deepwater Horizon Oil Disaster Oral History project received press coverage in the following venues:

February 6, 2012 Center Director Louis Kyriakoudes and Center graduate research assistant, Barbara Hester, are featured in a story in the *Mississippi Press* (Pascagoula) about the research effort, accessible at this link: http://blog.gulflive.com/mississippi-press-living/2012/02/fishermen_record_oral_historie.html

April 20, 2012 WLOX ran a print story on their web that featured the work of Center Managing Editor Linda Van Zandt in interviewing Vietnamese-American fishermen: http://www.wlox.com/story/17625234/usm-historians-document-impact-of-2010-gulf-oil-spill.

April 29, 2012 WLOX broadcasts an interview on *Sunday Night Extra* with Louis Kyriakoudes on the Center's Deepwater Horizon Oil Disaster oral history project.

Media Productions: Excerpts from interviews collected as part of the research project were incorporated into the Center for Oral History and Cultural Heritage's weekly radio program, *Mississippi Moments.* These programs are broadcast statewide over Mississippi Public Radio twice a week and reach a total audience of 120,000. Additionally, the programs are podcasted via iTunes and http://www.mississippimoments.org. These podcasts connect the wider public with the stories of fisherfolk and their struggles in the wake of the Deepwater Horizon Oil Disaster.

NGI FILE #11-NGI-MOD-51

Project Title: Summer Internship for NGI Ecosystem Data Assembly Center

Project Lead (PI) name, affiliation, email address: Sharon Hodge, Mississippi State University, shodge@ngi.msstate.edu

Related NOAA strategic goals: Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Russ Beard, National Coastal Data Development Center

Project objectives and goals

Summer interns would be exposed to the broad range of ongoing research efforts within the NGI and the relationship of those efforts to the EDAC. Finally, during the internship, the student will gain knowledge of NOAA activities and the potential career paths NOAA can offer.

Description of research conducted during the reporting period and milestones accomplished and/or completed

This is an education project associated with the Ecosystem Data Assembly Center research project and other socioeconomic work ongoing at NOAA National Coastal Data Development Center.

Description of significant research results, protocols developed, and research transitions

Interns helped program and conduct quality control on existing OceanNOMADS functions of EDAC. In addition, the interns supported the timely dissemination of coastal resiliency tools during the early phases of the hurricane season.

Information on collaborators / partners:

a. Name of collaborating organization: NOAA NCDDC
b. Date collaborating established: Summer 2008
c. Does partner provide monetary support to project? Amount of support? Yes, $21,000
d. Does partner provide non-monetary (in-kind) support? Yes, mentoring
e. Short description of collaboration/partnership relationship. Staff at NCDDC meet with the interns several times a week to discuss tasks and progress.

Information on any outreach activities:

Stories about intern accomplishments were featured in the Stennis News, and the NGI PORTAL.

NGI FILE #11-NGI-MOD-52

Project Title: NGI Diversity Internship Program

Project Lead (PI) name, affiliation, email address: Tina Miller-Way, Dauphin Island Sea Lab, tmiler-way@disl.org

Related NOAA strategic goals: Ecosystems Mission Goal, Climate Mission Goal, Weather and Water Mission Goal, Technology and Mission Support Goal

NOAA sponsor and NOAA office of primary technical contact: Russ Beard, National Coastal Data Development Center

Project objectives and goals

The NOAA-NGI Diversity Internship Program supported 10 interns at 9 academic and federal locations across the Gulf coast in Summer 2012. Interns were from 2 demographic groups underrepresented in NOAA's workforce (African-American and Asian) and included undergraduate students, Master's and PhD candidates. Internship activities and focus areas were very diverse and ranged from offshore field work to computer based modeling to surveying people, and from fisheries to ecosystem valuation to river stage forecasting. A two-day orientation session at the beginning of the program provided interns with an introduction to NOAA, NGI, oral presentation skills, and the Gulf the Mexico as well as metadata training. An Internship Summit, held at the conclusion of the program, gave interns an opportunity to speak to NOAA and NGI staff and other federal agency personnel about career opportunities and to deliver a presentation about their research. Pre and post-program assessments were conducted and interns reported high levels of overall satisfaction with the program. Specific knowledge gain occurred in their fields of study as well as with research, presentation and data skills and Gulf of Mexico literacy. Current efforts are focused on maintaining connections with all interns and building the program through blogging, webpage listings, and support for interns attending professional meetings and outreach.

