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Promoting Climate Change Awareness and Adaptive Planning in Atlantic Fisheries Communities using Dialogue-based Participatory Vulnerability Analysis, Mapping, and Collaborative Systems Dynamic Modeling

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COASTAL AND OCEANS CLIMATE ADAPTATIONS

PROJECT TITLE:

Promoting climate change awareness and adaptive planning in Atlantic fisheries communities using dialogue-based participatory vulnerability analysis, mapping, and collaborative systems dynamic modeling

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PROJECT YEARS:

8/1/2012 – 7/31/2015

TIME PERIOD ADDRESSED BY REPORT:

May 2014 – May 2015

I. PRELIMINARY MATERIALS

(Information in this section is standard and may be copied from previous reports)

A. Research project objective and the stakeholders and decision makers you are working with. *(Limit to one paragraphs)*

The goals for the proposed project are twofold:

- *First, the project will improve understandings of how a changing climate will affect fishing communities' abilities to maintain marine fisheries and the local economies historically dependent upon them.*
- *Second, the project will investigate the role of a structured dialogue and participatory modeling process to support decision makers in fishing communities addressing consequences, vulnerabilities, and adaptive strategies in a context of climate stressors.*

We are working with stakeholders and decision makers in three communities: South Thomaston ME, Wellfleet MA, and Beaufort SC. Decision makers include town or county officials (elected and appointed), municipal staff, fishermen, representatives of other related industry, environmental groups, and other community stakeholders as well as individual citizens. In each community our objectives are to:

1. *Apply the VCAPS + SD process in communities currently engaging with coastal management planning and climate change risks,*
2. *Demonstrate the feasibility and usefulness of the extended VCAPS + SD process as a planning and decision-making tool for communities that seek to support the marine fishing in a period of climatic change,*
3. *Assess the factors that contribute to individual and group learning through the use of decision support tools and dialogue-based participatory processes for hazard and vulnerability assessment.*

B. Approach including methodological framework, models used, theory developed and tested, project monitoring and evaluation criteria. Include a description of the key beneficiaries of the anticipated findings of this project (e.g., decision makers in a particular sector/level of government, researchers, private sector, science and resource management agencies). *(Limit to one page)*

To realize these goals, we will develop and demonstrate our structured dialogue and participatory modeling process that our past research has proven promising. It provides an efficient approach to develop and organize decision-relevant information. It begins with participants diagramming the fundamental cause-effect relationships in the system. This process

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uses a causal model of hazard events. We have adapted this general concept by adding sensitivity and adaptive actions to the diagram, essentially integrating vulnerability knowledge into the causal model of hazard events. We use this to elaborate scenarios that focus attention on relationships between critical variables, consider potential management interventions to influence cause-effect relationships (both positive and negative), and link to key consequences. We call this the Vulnerability and Consequence Adaptation Scenarios (VCAPS) process. We will then link the causal diagrams to visual data (databases and maps) and systems dynamic (SD) models. The SD models are also made with the involvement of the local decision makers and stakeholders. These explore specific elements of the system in greater detail. They can be qualitative or quantitative models, depending on the needs of the local decision makers, the availability of data, and the maturity of the science.

Effective decisions about marine fishing industries and infrastructure can be supported by the generation of realistic risk and adaptation scenarios and models that convey usable knowledge for decision-making and produce justifications that the community finds acceptable. For the purposes of building awareness and supporting adaptive planning, highly detailed models are not always necessary. Models are sufficient if they allow decision-makers to explore the implications of alternative actions. In fact, decision makers often fail to use models created by scientists, but they are more likely to use scenarios and models that were collaboratively developed by intended users. Such participation leads people to see the results as more credible. Models created in a participatory manner are also more likely to produce relevant and usable knowledge. They may also improve accuracy and comprehensiveness of information. Learning-based dialogue and deliberation in facilitated venues is productive and highly satisfying for participants. Finally, the ability of decision makers to use the results to justify actions depends on the participation and buy-in from local community. (We interpret “community” to be a set of individuals, groups and institutions that are connected by their common identities, practices, or location. A community is not necessarily a geographically defined municipality, but it might be.)

