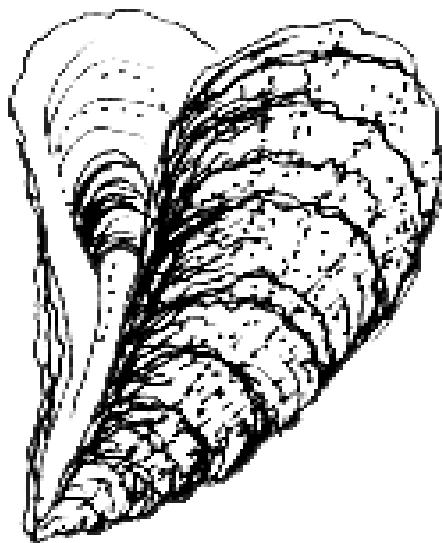


Synopsis of:
North Carolina Oysters
*Twenty years of oyster research, restoration, and
management in North Carolina*

A Workshop to
Chart Future
Restoration,
Learning from
the Past



Held on:
March 12-13, 2014

The workshop was supported by sponsorships from the Albemarle-Pamlico National Estuary Partnership and North Carolina Sea Grant. It was hosted and organized by:



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Executive Summary

On March 12-13, 2014 over sixty state and federal government, academic, private and non-profit professionals met at the National Oceanic and Atmospheric Administration (NOAA) Beaufort Laboratory on Pivers Island to assess the existing body of North Carolina's oyster research and restoration efforts. The workshop focused on highlighting lessons learned, identifying knowledge gaps and recommending options for future oyster research and restoration. Presentations on emerging oyster restoration and research were delivered by state and national experts, research, academic, private and non-profit professionals. The findings of the workshop will ultimately be used to revise and update the existing *Oyster Restoration and Protection Plan for North Carolina: A Blueprint for Action* (Blueprint). At the anticipated 2015 North Carolina Oyster Summit, the workshop findings will be reviewed and incorporated into a third edition of the Blueprint that will guide state research and restoration efforts from 2015 to 2020.

Oyster Summits and Workshops were held annually from 2003-2008, however in the last five years there has not been a workshop to bring together the research and restoration practitioner communities to talk the latest science and how that informs oyster restoration. Questions were raised in the restoration community such as what is working or not working for restoration? Do we now know enough to continue restoring oysters in the best manner possible or do we have more questions to answer? What are those questions? Are there guidelines or best management practices we should use to streamline restoration and monitoring of oyster projects? Are we collaborating effectively to use the limited funding and resources available? To assess these questions and to help guide the development of a workshop agenda, the workshop organizers designed a pre-workshop survey that was sent to 49 professionals. This survey collected information on their collaborators, project goals and objectives, locations, results, and knowledge gaps and recommendations.

Four major themes, identified as priorities in the pre-workshop survey, became the focus of the workshop. These themes were:

- scaling-up restoration and enhancement efforts;
- implementing restoration, research and enhancement projects;
- project evaluation and monitoring; and
- building and sustaining effective collaborations.

Panel presentations from national and local experts presented multiple facets of these themes in lightning-round style presentations. After the presentations on a theme, the attendees split into four breakout groups to further discuss and digest the information. Breakout groups were facilitated by workshop planners and a dedicated note taker captured the major themes and ideas discussed. These ideas were then brought back to the larger group in a report-out session. This synopsis document summarizes the major themes and ideas from the breakout group sessions.

For the first theme of scaling-up restoration, the workshop organizers had hoped the group would be capable of setting tangible, acreage goals for restoration in the sound. However, the participants felt there was still much they did not know, including having a good handle on the existing population and health of oysters in the state. A considerable amount of discussion centered around how best to assess the current extent, status and health of the oyster population given the large area of estuaries in North Carolina and limited staff and resources, so that future goals could be established. It was also recommended that goals be set for different functions: harvest, broodstock, ecosystem services. Overall the group was in agreement that their vision for oysters in the state was one where the population supported fishery goals and ecosystem services, was self-sustaining and on a large enough scale that the reef system is resilient to episodic events like disease, outbreaks, and longer term climate changes. Overall the group also realized that a good deal of thought and effort should go into prioritizing areas that are in need of restoration so that combined efforts can achieve this vision.

For the second panel and breakout group, presentations were given on various restoration planning tools and guidelines that researchers have developed in the past 5-10 years that can inform restoration projects and practices. Many tools exist for the state and general planning purposes, but there is no all-encompassing, decision-support tool. Also, many researchers have gathered information that helps to guide restoration in one area, but their findings may not translate across multiple scales or regions. Many of the practitioners agreed that synthesis of the existing tools and data is needed but cautioned that anyone practicing restoration must be proactive in doing their homework rather than relying on a tool to be told what to do and how to do it. The existing tools that participants knew about were discussed and are detailed further in the breakout group notes section. Key to integrating the tools is continued communication among research groups, testing and refining the existing models and research to inform the known knowledge gaps, and better understanding the differences between subtidal and intertidal restoration practices. Ways to achieve these outcomes that were discussed included continued meetings/workshops on a semi-regular basis and developing a catalogue of current and previous research to help point practitioners to experts who may be able to help them answer restoration questions. Most important was that participants felt that a way of communicating project failures was just as important as knowing what worked.

In the third panel and breakout group, discussion centered on how to best monitor oyster restoration projects so that results could be compared. Different groups presented different methods for project monitoring, from very basic techniques to difficult to quantify ecosystem services. The Nature Conservancy (TNC) presented their recently released handbook on how to monitor restoration projects in a universally accepted manner for reef area, height, density and oyster size. Discussion about whether or not this method should be adopted in North Carolina was the focus of the breakout group. At the time, those present, felt that adopting the TNC minimum monitoring guidelines would be reasonable, with the idea that project specific goal monitoring would also be incorporated. Much

discussion about testing the methods for North Carolina and confirming its utility, especially in subtidal waters, was a point that was raised. Concern about the highly variable conditions of NC waters and on-the-ground projects was expressed. It became apparent that a training in the manual to better introduce the methods and techniques may be warranted and then and an assessment of the use of the manual for North Carolina would also be of value. Questions were also raised about how this monitoring data would determine if a project was successful or not, the group expressed an interest in defining measures of success for different categories of projects.