Description of research conducted during the reporting period and milestones accomplished and/or completed

The NGI Diversity Internship program supported 10 internships during the summer of 2012. Table 1 lists the names, educational level, home institutions, internship locations, internship mentors and internship focus area of this year's interns. A total of 35 applications were received for these 10 positions. Five of the 10 interns were undergraduate students, 4 were Master's candidates and one was working on a PhD. Half were female. Three interns were African-American; the rest were Asian. Interns were placed at 9 different locations across the Gulf ranging from Texas to Alabama. Internships included both academic institutions (DISL, MSU, Texas A&M, USM) and NOAA Line Offices (NWS, NMFS, NOAA Coast Survey). Focus areas were very diverse including fishery surveys, bathymetric surveying, ecosystem valuation, GIS, biogeochemistry, hydrology, toxicology and oyster reef restoration.

A two day orientation session was held at the Dauphin Island Sea Lab at the beginning of the summer internship period (May 31-June 1, 2012). During this time, the interns received training in data management and metadata by Ms. Kathy Martinolich of NCDDC. Mr. Fred Zeile of

NCDDC introduced the interns to NOAA as an organization and discussed the missions of NOAA's various line offices. Additionally, interns received training in oral presentation skills. Interns were also introduced to Gulf of Mexico coastal and nearshore marine habitats during the orientation program through field trips around Dauphin Island and a cruise aboard the Sea Lab's research vessel.

Each of the 10 Diversity interns as well as 2 EDAC interns based at Stennis participated in the Internship Summit held at Stennis Space Center in August 2012. At the Summit, each intern presented a summary of their internship experience and participated in both a NOAA Career Roundtable and an introduction to the non-NOAA agencies at Stennis Space Center. Electronic copies of these presentations have been submitted to the NGI Program Office.

One measure of program impact was quantified using pre-and post-program assessments and post-program evaluations. Gulf of Mexico literacy, organizational awareness, presentation, research and data skills were assessed. Satisfaction with the program, mentors, projects and orientation and Summit experiences were evaluated. Prior to the program, most interns had visited the NGI website, most reported feeling neutral when asked if they had an understanding of NGI's or NOAA's missions, themes or organization or when asked about their awareness of career opportunities at NOAA, and none had worked on a NOAA project. With respect to presentation, research and data skills, most interns felt comfortable with entry level skills (preparing a PowerPoint presentation, doing basic data analysis, research experience, finding credible scientific information), however, levels of comfort declined with increasing specificity (training in experimental design, writing a research paper, use of databases, awareness of, accessing and using metadata, professional meeting experience, comfort with graphing software). None of the 10 interns considered themselves knowledgeable about the Gulf of Mexico or followed information about the Gulf in the news, however, half indicated that they understood the importance of the Gulf to the nation. Post-program assessment and evaluation revealed specific program impacts. Notable changes were indicated in the understanding of NOAA and NGI missions, themes and organization; comfort level in use of presentation software; use of federal data; metadata awareness; knowledge of, recognition of the importance, and tracking of news of the Gulf of Mexico. Smaller changes were noted in intern comfort with experimental design, research papers, data analysis, visual depiction of data and with the use of metadata. On a scale of 1 to 5, nine of the ten interns rated the overall experience a 5, one rated it a 4. Intern projects were a mix of pre-planned and intern-directed. Almost all interns reported helpful mentors, team/lab members, and were pleased with the amount of guidance they received. Additionally, most interns (9/10) indicated that the internship experience affected their career plans. Statements such as "helped me decide if working in a lab is really what I want", "increased my motivation", "did not really know what I wanted to do before the experience. Now I have an idea", and "gave me an alternate view of civil engineering" attest to this impact.