VCAPS’s bottom-up approach can help fisheries communities build decision-relevant and community-specific scenarios and models of exposure pathways and consequences to identify complex vulnerabilities associated with climate change. The involvement of scientists and decision makers will ensure that scenarios and models reflect the best available knowledge and accurately reflect uncertainties.

We will implement our process (VCAPS + SD process) in three Atlantic fishing communities, one in each of the following states: South Carolina, Massachusetts, and Maine.

C. Description of any **matching funds/activities** used in this project.

- i. *There are no matching funds, however, two graduate students from Clark University volunteered their time and participated in our Maine case study. They traveled to Maine and they have participated in several meetings. One developed GIS materials. The other participated in gathering data and background literature for modeling activities.*
- ii. *Participants from the community of South Thomaston, Maine, Wellfleet, Mass., and Beaufort SC donated their time by attending workshops.*
- iii. *Professor Robert Steneck of Maine donated 2 hours of time to deliver a lecture on climate change and fisheries at our first workshop in Maine. At*

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our second workshop he participated for 3 hours, answering questions and participating in the discussion.

- iv. *Dr. Carl Wilson donated two half-days of time by attending our community modeling workshops in Maine*
- v. *Professor Michael Childress of Clemson University donated 4 hours of time at the first meeting and 4 hours at the second meeting, providing his expertise on the ecology of Blue Crabs.*
- vi. *Diane Murphy of Cape Cod Cooperative Extension & Woods Hole Sea Grant attended three meetings, 4 hours each, in Wellfleet to participate in the VCAPS process and provide expertise in shellfish biology and vulnerability to climate change.*
- vii. *Greg Berman, Coastal Processes Specialist, Woods Hole Sea Grant and Cape Cod Cooperative Extension, attended one 2.5 hour meeting in Wellfleet to give a presentation about sea level rise impacts on shellfish aquaculture and Wellfleet Harbor. He also created 10 GIS maps with information about vehicle access to grants, location of grants, and sea level rise estimates.*
- viii. *Professor Roxanna Smolowitz of Roger Williams University donated a day of her time to drive to Wellfleet and participate in a 4 hour meeting about the impacts of warming seawater on diseases that affect clams.*
- ix. *Doctor Mark Borrelli, researcher at the Provincetown Center for Coastal Study contributed 4 hours and made a leading presentation on Sea Level Rise in the Cape Cod Bay.*
- x. *Graduate Student Sam Belknap, who is supported with a NSF IGERT Fellowship, has become involved with our project. He has attended meetings and taken on some responsibility for liaising with lobstermen. He has helped to gather and organize data used to make the system dynamics model. He is analyzing the interviews for South Thomaston and has plans to replicate some of the methods in another midcoast fishing community summer 2014*
- xi. *Julie Davis's time on this grant was covered by NOAA Sea Grant Omnibus funding. The funding we originally requested for her was, with the permission of the NOAA CPO, used to support additional research travel by the South Carolina team.*
- xii. *Shellfishermen in Duxbury MA donated time. They were interviewed as part of the case study in Wellfleet to provide information about the impacts of shellfish bed closures on the industry and community.*

D. Partners you are working with on this. Please make sure to include NOAA, other federal agencies, academia, nongovernmental organizations, private sector, etc.

- i. *We have an Advisory Committee of the following people:*
 1. Joe Costa, Executive Director, Buzzards Bay National Estuary Program, Mass. Coastal Zone Management.
 2. Kirstin Dow, Associate Professor, Department of Geography, University of South Carolina.
 3. Troy Hartley, Director, Virginia Sea Grant.
 4. Patricia Pinto da Silva, Social Sciences Branch, NOAA Fisheries – Northeast Fisheries Science Center.
 5. Michael Johnson, National Marine Fisheries Service, Northeast