Finally, the workshop focused on how to successfully collaborate and partner moving forward. All four groups expressed an interest in collaboration to forward the goals of oyster restoration and enhancement in the state. Key to successful partnering is to maintain close communication between and among groups; the idea of regular meetings/workshops was again raised. Breakout group participants felt that partnerships that work had funding that brought them together, as well as common well-defined goals. Possible new funding sources for both on-the-ground activities and research, as well as how to partner effectively to secure the funding was discussed. A specific need that was identified was how to keep the oyster shell recycling program viable in the state following the sunset of the tax provision. Participants felt that work needed to be done on watershed or regional scales and linking water quality and oyster restoration goals was important. The importance of oysters and the goals defined for oysters must be clearly communicated to the general public, legislature and watermen to build support for and understanding of them.

Regional workgroups will work through the information gathered and discussed at the workshop during the remainder of 2014 to sort out priorities and better define goals and action items for the coming years. These priorities will be incorporated into an updated Blueprint and presented at the Oyster Summit in 2015.

Welcome and Objectives

Todd Miller, executive director for the North Carolina Coastal Federation (federation), welcomed workshop attendees and explained the workshop's mission to (1) engage participants in a two-day forum focused on assessing the existing body of North Carolina's oyster research and restoration efforts to document lessons learned, find knowledge gaps and identify options for future oyster research and restoration; (2) produce a set of workshop findings, based on presentations, discussions, and consensus-building, to help determine future action items, strategies, resources and partnerships to achieve sustainable oyster harvest and robust, diverse and resilient fishery habitats; and (3) use workshop findings to revise and update the existing *Oyster Restoration and Protection Plan for N.C.: A Blueprint for Action* (Blueprint). At an anticipated January 2015 N.C. Oyster Summit, workshop findings will be reviewed, and then, incorporated into a third edition of the Blueprint that will guide state research and restoration efforts from 2015 to 2020.

The workshop objectives were stated to be:

- Participants will hear and discuss lessons learned from the last 20 years of oyster research, restoration, harvest and management; and
- Participants will aid in the identification and development of needed actions, strategies and resources to ensure healthy oyster habitats as essential fish habitat, as well as for sustainable recreational and commercial harvest.

N.C. Oyster Blueprint: Summary of Major Accomplishments

Ted Wilgis, a coastal education coordinator for the federation, provided an overview of the existing Blueprint for Action and summarized major progress that has been made on the plan's goals and actions by partners in the last 10 years.

The eastern oyster (*Crassostrea virginica*) is an ecological, economic and educational treasure for North Carolina. As a "canary in the coal mine", oysters reflect the health of coastal ecosystems. Alarmingly, the state's oyster population has declined over 50 percent in the last century and it is now listed as a species of concern. This decline results from: habitat loss, pollution, diseases and historical harvest pressure. Given the importance of the species and its current status, a diverse group of stakeholders have worked in concert since 2003 to link strategies and develop targeted initiatives to create and implement the *Oyster Restoration and Protection Plan for North Carolina: A Blueprint for Action*.

Since its inception in 2003, the Blueprint has provided stakeholders with a cohesive direction and guidance that allowed them to come together as a united force to pursue tangible restoration and protection strategies. The Blueprint enabled government, private agencies and other shellfish stakeholders to coordinate and link their habitat and water quality protection and restoration, and fishery management activities. This resulted in funding increases for oyster related protection and restoration programs that are about ten times higher than they were in 2003. As a result of this coordination and funding, efforts to protect and restore North Carolina's native oyster also increased with tangible results of oyster habitat enhanced and restored, increased annual oyster harvests, and a greater number of watershed restoration projects along the coast.

The organizations listed below are just a few of those involved with the Blueprint. Many others serve as active participants including shellfish growers and harvesters and members of the public.

- Albemarle-Pamlico National Estuary Program (now Partnership);
- Environmental Defense;
- Carteret Community College;
- Duke University Marine Lab;
- J&B Aquafood;
- North Carolina Aquariums;
- North Carolina Clean Water Management Trust Fund;
- North Carolina Coastal Federation;
- North Carolina Department of Agriculture & Consumer Services Aquaculture Division;
- North Carolina Department of Environment and Natural Resources;
- North Carolina Division of Coastal Management;
- North Carolina Division of Environmental Health;

- North Carolina North Carolina Division of Highways;
- North Carolina Division of Marine Fisheries;
- North Carolina Division of Water Quality;
- North Carolina Sea Grant;
- North Carolina Shellfish Growers Association;
- The Nature Conservancy;
- United States Army Corps of Engineers;
- University of North Carolina Chapel Hill- Institute of Marine Sciences;
- University of North Carolina Wilmington

Summary of the Blueprint Goals and Recent Progress by Partners

The goals of the Blueprint are regularly updated to reflect the changes in knowledge and technology in the oyster restoration field. A revision to the goals will be presented at the 2015 Summit as a result of ideas generated at this workshop (which are summarized in the Breakout Sessions below).

Overarching Blueprint Goals

- To restore and protect North Carolina's native oyster populations and habitat in an effort to restore our estuaries to robust, diverse, & resilient ecosystems.
- To build broad public awareness & support for the value of oyster restoration, estuarine conservation and sustainable fisheries.
- To establish and work with a comprehensive coalition to build and maintain significant, demonstrable and meaningful progress towards oyster restoration in the next five years.

Goal 1: Engage and lead a comprehensive coalition of partners on a state and federal level to achieve oyster and water quality protection and restoration objectives.

Progress:

- The Blueprint Steering Committee and Regional Workgroups worked together to craft, refine, update and implement the objectives and recommended actions of the Oyster Restoration and Protection Plan for North Carolina.
- Regional public forums, stakeholder meetings and legislative oyster roasts, including the Encore for Oysters Conferences and Summits, were held in 2004, 2005, 2006 and 2007. These workshops engaged the public, stakeholders and legislators in the protection and restoration of oysters and shellfish waters.

Goal 2: Protect and restore healthy oyster populations and habitat as a means to improve water quality, provide essential habitat, and support a sustainable fishery.