The NOAA-NGI Diversity Internship Program provided partial support to two 2011 interns to attend and present at professional society meetings. Mr. Gabriel Roman Valentin, intern of Dr. Jairo Diaz-Ramirez of Mississippi State University, was invited to attend and present at the student technical paper competition of the 2011 Society of Hispanic Professional Engineers (Anaheim, CA; October 26-30). Additionally, he presented at the 2011 AGMUS Research

Symposium (San Juan, PR; September 17-18). Ms. Zhengzhen Zhou, mentored by Dr. Guo of the University of Southern Mississippi, presented a poster on her summer internship research results at the Deepwater Horizon Oil Spill One year Principal Investigator One Year Update Workshop (St Petersburg, FL; Oct 25-26). We continue to offer these opportunities to NOAA-NGI interns.

DISL has continued efforts to maintain connections to previous interns and to build and advertise this program. An existing database allows us to distribute job opportunities, calls for submissions to professional meetings that include student activities and other items of potential interest. The NOAA-NGI Diversity Internship Program is currently listed on the Pathways to Science website (http://www.pathwaystoscience.org/programhub.asp?sort=SUM-NorthernGulfInst-DiversityInternship), and was posted on both the Association for the Sciences of Limnology and Oceanography and Coastal and Estuarine Research Federation webpages during the recruitment phase. Additionally, we now have a NGI Diversity Intern blog (http://blogs.disl.org/ngi/) that served to keep interns connected during the 10 week period and will now serve as an additional communication mechanism. Lastly, efforts to build the program are beginning to result in action. The Deep-C GOMRI consortium has agreed to support at least 2 intern positions in Year 3 of their program.

Description of significant research results, protocols developed, and research transitions

Electronic copies of each of the 10 interns' presentations at the NOAA-NGI Internship Summit (which include pictures and other graphics) have been submitted to the NGI Program Office.

Information on collaborators / partners:

a. Name of collaborating organization: NOAA NESDIS, NCDDC
b. Date collaborating established: Jan 2010
c. Does partner provide monetary support to project? Amount of support? Yes,$40,000 (NESDIS) and $25,000 (NCDDC)
d. Does partner provide non-monetary (in-kind) support? No

Information on any outreach activities:

a. General Description
b. Hosted speakers, workshops and/or any training:
    i. Type (speaker, workshop, training): Training
    ii. Name of event: An introduction to metadata
    iii. Date: May 31, 2012
    iv. Location: Dauphin Island Sea Lab (AL)
    v. Description: An introduction to metadata –what is it, why do we have it, where is it and how do you access it
    vi. Approximate Number of Participants: 12

    i. Type (speaker, workshop, training): Speaker
    ii. Name of event: NOAA Career Roundtable
    iii. Date: Aug 6, 2012
    iv. Location: Stennis Space Center (MS)
    v. Description: A discussion of experiences, opportunities and career advice among NOAA personnel and interns
    vi. Approximate Number of Participants: 15

APPENDIX A. PUBLICATION DOCUMENTATION

All items listed are under award number NA06OAR4320264.

Table 4. Publication and presentations completed during the reporting period

Amend Number	Forum	Date	Vol	Pages	Citation
09-NGI-04	***Title: Spatial Variation and Temporal Trend of Water Quality in the Northern Gulf of Mexico***				
	Estuar. Coast. Shelf Sci.	2012	96	96-104	10.1016/j.ecss.2011.10.017
	Geochim. Cosmochim. Ac.	2012	87	283-298	10.1016/j.gca.2012.03.040
	Remote Sens. Env.	2013	128	259-267	10.1016/j.rse.2012.10.013
09-NGI-05	***Title: Sediment and Mercury Path and Fate Modeling***				
	American Geophysical Union Annual Fall Meeting	Dec 2011	-	-	-
09-NGI-06	***Title: Toward an Understanding of Gulf Coast Resident Preferences and Perceptions on Risk and Restoration***				
	Southern Economic Association Annual Conference	Nov 2011	-	-	-
	J. Agr. Resour. Econ.	2012	37	289-300	
	Resour. Energy Econ.	2011	33	515-526	10.1016/j.reseneeco.2010.10.001
	Nat. Hazards Rev.	2011	12	117-124	10.1061/(ASCE)NH.1527-6996.0000038
09-NGI-07	***Title: Food Webs Without Borders: A Case for Ecosystem-Based Management in the Northern Gulf of Mexico***				
	Benthic Ecology Meeting	Mar 2012	-	-	-
	Northern Gulf Institute Annual Conference	May 2012	-	-	-
09-NGI-08	***Title: Understanding Coastal Resiliency from Hurricane Impacts Using Integrated Modeling and Observations***				
	Geophys. Res. Lett.	2011	38	7 pp.	10.1029/2011GL049145
	Nat. Hazards	2012	61	1029-1050	10.1007/s11069-011-9960-z
	J. Eng. Mech.	2012	138	221-229	10.1061/(ASCE)EM.1943-7889.0000318
	Northern Gulf Institute Annual Conference	May 2012	-	-	-
	American Meteorological Society Annual Meeting	Jan 2012	-	-	-
	Center for the Study of Natural Hazards and Disasters Department of Homeland Security Center of Excellence – Natural Disasters, Coastal Infrastructure and Emergency Management Annual Meeting	Jan 2012	-	-	-
	State of the Coast Conference	Jun 2012	-	-	-