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- Regional Office, Habitat Conservation Division. Gloucester.
6. David Whitaker, from SC DNR Marine Resources Division. Charleston.
- ii. *We have had repeated involvement by:*
1. Professor Robert Steneck, University of Maine
 2. Professor Robert Goble, Clark University and two of his graduate students.
 3. Dr. Carl Wilson, Lobster Biologist, State of Maine
 4. Professor Michael Childress, Clemson University
 5. Dr. Mark Borrelli, Provincetown Center for Coastal Studies
 6. Diane Murphy, Fisheries and Aquaculture Specialist, Cape Cod Co-operative Extension and Woods Hole Sea Grant
 7. Greg Berman, Coastal Processes Specialist, Woods Hole Sea Grant and Cape Cod Cooperative Extension
 8. Florencia Sangermano, GIS Specialist, Clark Labs
 9. Professor Khalid Saeed, System Dynamics expert, Professor of System Dynamics at Worcester Polytechnic Institute
 10. Jim Thompson, systems dynamics consultant
 11. Peerapas Thongsawas, MS Student of System Dynamics at Worcester Polytechnic Institute
 12. John Brawley, Shellfish and Aquaculture Specialist at Wellfleet Shellfish Promotion and Tasting
- iii. *We are involving community members and groups in our meetings:*
1. Local chapter of the Sierra Club, Midcoast Maine
 2. Maine Lobsterman's Association
 3. Gulf of Maine Foundation
 4. Massachusetts Audubon Society
 5. Massachusetts Aquaculture Association
 6. Woods Hole Sea Grant
 7. Cape Cod Co-operative Extension
 8. Town of Wellfleet Boards and Committees: Shellfish Advisory Board, Board of Health, Conservation Commission, Comprehensive Wastewater Management Committee

II. ACCOMPLISHMENTS

(This information should be updated annually)

- A. Brief discussion of **project timeline and tasks accomplished**. Include a discussion of data collected, models developed or augmented, fieldwork undertaken, or analysis and/or evaluation undertaken, summary of findings, workshops held, stakeholder/user collaborations, training or other capacity building activities implemented. Where appropriate, describe the climate information products and forecasts considered in your project (both NOAA and non-NOAA) and identify any specific feedback on the NOAA products that might be helpful for improvement. If possible, please include a relevant high-resolution graphic or figure and if we have permission to use the images provided. *(This can be submitted in bullet form – limit to two pages)*

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OVERVIEW OF TASKS ACCOMPLISHED

- Due to changes in personnel in New Bedford City government, we had to abandon plans to work in New Bedford.
- We made connections with the Town of Wellfleet and began our Massachusetts case study there in summer 2013
- Due to extreme interest in Maine, we decided to run the Maine case study first.
- We held meetings with our advisory panel via telephone conference.

MAINE CASE STUDY

- We conducted the two VCAPS meetings with lobstermen (about 7) and community members (5). There was representation from Fire Department, Health Code Enforcement, Select board, Construction industry, local environmental activism. It was a good-sized group with good breadth. All these people (total 23) were interviewed before the meeting to collect input on their perceptions of climate change impacts.
- Professor Robert Steneck of University of Maine made a presentation to the group about the impacts of climate change on the lobster fishery. He covered OA and warming temperatures. His talk was 1 hour long, much longer than we planned, but the audience was very enthusiastic about it and said they learned a lot.
- Carl Wilson from Maine Department of Fisheries made a presentation and discussed the state of the lobster fishery in Maine.
- We constructed VCAPS diagrams of impact from climate change to the community and to the lobster fishery. We linked these two diagrammatic models together. We focused at the end on identifying places where more clarity or knowledge would support their decision-making. We revised the diagrams and wrote the narratives, gave these back to the participants for comment, used their comments to revised and make final versions of the narratives, produced a report and distributed it to the community.
- We held system dynamics collaborative modeling workshops with these same individuals who participated in the VCAPS meetings. Two workshops with the group were held and one meeting with two key individuals was held. The group collectively decided that SD model would be most helpful to them if it clarified the connections between water temperature, the number and timing of shedders, and the marketing considerations. We constructed a model and calibrated it with data from our participants.
- Following four unsuccessful attempts to conduct our final meeting and interviews with the South Thomaston, ME community due to snowstorms, we held this meeting on Sunday, April 26th. The purpose of the meeting was to revisit the elements of the process over the two years of working together, to present the SD Model for discussing how the model can be used in the future based on the lobstermen's knowledge and experience through our project, and to determine next steps. We were able to conduct five post interviews following the meeting.