Progress:

- Stakeholders identified and characterized priority Shellfish Growing Areas (SGAs) in the southern and northern regions, and they are implementing the recommendations for oyster reef and watershed restoration for the high priority SGAs and their watersheds.
- DMF has mapped 90% of the estuarine substrate, identifying 15,778 acres of shell bottom.
- The Coastal Habitat Protection Plan, Division of Marine Fisheries (DMF) Oyster Fishery Management Plan and Albemarle-Pamlico National Estuary Partnership (APNEP) Comprehensive Conservation and Management Plan were developed and updated to include a number of recommendation to protect oyster habitat and were incorporated into the Blueprint.
- Living Shorelines were promoted, legislation was passed and the use of natural alternatives to preserve and/or restore estuarine shorelines to protect and restore oyster habitat was expanded.
- The 2005 Oyster Restoration & Protection Act resulted in increased funding for oyster sanctuaries, SGA mapping and surveying resources; shell recycling resources and fisheries staff for permit reviews.
- DMF increased the number of oyster sanctuaries to 12, encompassing over 228 acres; and almost 80 acres of sanctuaries were constructed, bringing the total to over 138 acres of created reef habitat in the sanctuaries.
- DMF has been able to maintain a cultch planting effort of 150,000-300,000 bushels of material annually.
- DMF Oyster Shell Recycling program collected 185,866 bushels of oysters from 2003-2012.
- NGOs, research institutions, municipalities ramped up restoration efforts resulting in over 120 acres of oyster habitat creation and restoration projects.
- The Shellfish Research Hatchery was constructed at UNCW and began operation with larvae production and remote setting tests.
- Larval transport, distribution and spatfall monitoring programs and studies have been initiated.
- DMF's Coastal and Recreation Fishing License Fund was implemented, and it has supported a number of projects to restore and monitor oyster habitat.

Goal 3: Protect and restore water quality throughout coastal waters and especially near areas designated as oyster habitat.

Progress:

- Stakeholders are implementing the regional water quality protection and restoration recommendations for the identified high priority SGAs and their watersheds.
- The N.C. Division of Water Resources (DWR), N.C. Department of Transportation (DOT) and the N.C. Clean Water Management Trust Fund supported projects to remove stormwater outfalls that discharge to shellfish waters.

- The N.C. Clean Water Management Trust Fund and N.C. Ecosystem Enhancement Program supported a number of projects along the coast protecting shellfish waters and their watersheds.
- The Phase II National Pollutant Discharge Elimination System (NPDES) Stormwater rules were implemented, and Low Impact Development ordinances were developed and adopted in several communities, resulting in less stormwater runoff.
- DMF Shellfish Sanitation Section developed and implements its Enhanced Shoreline Survey Methodology to identify and track pollution sources in shellfish waters.
- DWR Coastal Non-Point Source program and U.S. EPA/DWR 319 Projects are supporting Total Maximum Daily Load (TMDL) studies and watershed restoration plans. These plans are being implemented in a number of prioritized areas with the goal of developing and implementing successful strategies for cleaning up impaired shellfishing and swimming waters.
- Large and small scale wetland restoration projects have been completed and are underway in a number of priority areas.
- The N.C. Department of Environment and Natural Resources (DENR) Community Conservation Assistance Program was developed and has implemented several stormwater reduction and Living Shoreline projects.
- The Onslow Bight and Cape Fear Arch conservation initiatives support the regional recommendations of the Blueprint.

Goal 4: Develop a sustainable native oyster fishery.

Progress:

- DMF Oyster Fishery Management Plan was updated in 2008 and is in the process of being updated again. A number of recommendations from the Blueprint are incorporated in the updates.
- The shellfish research hatchery program is providing support for shellfish growers through larval research and seed testing.
- The N.C. Sea Grant Program has supported oyster fishery research projects through its fishery grant programs, and it established a Mariculture Extension & Research Program.
- A number of programs including N.C. Catch and the Freshness From North Carolina Waters campaign are helping to market and support shellfish growers and harvesters.
- The N.C. Shellfish Growers Association continues to hold its Annual North Carolina Aquaculture Conference.
- DMF established an education and permitting program for the U-Dock Oyster Growing Program and the Shellfish Gardeners of North Carolina worked to recruit and train gardeners.

Goal 5: Increase public awareness of the ecological and economic roles, values and importance of a healthy oyster population, and expand citizen and stakeholder support and participation efforts to protect and restore water quality and oyster habitat.

Progress:

- Increased opportunities for student, teacher and public participation in shell recycling, shellfish protection and restoration activities were developed and offered by agencies, researchers, municipalities and NGO's.
- Biannual Summits and Public Forums were held to engage the public, legislators and stakeholders.
- Education programs with U-Dock program were developed by Sea Grant.
- The oyster shell recycling program increased outreach efforts to explain the value and importance of oysters. It also provided a number of volunteer opportunities.
- The Blueprint stakeholders developed and implemented a number of oyster education programs to engage students and the public in oyster restoration efforts.

Goal 6: Link and Coordinate Oyster Restoration and Protection Plan activities to Ongoing Planning Efforts.

Progress:

- A strong effort has been made by the Blueprint stakeholders to link its habitat and water quality protection and restoration, and fishery management objects to: DMF Oyster Fishery Management Plan, Coastal Habitat Protection Plans, Basinwide Water Quality Plans, CAMA Land Use Plans, APNEP Comprehensive Conservation Management Plan, Ecosystem Enhancement Program Basinwide Wetlands Restoration Plans, State of North Carolina/ Corps of Engineers Neuse River, Tar River and Pamlico Sound Basins Studies, Onslow Bight Conservation Forum and Cape Fear Arch initiatives, One North Carolina Naturally, Land for Tomorrow/Horizon 2100, and the Sea Grant Strategic Plan.

Goal 7: Secure Funding for Full Implementation of the Goals, Objectives and Actions of the Oyster Restoration and Protection Plan for North Carolina.

Progress:

- The Blueprint stakeholders have worked to identify and secure funding for a number of planning and project implementation efforts from state, federal and private sources.

Oyster Pre-Workshop Survey Overview

Dr. Brandon Puckett, a post-doctoral scholar at NCSU-CMAST, provided a synopsis of the pre-workshop survey results to participants. An accompanying survey summary document was provided in workshop programs. The survey was designed to assess the existing body of oyster research and restoration activities within North Carolina inshore waters and to identify knowledge gaps to assist in delineating future oyster research and restoration priorities. Information obtained from the pre-workshop survey helped to guide development of the workshop agenda.

Nearly half of the workshop participants, ranging from government, academia, private business, and environmental nonprofits, responded to the pre-workshop survey. Collectively, survey respondents have participated in approximately 219 oyster-related projects and provided in-depth details on 80 oyster research and/or restoration and enhancement projects. Survey responses were skewed heavily towards projects conducted north of the White Oak River and slightly skewed towards academic research.