Amend Number	Forum	Date	Vol	Pages	Citation
09-NGI-08 cont.	Hurricanes and Tropical Meteorology Conference	Apr 2012	-	-	-
	DWH Oil Spill Principal Investigator's One Year Update Workshop	Oct 2011	-	-	-
09-NGI-10	***Title: Climate-Related Ichthyofaunal Shifts in the Northern Gulf of Mexico: Implications for Estuarine Ecology and Near Shore Fisheries***				
	Benthic Ecology Meeting	Mar 2012	-	-	-
	Biennial Conference of the Coastal and Estuarine Research Federation	Nov 2011	-	-	-
09-NGI-11	***Title: Identifying Linkages between Zooplankton Dynamics, Fishery Resources and Climate Change in the Northern Gulf of Mexico***				
	Northern Gulf Institute Annual Conference	May 2012	-	-	-
09-NGI-13	***Title: Monitoring and Assessment of Coastal and Marine Ecosystems in the Northern Gulf***				
	Mississippi Nutrient/Hypoxia Summit	Nov 2011	-	-	-
09-NGI-14	***Title: Assessment of Ecosystem Services of Selected Coastal Habitat Types: Towards a Model-Based Toolset for Management Planning***				
	Northern Gulf Institute Annual Conference	May 2012	-	-	-
	Gulf Caribb. Res.	Mar 2012	24	51-62	-
09-NGI-19	***Title: Integrated Research for the Northeast Gulf of Mexico Big Bend Region***				
	American Fisheries Society Annual Meeting	Sep 2011	-	-	-
	Biennial Conference of the Coastal and Estuarine Research Federation	Nov 2011	-	-	-
	American Geophysical Union Fall Meeting	Dec 2011	-	-	-
	FL Chapter of the American Fisheries Society Annual Meeting	Feb 2012	-	-	
	Northern Gulf Institute Annual Conference	May 2012	-	-	-
	Ocean Sciences Meeting	Feb 2012	-	-	-
	International Ocean Vector Winds Science Team Meeting	Jun 2012	-	-	-
	Mar. Biol.	Feb 2012	159	365-372	10.1007/s00227-011-1814-4
	Estuar. Coast. Shelf Sci.	2012	98	1-15	10.1016/j.ecss.2011.10.024
	SouthEast Acoustics Consortium Workshop and Forum	Mar 2012	-	-	-