MASSACHUSETTS CASE STUDY

- Made poster presentation at Wellfleet State of the Harbor conference to educate the community about our project and to recruit growers and dealers.
- Established a Working Group on Climate Change Impacts on Shellfishing in Wellfleet Harbor which will liaison with us and the community and be the focus and direction of

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our effort. The group has membership from a number of town committees as well as a prominent oyster researcher from Woods Hole Sea Grant, other national and local NGOs, as well as several oyster and quahog growers and dealers.

- Held three VCAPS workshops on risks of Sea Level Rise and ocean warming on oysters. Guest expert presentations were provided by Mark Borrelli, Diane Murphy, and Roxanna Smolowicz.
- Attended public meeting on Massachusetts vibrio control plan (January 13, 2014)
- Arranged conference call between MA DPH and Wellfleet Working Group members so that they could give feedback to DPH before going to Interstate Shellfish Control Committee annual meeting.
- Developed a questionnaire for gathering input on management action priorities, using potential strategies identified during VCAPS meetings. Questionnaire distributed to all participants in the Working Group. Results to provide input for further discussions and preparation of report.
- Conducted interviews with oyster growers and wholesalers in Wellfleet about potential impacts of closures due to vibrio events, as part of development of systems dynamics model.
- Major accomplishments included: completion of report reviewing climate change impacts on shellfish, completion of draft report on impacts of sea level rise on shellfish aquaculture in Wellfleet Harbor, creation of GIS maps highlighting potential impacts of sea level rise and coastal erosion on access to commercial shellfish beds, and a list of adaptation strategies to address climate-related risks.
- During most of 2014 and continuing into early 2015 we developed a systems dynamics model of economic impacts of vibrio-related closures on individual aquaculture growers in Wellfleet Harbor. These meetings involved many of the same participants who took part in the VCAPS workshops.
- This effort was abandoned in early 2015 for two reasons: a) the desire for the model waned because threats of long-term vibrio related closures by the state were eliminated by implementation of new vibrio management rules in spring of 2014 (until then closures could be up to 6 weeks or more, with no clear decision rules for reopening the beds), and b) complexity of the model.
- Beginning in the winter of 2015 we began development of a new systems dynamics model to explore community-wide and statewide economic impact scenarios related to oyster and quahog closures due to various causes (vibrio, red tide). The impetus of the model is interest of shellfishermen to show the important economic contribution of the shellfishing sector in Wellfleet, Cape Cod, and Massachusetts. The model was calibrated using data from growers involved in our group.
- This model was completed over the winter 2014-2015 and was presented back to the working group. The group had very strong positive reactions to the value of the model and is seeking additional funding to continue to work with us.

SOUTH CAROLINA CASE STUDY

- Held two VCAPS workshops in August and September 2013 with crabbers. Meetings included participation by one of the members of our advisory committee and Professor Michael Childress of Clemson University.

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- The VCAPS narratives were drafted into a report and that was shared with our participants before we finalized the report and distributed it.
- We held a workshop on system dynamics modeling with some of the same participants of the VCAPS meetings. What emerged from this meeting was a clearer understanding of what ecologists who study blue crab need to know so that a system dynamics model that will be relevant to crabbers and policy makers can be built. It was clear that there is not enough understanding of the blue crab lifecycle.
- Consequently, we established a group – Crabbers Who Care – which has the goal of gathering in situ ecological data about crabs. We facilitated an exchange between crabbers and Michael Childress, a leading ecological researcher on the blue crab. Together, the group reach consensus for a data gathering initiative. Crabbers agreed to randomly sample pots for temperature, salinity, sex, age, and number of crabs. We estimate it will take several years of data collection before a system dynamics model can be constructed.
- South Carolina Sea Grant agreed to continue to support the Crabbers Who Care network after the completion of this project.
- Unused resources in South Carolina were deployed to improve the system dynamics models and to hold additional meetings with fishermen in Maine and Massachusetts.