Over 75% of survey respondents provided restoration goals for their specific projects. However, less than 20% of the goals identified could be broadly grouped into similar categories. As a result, a major focus of the workshop was to determine the feasibility and/or necessity of reaching consensus on oyster restoration and research goals.

Creating new habitat was the primary goal for oyster restoration projects in subtidal restoration (46%) and intertidal restoration (70%). The restoration was to benefit both oyster populations by providing a substrate for oyster larvae and to provide a structure that would benefit the many species that use oyster reef as habitat. Broodstock function and shoreline stabilization were the primary goal of 27% of subtidal restoration and 20% of intertidal restoration, respectively. Harvest was the explicit purpose of only 5-7% of subtidal and intertidal restoration projects reported.

Techniques used for restoration varied among subtidal and intertidal environments. Subtidal restoration has predominately occurred in sandy substrates in polyhaline waters (salinity of 18-30 practical salinity units) using a combination of hard substrates, such as marl and oyster shell. Most often, oyster shell was “scattered” along the bottom forming a thin veneer less than one meter in height. Recent restoration efforts in subtidal waters have used marl in a mounded vertical relief extending 1-2 meters above the bottom. Subtidal restoration efforts were often relatively large in size, providing over 1000 square meters of substrate. Relative to subtidal restoration, intertidal restoration has predominately occurred in higher salinity waters and often at smaller spatial scales, providing between 100 and 1000 square meters of substrate. Intertidal reefs are most often restored at or above mean low water on sandy substrates. Restoration in intertidal environments primarily uses oyster shells, and the shells are often consolidated in bags. Most often, the oyster shell is “layered” or “mounded” forming structures ranging in height

from 0.25-1.0 meters. As a result of these findings, workshop planners were interested in facilitating a discussion about the design elements that should be considered when conducting oyster restoration in intertidal versus subtidal areas, and in increasing awareness of the decision-support tools that exist for this work.

Following the implementation of restoration, survey respondents indicated that over 85% of the projects detailed in the survey were monitored. The frequency of monitoring varied, but most often occurred at a bi-annual to annual frequency. The metrics that were monitored (from most to least commonly referenced) were: 1) oyster population demographics (density, size structure, growth rate, survival rate, etc.); 2) finfish and infauna assemblages; and 3) water quality, though this was more commonly measured in subtidal restoration. Nutrient cycling was not monitored on the projects detailed in the survey. About 25% of projects were monitored with additional metrics including reef accretion and shoreline stabilization. Based on the aforementioned suite of metrics, over 83% of projects were considered successful, suggesting that we are effective at restoring reefs and meeting oyster demographic goals. The difficulty in oyster restoration is scaling-up restoration from individual reefs to ecologically meaningful scales. Therefore, workshop planners were interested in coming to consensus on uniform metrics for monitoring success of oyster restoration from small- (e.g., reef) to large-scale (e.g., population). Ideally, consensus building would enable the development of a long-term, consistent monitoring data set.

Oyster restoration in North Carolina historically has been a collaborative effort. Over 85% of projects, going back more than 15 years, were collaborative in nature. However, only 43% of collaborations were multi-sector—that is, collaborations that involved one or more of the following sectors: environmental nonprofits, state government, academia and shellfish producers. As we attempt to scale-up restoration, increasing multi-sector collaborations will be essential to success. How to increase collaborations and attract new funding was the fourth focus of workshop conversation.

Based on survey responses, the workshop organizing committee identified four common themes and divided the workshop agenda accordingly into four sessions consisting of 1) identifying/setting restoration goals, 2) best ways to implement restoration, 3) how to develop consistent and long-term restoration monitoring, and 4) collaborations and partnerships.

Breakout Sessions

During the March 2014 workshop, four themed breakout sessions were held. The attendees were split into four groups for each session, with an effort made to ensure multiple sectors of academia, state and federal agencies, resource management, non-profit, citizens and fishermen were represented in the various groups. The intent of the breakout sessions was to generate discussion based on a set of questions posed during each session. The following sections represent the questions that were posed and a synopsis of the resulting discussion.

Breakout Session I: Scaling-up Restoration and Enhancement Efforts

Q1: Do we know the oyster stock status or acreage of oyster reef habitat (healthy, degraded and etc.)? If not, what is needed to determine current stock status?

Q2: How do we set a baseline to identify population, habitat and harvest/mariculture goals?

Q3: How should oyster restoration and enhancement goals be set? Should goals be qualitative (e.g., viable commercial fishery) or quantitative (e.g., number of acres based on a proportion of historical reef footprint)?

Q4: What are the ultimate goals for oyster restoration and enhancement efforts?

Most of the breakout groups began by discussing the role of the N.C. Division of Marine Fisheries (DMF) in assessing the oyster population, and more specifically, the agency's Benthic Habitat Mapping Program. To date, DMF has mapped over 600,000 acres of coastal estuarine waters from Little River in Brunswick County, to the northern end of Roanoke and Croatan Sounds in Dare County. The objective is to determine habitat type, acreage and abundance of shellfish and submerged aquatic vegetation. Several breakout group participants noted this was a good start, but the shellfish mapping only measures presence versus absence and does not look at other measures of population viability and extent, such as size-frequency distributions and percentage of live versus dead oysters. While the state might have a rough estimate of acres covered by oyster reefs, they are not designated as degraded versus healthy. Another limitation to the mapping is that the focus has been on waters less than 15 feet deep. Due to the extent of North Carolina waters and the various demands on DMF staff, it was noted that it is not possible/feasible to map the bottom on a regular (annual) basis as would be needed if we used mapping for monitoring harvest and population goals. It may be better to identify sentinel sites and use those for annual monitoring of the population. It was noted that DMF built the most sanctuary acreage in 2013 since the creation of the program, but the agency still is not even two-thirds of the way to target acreage (goal of 500 acres).

There was agreement that North Carolina's coastal estuarine waters are substrate- versus spat-limited. Some participants recommended examining the methods Delaware via Rutgers University, Virginia and Maryland use in developing a standing oyster stock assessment.