Amend Number	Forum	Date	Vol	Pages	Citation
09-NGI-19 Cont.	Sci. Total Environ.	2012	425	223-230	10.1016/j.scitotenv.2012.02.030
	Cont. Shelf Res.	2012	45	116-125	10.1016/j.csr.2012.06.010
10-NGI MOD-34	***Title: Advanced Data Assimilation Experiments for GOES-R Series Applications***				
	Mon. Wea. Rev.	2012	-	-	10.1175/MWR-D-12-00079.1
10-NGI MOD-39	***Title: Development and Demonstration of a Single-Point-of-Access to Satellite Wind and Wave Products***				
	International Ocean Vector Winds Science Team Meeting	Jun 2012	-	-	-
10-NGI MOD-40	***Title: Inundation Mapping Strategies Workshop and Support***				
	Southeast Division of the Association of American Geographers	Nov 2012	-	-	-
10-NGI MOD-41	***Title: Developments of Global Bias Monitoring System***				
	J. Geophy. Res.	Mar 2012	117	D06219	10.1029/2011JD016452
	IEEE Trans. Geosci. Remote Sens.	Dec 2012	50	4875-4884	10.1109/TGRS.2012.2196438
	IEEE Trans. Geosci. Remote Sens.	Dec 2012	50	4994-5003	10.1109/TGRS.2012.2191792
	IEEE Trans. Geosci. Remote Sens.	Dec 2012	50	4892-4902	10.1109/TGRS.2012.2202122
10-NGI MOD-43	***Title: Developments of Advanced Satellite Microwave Products***				
	J. Ocean Atmos. Tech.	Mar 2012	29	417-432	10.1175/JTECH-D-11-00108.1
	Clim. Dyn.	Feb 2012	-	18 pp.	10.1007/s00382-012-1296-1
	Antarct. Sci.	Mar 2012	-	8 pp.	10.1017/S0954102012000417
	IEEE Trans. Geosci. Remote Sens.	Dec 2012	50	4986-4993	10.1109/TGRS.2012.2197003
10-NGI MOD-44	***Title: Time-Series and Underway Assessments of Ocean Acid CO_2***				
	Northern Gulf Institute Annual Conference	May 2012	-	-	-
11-NGI MOD-50	***Title: Social Impact and Resiliency in the Wake of Deepwater Horizon Industrial-Environmental Disaster: Development of Well-Being Indicators and collection of Oral Histories: Component Two – Oral Histories***				
	Oral History Association Annual Meeting	Oct 2011	-	-	-

Table 5. Summary of publications and presentations reported in Table 4

	Institute Lead Author	NOAA Lead Author	Other Lead Author
*Peer-reviewed ()**	14	-	9
*Non peer-reviewed ()**	26	4	16

*Numbers are not directly additive from Table 4 because in some instances a single record for a conference represents multiple presentations

APPENDIX B. EMPLOYEE SUPPORT

Northern Gulf Institute Employee Support - July 1, 2011 - September 30, 2012

Personnel (DISL, FSU, LSU, MSU, USM combined)

Category	Number	B.S.	M.S.	Ph.D.
>= 50% Support				
Research Scientist	17	0	2	15
Visiting Scientist	1	0	0	1
Postdoctoral Fellow	4	0	0	4
Research Support Staff	62	38	23	1
Administrative	0	0	0	0
Total (>= 50% support)	**84**	**38**	**25**	**21**
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Employees w/ <50% support	66	14	13	38
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Undergraduate Students	11	11	0	0
Graduate Students	98	36	44	18
Category	**Number**	**B.S.**	**M.S.**	**Ph.D.**
Employees/students that receive 100% of their funding from an OAR lab	0	0	0	0
Obtained NOAA employment within the last year	3	0	3	0

APPENDIX C. OTHER AGENCY AWARDS

PI Name	Project Title	Lead NOAA Collaborator	Awarding Agency	Funding Amount
Hodge, Sharon Hatch	Instruction on International Maritime Law to our International Hydrographic Management and Engineering Program (Cat B)	N/A	U.S. Dept of Navy	$1,500.00
Mishra, Deepak R.	Comprehensive Study of the Impact of the Deepwater Horizon Oil Spill on the Health and Productivity of Gulf Coast Salt Marshes	N/A	BP America	$80,876.00
Moorhead, Robert J.	Modeling and Ocean Color Remote Sensing in Oceanic and Coastal Waters	N/A	Naval Research Laboratory	$25,000.00
Moorhead, Robert J.	Modeling and Ocean Color Remote Sensing in Oceanic and Coastal Waters	N/A	Naval Research Laboratory	$45,000.00
Moorhead, Robert J.	Modeling and Ocean Color Remote Sensing in Oceanic and Coastal Waters	N/A	Naval Research Laboratory	$46,000.00
Moorhead, Robert J.	Physics-based Ocean-Color Algorithms for Water-Quality Products of Coastal and Inland Waters	N/A	NASA HQ	$68,954.00
Moorhead, Robert J.	Modeling and Ocean Color Remote Sensing in Oceanic and Coastal Waters	N/A	Naval Research Laboratory	$143,400.00
			Total	**$410,730.00**