Outreach and Presentations

Belknap, S. 2014. The VCAPS process and SD model for South Thomaston. *The Island Institute*, Rockland ME.

Belknap, S. 2014. The VCAPS process and SD model for South Thomaston. *2014 Predictive Capabilities workshop at the Island Institute*, December, Rockland, ME.

Belknap, S. 2015. The VCAPS process and SD model were part of the Anthropology 102: Introduction to Cultural Anthropology curriculum at the University of Maine in Orono for the spring of 2015. The process and SD model were used as examples of: applied anthropology, utilizing local ecological knowledge, and participatory research.

Davis, J. 2015. Using participatory modelling to help seafood producers on the US East Coast identify ways to adapt to a changing climate. *National Shellfisheries Association Annual Meeting*. Monterey, CA March 23-26, 2015.

Liz Fly, L. 2015 Using participatory modeling and citizen science to help fishermen on the US East Coast identify ways to adapt to a changing climate. *RISA Annual Meeting*, Charleston, SC, Jan 13-15, 2015.

Fly, L. 2015. Using Participatory Modeling and Citizen Science to Help Fishermen Adapt to a Changing Climate. *21st International Symposium on Society and Resource Management*. Charleston SC, June 13-18, 2015.

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Pignatelli, T. 2013. Planning for Coastal Change: A participatory approach to climate change adaptation planning. Poster presentation at the American Planning Association Annual Meeting. Chicago. February 2013, public/profession presentation, 30 attendees, 2013-02-20

Stancioff E. 2013. The 2012 Gulf of Maine heatwave: anomalous year or the new normal? Poster Presentation at *RARGOM Science Conference: Planning for a Changing Climate: A Participatory Approach to Fishing Community Adaptation* Portsmouth, NH. October 8, 2013.

Stancioff E. 2013. Climate Adaptation in Maine's Marine Waters. *Maine Food Summit*. Wells Conference Center. Orono, ME, December 8, 2013.

Stancioff E. 2014. Planning for a Changing Climate: A Participatory Approach to Fishing Community Adaptation. Poster Presentation at *Maine Sea Grant Science Symposium: Working Toward Resilience: Maine Sea Grant Research Biennial Symposium*. Buchanan Alumni Hall, University of Maine. April 3, 2014.

Stancioff, E. 2014. Monitoring Change At Your Scale of Interest. *Climate Adaptation and Sustainability (CLAS) Planning for Maine Communities Conference*. Portland, ME. October 2014.

Stancioff E. 2014. How are things changing in Maine? *ENCOrps Summit Annual Forum*. Phippsburg, ME. May 21, 2014.

Stancioff, E. 2014: Planning for a Changing Climate: A Participatory Approach to Fishing Community Adaptation. Paper presentation at the Social Coast Forum. Charleston SC. 18-20 February.

Stancioff, E. 2015. Promoting climate change awareness and adaptive planning in Atlantic fisheries communities using dialogue-based participatory vulnerability analysis, mapping, and collaborative systems dynamic modeling. *National Adaptation Forum*. St Louis. May 2015.

Tuler, S., Whitehead, J. and Stancioff, E. 2015 Challenges and Opportunities for Climate Adaptation in Marine Fisheries: Reflections on the Use of Tools and Processes to Facilitate Planning. *National Adaptation Forum*. St Louis. May 2015.

Webler, T. 2012. Promoting climate change awareness and adaptive planning in communities through mediated modeling. *UMass, Amherst, MA. Water Governance Lecture Series*. 14 September 2012.

Webler T. 2013. Combining hazard management with deliberative learning to empower resilient communities. *iNTeg Risk Annual Meeting*. Stuttgart. May 21-13, 2013.