Repeatedly, breakout participants expressed a need to know what regional broodstock levels currently are. And adding to that, what level of broodstock is needed regionally to ensure continued ecosystem services, as well as a wild-harvest fishery. Several participants noted that population modeling has not taken into account closed shellfish areas as a reserve source of broodstock. Ahead of setting a baseline, several participants expressed a need for more fishery-independent data, as well as for more data on the status of subtidal reefs. Some participants countered, asking what purpose there even was in setting a baseline – past or present - as resource managers and conservationists still do not have consensus of what will be measured against this baseline. Facilitators tabled this discussion, since on Day 2 there would be a breakout devoted to monitoring and metrics.

Overall, breakout group participants felt that knowing the status/extent of current oyster reefs is a critical need ahead of goal setting; more useful is knowing the trends—time series of data of when populations were up and down and why. Additional management tools, such as the establishment of coast-wide

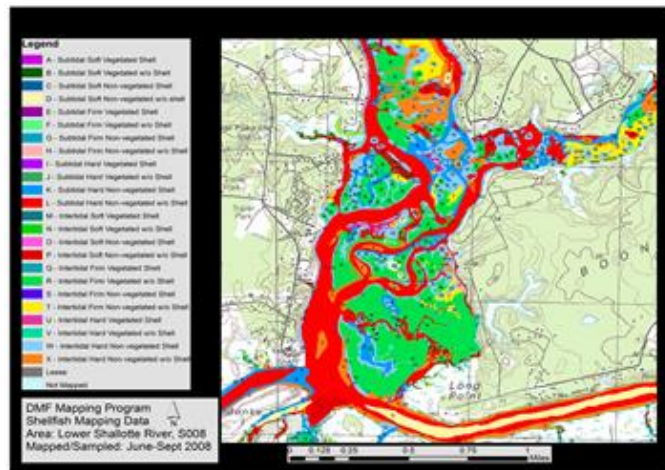
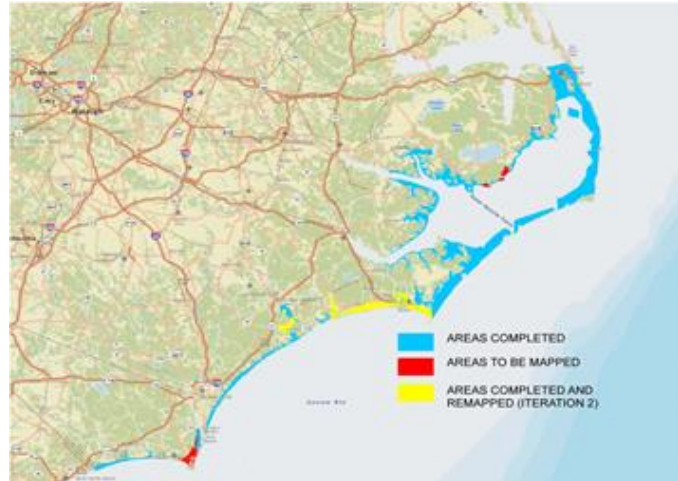


Figure 1: a. Map of Division of Marine Fisheries (DMF) Benthic Habitat Mapping Program's effort to date. b. Detailed Bottom Map, a product of the effort. c. Extent of area deeper than 15 ft. still to be mapped in Pamlico Sound. Source: Brian Conrad, DMF

sentinel sites, could help tease out population trends. Knowing further information on historic population levels beyond what already exists (e.g., Winslow historical survey) would not be beneficial. A wild-harvest fishery, combined with periodic disease outbreaks and storms, will make it difficult to ever restore oysters to historic levels, even if it were known.

Interestingly, none of the breakout groups mentioned the potential role of shellfish leasing to enhance restoration and wild-harvest stock replenishment during this breakout group; it was mentioned as a way of reaching goals in later discussions. Further, assistance from the shellfish research hatchery at University of North Carolina Wilmington (UNCW) to help reach goals was not mentioned.

In considering goal setting, some breakout discussions centered around planning for potential catastrophic events, such as disease outbreaks, red tide events and similar. The DMF Strategic Habitat Areas (SHAs) represent priority habitat areas for protection due to their exceptional condition or imminent threat to their ecological functions supporting estuarine and coastal fish and shellfish species. These should be considered for priority areas as it relates to setting oyster restoration and enhancement target areas and goals.

Naturally, a conversation on goal-setting elicited a sidebar on resource capacity and needs. Several breakout participants stated that different substrate material need to be looked at for reef construction, especially given limited private and public dollars for restoration and enhancement efforts. Citizen science or collaborations with fishermen would help in data gathering, monitoring and on-the-ground restoration/enhancement, making goals more achievable. Before brainstorming too much further, facilitators tabled the discussion for the afternoon breakout on implementing restoration and enhancement projects.

The majority of breakout group participants had a similar vision as to what they wanted the oyster population to “look like” in the future—a population where fishery and ecosystem services are self-sustaining and on a large enough scale that the reef system is resilient to episodic events, like disease outbreaks, and longer term climate changes. Ultimately, the breakout group discussions left measurable goals undefined. Consensus seemed that there should be both goals for ecosystem service and harvest, and that these should be regional. Ecosystem and fishery goals could be further subdivided. Ecosystem goals should include improvements in water quality, fisheries habitat availability, and shoreline restoration/stabilization. Fishery goals would include more traditional goals like bushels harvested. The profound truth shared by most participants was that, in a limited funding environment, areas need to be prioritized for scaling-up of project efforts. This is the best way to make demonstrable impacts. Important to keep in mind is connectivity; if the North Carolina oyster population is to be self-sustaining, restoration and enhancement sites need to function as a network with linkages between natural populations, so that they can rebuild themselves. Also important to keep in mind is the reality that public and political support is needed for these effort to move forward, and goals need to be readily understandable and defined— both qualitative and quantitative— to generate backing.

Breakout Session II: Implementing Restoration, Research and Enhancement Projects

Q1: What decision-support tools are available for implementing oyster restoration? Are these tools sufficient to keep going as we have been, applying adaptive management techniques as we go? If so, where are these tools available?

Q2: If not, what decision-support tools are needed to more effectively implement oyster restoration?

Q3: To develop tools, where should resources be allocated? Testing techniques? Identifying limiting factors? Site selection criteria?

Q4: Identify lessons learned, critical knowledge gaps, and necessary management tools/resources to develop tools identified in question 2.

In the pre-workshop survey, participants identified the need for one or more oyster restoration project decision-support tools to assist with choices pertaining to site selection, project design, coordination and construction, as well as with what best management practices to employ at selected sites. Breakout group participants confirmed the absence of an all-encompassing, decision-support tool and generally agreed that tools to provide support throughout the restoration process would be invaluable for practitioners, resource managers, and researchers with a common need to maximize restoration success with limited resources.

Breakout group participants identified several currently available documents, as well as emerging tools, that may be useful in developing a state-wide oyster restoration decision-support tool. Four documents in particular were noted for their relevance to the implementation of oyster restoration:

(1) *Oyster Habitat Restoration Monitoring and Assessment Handbook*¹

(2) *Weighing Your Options, How to Protect Your Property from Shoreline Erosion: A handbook for estuarine property owners in North Carolina*²

¹ Baggett, L.P., S.P. Powers, R. Brumbaugh, L.D. Coen, B. DeAngelis, J. Green, B. Hancock, and S. Morlock, 2014. [Oyster habitat restoration monitoring and assessment handbook](http://www.oyster-restoration.org/wp-content/uploads/2014/01/Oyster-Habitat-Restoration-Monitoring-and-Assessment-Handbook.pdf). The Nature Conservancy, Arlington, VA, USA, 96pp. <<http://www.oyster-restoration.org/wp-content/uploads/2014/01/Oyster-Habitat-Restoration-Monitoring-and-Assessment-Handbook.pdf>>.

(3) *Restoration Goals, Quantitative Metrics and Assessment Protocols for Evaluating Success on Restored Oyster Reef Sanctuaries*³

(4) *North Carolina Oyster Fishery Management Plan Amendment 3*⁴

Tools available to support oyster restoration activities were divided into regional and state-specific categories. Regional tools developed for oyster restoration outside of North Carolina include:

- (1) Oyster restoration suitability models used for the Hudson River, Florida Everglades, and Port Aransas
- (2) Gulf of Mexico oyster restoration tool developed by Dr. Loren Coen at Florida Atlantic University

North Carolina-specific oyster restoration tools discussed were:

- (1) Alphin-Posey (UNCW) site-selection model for oyster aquaculture
- (2) Puckett-Eggleston (N.C. State University) site-selection model for oyster sanctuaries
- (3) DMF document for siting oyster sanctuaries
- (4) Strategic Habitat Areas identified as part of DMF's Coastal Habitat Protection Plan (CHPP)
- (5) decision tree for shoreline stabilization produced by the N.C. Division of Coastal Management (DCM).

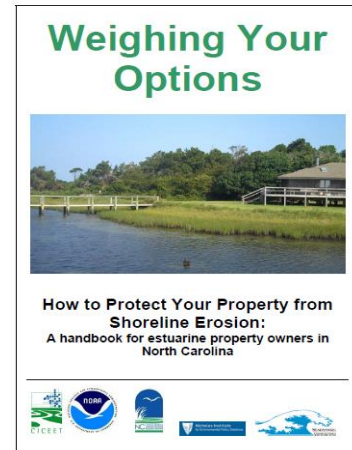


Figure 2: Cover of *Weighing your Options* handbook.

² Seachange Consulting, June 2011. [Weighing Your Options, How to Protect Your Property from Shoreline Erosion: A handbook for estuarine property owners in North Carolina](http://dcm2.enr.state.nc.us/estuarineshoreline/WeighingyourOptions.pdf). <<http://dcm2.enr.state.nc.us/estuarineshoreline/WeighingyourOptions.pdf>>.

³ Oyster Metrics Workgroup, December 2011. [Restoration Goals, Quantitative Metrics and Assessment Protocols for Evaluating Success on Restored Oyster Reef Sanctuaries](http://www.chesapeakebay.net/channel_files/17932/oyster_restoration_success_metrics_final.pdf). <http://www.chesapeakebay.net/channel_files/17932/oyster_restoration_success_metrics_final.pdf>.

⁴ [North Carolina Oyster Fishery Management Plan Amendment 3](http://portal.ncdenr.org/c/document_library/get_file?uuid=236c9be2-7384-4017-b828-b2fb312454bf&groupId=38337). N.C. Division of Marine Fisheries, April 2014. <http://portal.ncdenr.org/c/document_library/get_file?uuid=236c9be2-7384-4017-b828-b2fb312454bf&groupId=38337>.

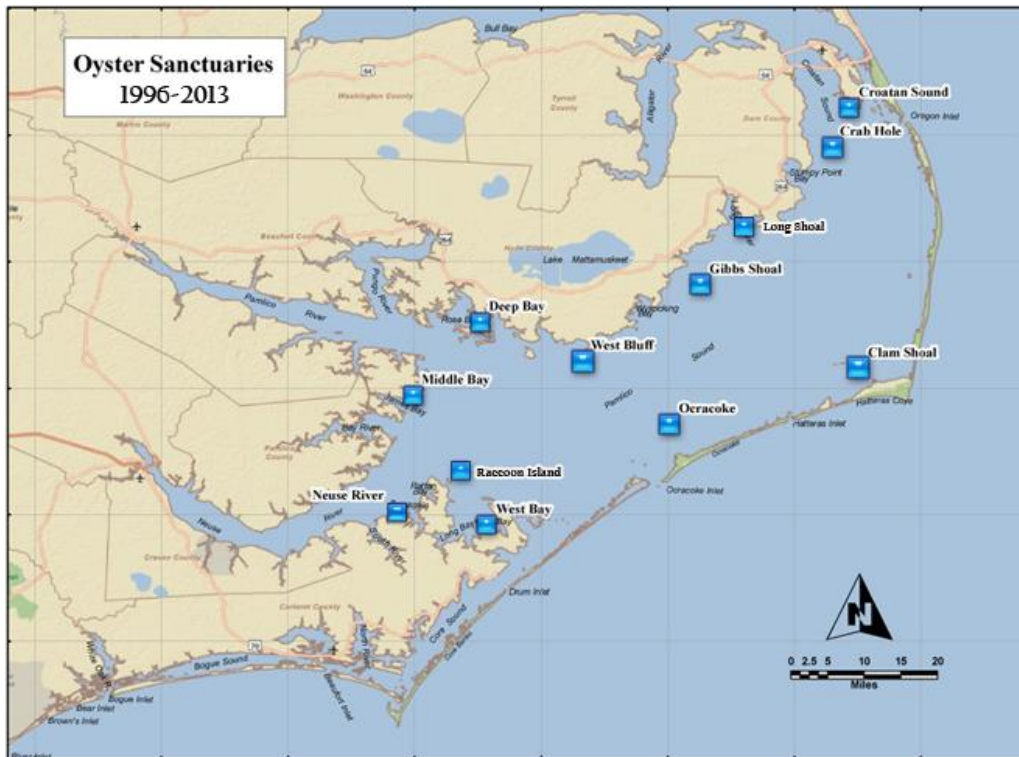


Figure 3: Current 2014 Map of DMF Oyster Sanctuaries in Pamlico Sound. Additional sanctuaries in the state, including in the Cape Fear River, are being considered. Siting of the sanctuaries is guided by a number of tools including DMF protocol, modeling from NC State University as well as, the latest science and stakeholder input.