Webler, T. 2013. Progress in new tools for participatory vulnerability analysis to climate stressors. *American Association for the Advancement of Science*. Boston, February 14-18, 2013.

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Whitehead, J. and Stancioff, E. 2015. Engaging Coastal Communities: Success and Lessons Learned from Sea Grant Climate Extension. *National Adaptation Forum*. St Louis. May 2015.

- B.** Brief discussion on the **application of your findings to inform decision making** and any highlights of communicating or translating science to decision makers (e.g. media events, presentations, briefings, representation on or input to decision making bodies, etc.). (*Limit to two 2 pages*)

South Thomaston, ME

Lobstermen in Zone D (South Thomaston and Spruce Head) are all decision makers. They run their own businesses and need to make decisions about their industry and everyday decisions based on conditions. The six meetings we held over the period of two years were consistent in translating the science and discussing changing conditions, looking at a variety of scenarios in order to make wise management decisions. They were able to consider the extreme warming event of 2012 and determine that they had options based on the use of the system dynamics model as a tool.

The lobster industry in Maine is co-managed by zone councils and the Maine Department of Marine Resources. We had two leaders in the lobster industry in South Thomaston, both the president of the Maine Lobster Association and a board member, who are very influential within the zone councils and continued to discuss this tool with others and assisted us in the development of grant proposals to develop the model further for providing a forum for policy discussions with industry leaders and resource managers. We also had the ME Department of Marine Resources lobster biologist engaged in our project and we continued to present the model to him as it progressed.

Many of the presentations listed had decision makers in the audience and connections were made with interest in learning more about how to engage a broader audience of fishermen.

Our project was also selected by NOAA to create an educational video both filmed interviews at the National Adaptation Forum and in Maine at the Spruce Head Co-op and on a project participant's lobster boat. We will use this as a tool to show how our system dynamics model can assist in policy discussions and create flexibility in the industry, crucial to adapt to our changing climate.

Wellfleet MA

In Wellfleet, MA, the Working Group we established met until the spring of 2015. As part of their efforts they developed lists of potential adaptation strategies that can be studied, implemented, or recommended by different boards and committees in Town. Their intention is to inform town decision makers about the threats pending the shellfishing industry and to recommend town actions.

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The Working Group decided they did not want to continue to meet as a stand-alone group. Rather, they wanted to continue their efforts to promote climate adaptation planning within existing boards and committees in the Town. Many of the participants serve on Town boards and committees, including the Shellfish Advisory Board, Wastewater Planning Committee, Conservation Commission, and Board of Health.

With additional support from MIT-Sea Grant and our continued assistance, our group of shellfishers is developing a website that will highlight all the materials developed as part of the project and other resources to help inform town-wide short and long term planning that impacts shellfish and the shellfishery of Wellfleet Harbor. This website will be linked to the Town of Wellfleet website and is intended to be a resource for elected officials, town staff, and volunteer board and committee members.

In conjunction with the activities of the Working Group a systems dynamics model was developed to illustrate potential economic impacts of closures to shellfish beds in Wellfleet Harbor. Closures can occur because of vibrio events and red tides. The model was developed using in-kind support by Jim Thompson, an expert systems dynamics modeler and Alex Hays, one of the larger wholesalers of oysters on the Cape (located in Wellfleet). The intent of the systems dynamics model is to help local and state officials, commercial shellfishers, and wholesalers better understand the potential impacts of policy responses to vibrio and other public health threats involving shellfish.

Our group of participants asked us to arrange a conference call between them and the Massachusetts State Department of Public Health to discuss the state's proposed Vibrio guidelines. An hour-long discussion between the key state officials who were involved in Vibrio planning and three of the core participants of our group, as well as Seth Tuler took place. The results were reported back to the entire group at the next meeting.

Our project will be featured in a presentation at the community-wide State of Wellfleet Harbor conference in November 2015. This is a meeting that attracts a large number of citizens from the community. Tuler will be attending this meeting using travel funds from another source.