Map source: <http://portal.ncdenr.org/web/mf/map-of-current-and-future-sanctuaries>

The accessibility of existing tools and information relevant to the implementation of restoration is an issue that many breakout group participants identified as prohibiting their widespread integration into on-the-ground efforts. Discussions in several breakout groups suggested that existing research, while substantial, is often times hard for practitioners to locate, as well as to understand and implement into restoration activities. Several solutions were proposed by participants with a common theme of increasing communication of research and tools among stakeholders. Ideas included:

- (1) An annual presentation of science to inform stakeholders of recent progress relevant to restoration;
- (2) Development of how-to-guides;
- (3) Development of a portal to catalogue oyster-related research in North Carolina. This portal could also store easily accessible data and metadata, as well as provide an interactive component with video tutorials from region-specific experts.

While many believed these ideas would improve implementation of the best science available into restoration efforts, some cautioned that anyone practicing restoration must be proactive in doing their homework rather than being told what to do and how to do it.

To further develop and refine restoration tools, participants suggested allocating resources in a few ways. One idea was to allow models to drive the resource allocation process. For instance, if models indicated that salinity were most important for long-term ecological function of a restoration effort, then resources should be allocated accordingly. The need to formalize a network of oyster restoration experts that are tasked with integrating existing tools applicable to regions of North Carolina into a statewide tool was discussed. Funding through the Coastal Recreational Fishing License Grant Program and APNEP was noted as a potential means to assemble a working group to develop a statewide tool.

Participants also identified the need for more guidance on permitting (e.g., permitting check-list) to make the permitting process easier to understand and follow, noting that there are not restoration-specific standards for permitting. The need for long-term monitoring to identify restoration successes and failures was repeatedly mentioned in breakout group discussions because this knowledge can provide predictive power for projecting the success of restoration projects.

Several critical knowledge gaps that reduce the utility of existing tools, as well as the development of new tools, were highlighted during breakout group discussions. Several participants suggested that tools needed to better integrate dynamic processes across multiple temporal scales to more accurately determine restoration success. Integration of land-use planning also was identified as a missing component of existing tools. Several participants indicated that existing tools needed greater predictive power and that assumptions must be tested and predictions validated. A few participants identified existing management plans (e.g., CHPP, APNEP's Comprehensive Conservation and Management Plan) that reach multiple audiences as a means of filling critical restoration knowledge gaps.

Breakout groups discussed lessons learned that were relevant to development of oyster restoration decision-support tools. A key lesson learned relevant to the development of predictive restoration models is the tradeoff between model complexity and model resolution. Increasing complexity may increase the models ability to depict reality, but model resolution may become too small or too large for widespread use. Secondly, participants identified the differences in factors determining the success of intertidal and subtidal restoration as a key lesson learned. The development of a statewide decision-support tool must include these discrepancies to be useful in these two restoration environments. On a related note, participants identified the "subtidal-intertidal divide" as a barrier in communication between oyster researchers and managers in the northern and southern parts of the state. A key lesson learned was the need for regular meetings to facilitate information exchange. Lastly, a key lesson participants noted was the need to communicate information on restoration project successes and, perhaps more importantly, failures to further inform and refine future iterations of decision-support tools.

Breakout Session III: Project Evaluation and Monitoring

Q1: Should North Carolina follow and/or base a monitoring protocol on NOAA recommendations?

Q2: What are the minimum monitoring standards that should be implemented on all restoration and enhancement projects, and how should standardized data be shared?

Q3: Should these monitoring standards focus only on oysters? If not, what else should be monitored?

Q4: Do these monitoring standards enable the detection of any positive "signal" from restoration efforts?

Q5: How often should the procedures and metrics be reevaluated?

Q6: What monitoring criteria and techniques are most versatile, practical and valuable in providing data needed to set and evaluate restoration and management goals?

The majority of breakout group participants felt a large-scale, long-term monitoring effort and state-wide, standardized minimum monitoring protocol would be useful in detecting any positive (or negative) "signal" from restoration efforts, in sharing data, and in setting future restoration and management goals. Many participants expressed adoption of these metrics seems prudent, since funders, such as NOAA, are working to make meeting minimum monitoring standards a condition of project funding.

Much discussion ensued in all four breakout groups regarding the new 2014 The Nature Conservancy (TNC) publication titled, *Oyster Habitat Restoration Monitoring and Assessment Handbook*. In partnership with NOAA and with additional expert input, TNC developed recommendations for a set of Universal Metrics including: (1) reef areal dimension, (2) reef height, (3) oyster density and (4) oyster size-frequency distributions, which should be monitored for all oyster restoration projects. The Handbook also outlines optional Goal-based Metrics that would allow practitioners to assess the performance of project-level outcomes. In developing the Handbook, authors were looking for the least common denominator for measurements, focusing on things that were cheap and routine.

The majority of attendees preferred to have a set of general guidelines, models as examples, and sampling regimes to choose from in meeting the goals and objectives of individual projects. They acknowledged that following the Handbook would produce consistent data while maintaining individual goals of a project. But, the Handbook needs to be tailored to the high variability of North Carolina on-the-ground projects. Breakout group participants noted that most of the Handbook is geared for monitoring intertidal reefs, with little guidance on how to approach North Carolina's vast array of subtidal reefs. The groups

re-emphasized that, in developing a state-specific monitoring protocol, authors should be ever-mindful to the diversity of project designs, substrates and structures within the state. Some participants recommended taking the required state monitoring indices and making those requirements universal to all state oyster restoration efforts. But, it quickly became apparent most participants were not familiar enough with the array of indices currently monitored by the DMF and other state agencies.