South Carolina

The main outcome of the work in South Carolina was the development of the Crabbers Who Care Research Network (CWCRN). This citizen science effort is a direct outcome of the crabbers' and managers' stated needs during the VCAPS meetings for more information to improve the scientific understanding of drought impacts on blue crab *catch* (not just stock), necessary for them to understand which adaptations would be most appropriate and cost efficient. The CWCRN is a group of fishermen helping to collect data on blue crab populations in South Carolina by voluntarily taking salinity measurements at the time pots are hauled and crabs counted. The data collected help to inform crabbers, scientists, and resource managers who are working to understand the future of blue crabs. While the network is still in its infancy, the long-term goal is that data collected by the fishermen will power a business management forecasting tool that takes into account environmental, fishery, and economic data. Once

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populated with data, this tool will help crabbers and resource managers adapt to annual climate-related variability and strengthen the sustainable management of the fishery.

A member of the CWCRN was recently interviewed and filmed by a group from the National Integrated Drought Information System (NIDIS), to highlight issues of coastal drought. This video, which should be featured on NIDIS' website, will bring more attention to the CWCRN and the potential partnerships between decision makers and fishermen.

C. Brief discussion of the **planned methods to transfer** the information and lessons learned from this project. *(Limit one paragraph)*

Our plans are to continue to do what we have done in the past years, as opportunities arise. We will continue to conduct training workshops with Sea Grant on other personnel interested in working with communities on climate change adaptation planning.

There is interest in expanding the blue crab work and the citizen-science research network to North Carolina, where drought conditions impacts fisheries in that state similarly to in South Carolina. There is also interest in expanding the sampling to areas outside of Beaufort SC following successful piloting in Beaufort.

D. Discussion of any **significant deviations from proposed workplan** (e.g., shift in priorities following consultation with program manager, delayed fieldwork due to late arrival of funds, obstacles encountered during the course of the project that have impacted outcome delivery). *(Limit to one paragraph)*

There have been four major shifts. In Maine and Massachusetts we have **expanded** our work beyond the original proposal, in response to local demand. In Maine, we brought in Sam Belknap, doctoral student at the University of Maine and graduate students Anne Baker and Yue Sun from Clark University. These students have become interested in the project and decided to do applied work for the benefit of the project. Anne Baker used GIS to prepare two booklets that summarized climate impacts for the ocean system in mid coast Maine. Sam Belknap is meeting with lobstermen and interested in possibly applying our method to another lobster community. This work went beyond our proposed workplan and have been positively received by the community in Maine.

In Massachusetts, we **held additional VCAPS workshops** on impacts to oysters and clams. We also became engaged with policymaking about the state's new vibrio control plan. Our group members wanted to engage the Department of Public Health and we arranged for a conference call between the DPH senior policy advisor on vibrio and our group members. Our group has also expressed an interest in prioritizing management actions identified during the VCAPS workshops and we have arranged an on-line tool to allow them to do that. The group will issue a report to the community. Because our group members are well-connected, their report will be seen by the Selectboard and other key town committees.

In South Carolina, blue crab fishermen had difficulty visualizing how system dynamic modeling could be useful in helping them better understand the fishery system in which they work. In

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consultations with Professor Michael Childress of Clemson, we learned that a lack of basic data is a limiting factor in having a sufficient understanding of blue crab ecology, which is needed for system dynamics to be effective. In response to this identified need, we worked with our cohort of blue crab fishermen to **develop a data gathering program**. Fishermen will collect data from a string of five crab pots per week, recording their location within a predetermined grid. Data collected will include: number of males and females, number of egg-bearing females, number of peelers, and other relevant data. Fishermen will also record water temperature and salinity in the vicinity of their sampled pots. The data will be organized by SC Sea Grant and provided to Professor Childress and the SC Department of Marine Fisheries. We have asked for a one year extension in our project, but there is no guarantee that enough data will be collected to allow us to do sufficient SD modeling. Prof. Childress estimates that five years of data collection will be needed before sufficient data are available for him to analyze and begin to assemble testable hypotheses about blue crab ecology. We have planned to make one final presentation to our group of blue crab fishermen and the public community in Beaufort about the use of system dynamics in other locations (Maine and Massachusetts) with discussion about its potential to help in Beaufort.

Fourth, we have requested a one year no-cost extension. This was necessary for the Wellfleet group because fishing season is long and there are few opportunities for the growers to meet. It was also necessary for the Maine project, because it is almost impossible to schedule a meeting between May-October and we had several meetings cancelled in winter due to snow storms. The extension allowed us to complete our meetings with both groups. The extended time also enabled us to put more work into the system dynamics models, and allowed for further interaction with individual fishers when we were calibrating the models with local data. The extension also permitted us more time to continue to do trainings with key personnel as opportunities arose, to make additional presentations about the project, and to write additional products for practitioner and scholarly audiences.

E. List of completed publications, white papers, or reports (with internet links if possible). These can be either non-peer reviewed or peer-reviewed. For peer-review publications, please list either **published** or in **press**, but **not** “in review”. (*No text limit*)

Alicia Albee featured the VCAPS process tool on NOAA’s Climate Resilience Toolkit <http://seagrant.noaa.gov/WhatWeDo/ResilienceToolkit/BrowseToolkit/TabId/618/ArtMID/5569/ArticleID/428/Vulnerability-Consequences-and-Adaptation-Planning-Scenarios-VCAPS.aspx>

The NOAA COCA project, Promoting resilience to climate change for lobstermen and fisheries dependent communities through participatory system dynamics modeling, was highlighted as one of 14 Resilience in Action projects:

<http://seagrant.noaa.gov/WhatWeDo/ResilienceToolkit/BrowseToolkit/TabId/618/ArtMID/5569/ArticleID/401/NOAA-COCA-project-Promoting-resilience-to-climate-change-for-lobstermen-and-fisheries-dependent-communities-through-participatory-system-dynamics-modeling.aspx>

Webler, T., S. Tuler, J. Whitehead, E. Stancioff, E. Fly, B. Seitzman, J. Davis. 2015. Using participatory modelling to help seafood producers on the United States East Coast identify ways to adapt to a changing climate. *J. Shellfish Res.* 34: 689-690.

COASTAL AND OCEANS CLIMATE ADAPTATIONS

Webler, T., Stancioff, E., Goble, R., and Whitehead, J. (in press 2015). Participatory modeling and community dialogue about vulnerability of lobster fishing to climate change. In: Steven Gray, Michael Paolisso (eds.). *Participatory modeling in environmental decision-making: Methods, tools, and applications*.

Tuler, S., Dow, K., Webler, T., and Whitehead, J. (in press 2015). Learning through participatory modeling: Reflections on what it means and how it is measured. In: Steven Gray, Michael Paolisso (eds.). *Participatory modeling in environmental decision-making: Methods, tools, and applications*.

III. GRAPHICS: PLEASE INCLUDE THE FOLLOWING GRAPHICS AS SEPARATE ATTACHMENTS TO YOUR REPORT

A. In order to better promote your work and the work of the X program, please provide the following that can be used in communication materials for NOAA and external audiences.

- i. One Power point slide depicting the overall project framework/approach/results to date.

This is attached

- ii. If appropriate, additional graphic(s), photograph(s), or presentation(s) depicting any key information or research results thus far.

IV. WEBSITE ADDRESS FOR FURTHER INFORMATION (IF APPLICABLE)

[HTTP://SERI-US.ORG/CONTENT/FISHERIES-AND-CLIMATE](http://seri-us.org/content/fisheries-and-climate)

We have been developing a website to help disseminate the VCAPS method: This was recently built and we are populating it with relevant content and links.

<https://sites.google.com/site/vcapsprojects/home>

V. ADDITIONAL RELEVANT INFORMATION NOT COVERED UNDER THE ABOVE CATEGORIES

Attached is a poster presentation for the project at large.

Attached is a brochure for the Crabbers Who Care Research Network in South Carolina.

Attached is a letter from Dr. Cohen-Blankshtain of Hebrew University of Jerusalem about including VCAPS as an exemplary tool for public and stakeholder engagement.