In reviewing the Handbook, Universal Metrics (i.e., area, height, density and oyster sizes) specifically, the majority of breakout group participants felt that those minimum measures would be basic measures for whether a population of oysters is surviving through time. Possible project-level performance metrics appropriate for North Carolina include nutrient levels and catch-per-unit-effort (CPUE) of reef fish species. Again, project-specific measures should be low-tech and not time-intensive.

Measurements of a slew of other possible environmental parameters were discussed amongst the groups, from shoreline change, to water quality change, to disturbances (e.g., oil spills, hurricanes,

etc.). Much of the discussion centered on not just measuring oyster reef paybacks but larger ecosystem and habitat benefits, such as nitrogen uptake and carbon sequestration. Many participants felt environmental variables should be documented, but the ability to measure environmental parameters largely depends on resource availability. There was a substantial amount of discussion devoted to brainstorming existing monitoring efforts, so as to take advantage of data available to enhance a project without any added cost or labor. Examples included Shellfish Sanitation's monitoring of shellfish harvesting waters and swimming sites, and the N.C. Coastal Reserve Program's system-wide monitoring program, from which parameters like tide-level data is available for all program sites along the coast. Once more, it quickly became apparent the groups were not familiar enough with what currently was ongoing in the state. It also became apparent that the ability to conduct monitoring is dependent on the project lead.

Some breakout groups discussed proposed frequency of Universal Metrics, ranging from annual to triennial. For example, reef area/height could be checked less frequently, such as once per year or even every three years. Density and size-frequency would need to be checked a bit more often like twice a year. Some project-level metrics, such as water

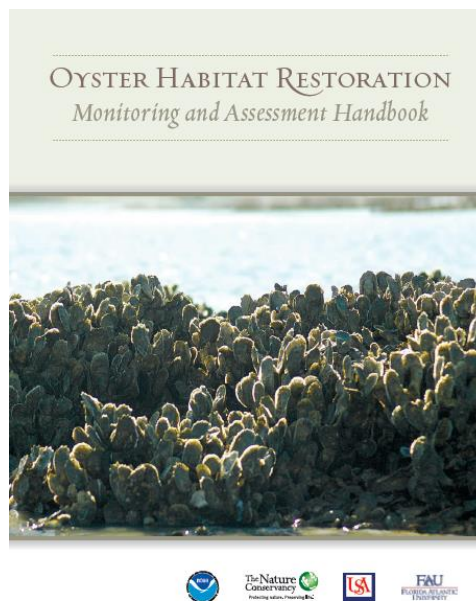


Figure 4: The NOAA-TNC Oyster Habitat Restoration Monitoring and Assessment Handbook cover. The Handbook details universal and project goal specific metrics that are recommended for monitoring oyster restoration projects.

quality, would need to be monitored routinely. Organizations with a sizable volunteer/intern core can do this level of monitoring, but state and local agencies do not have these resources. Academia, while having a ready-and-able undergraduate and graduate student body, has the challenge of consistency due to big turnover with students. Several participants suggested the use of camera systems; in situ monitoring to tell if a reef is consolidating and sloughing off and similar. But overall, it raises the questions in developing a state-wide consistent minimum monitoring protocol as to whether monitoring can be designed for both scientific and community-based restoration? In discussing minimum reporting metrics, breakout conversations naturally centered around the question of what exactly constitutes “success” of a project, and whether we should even concern ourselves with it. Several participants raised the question, “What are effective ways to communicate failures?” The groups universally acknowledged the importance in reporting unsuccessful research and restoration efforts, but no one wants to report that. Editors of peer-reviewed journals and other media outlets do not want to publish non-significant results or failure of restoration efforts. Funders do not want to hear their monies resulted in non-significant results or failure of restoration efforts, and are less likely to fund continuing efforts in the next cycle. Yet, there’s valuable learning amongst practitioners in knowing “what went wrong.”

Breakout group participants also thought it important to collect and share metadata. Descriptive project information also looks to become a requirement for federally funded projects. Emerging is a metadata protocol for reporting anything related to oyster reef restoration. Participants thought the challenge in sharing data firstly is the ability for it to be shared amongst an array of stakeholders, from academics to community organizations.

Amongst breakout group participants there seemed to be mixed emotions regarding development of a shared database for all state oyster restoration monitoring data. It will be cumbersome for practitioners to have to continually update multiple data repositories—their own and then a shared site. A compromise might be to add project metadata on a clearinghouse site, and several existing open-source resources were referenced— NC OneMap or NC Coastal Atlas. To many participants, it was less about who would host the database and more about how it will be updated; who is going to manage it, perform quality control, and ensure its updated? There also was some discussion about the need and, responsible persons deciding on, state-wide, standardized “keyword” project tags, so that people can easily access only the data that is relevant to their needs.

Another idea briefly discussed among participants in lieu of, or in addition to, a state-wide, standardized monitoring protocol was expansion of the N.C. Sentinel Site Cooperative. In the greater Beaufort, N.C. area there are a number of regional NOAA assets that have formed a cooperative to bring to bear the full force of NOAA coastal and ecosystem monitoring, measurement and tools in partnership with federal, state and local efforts.

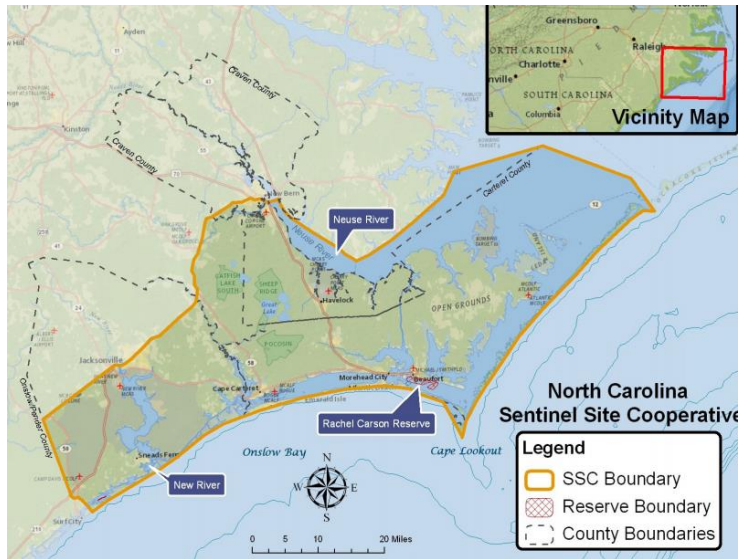


Figure 5: The North Carolina Sentinel Site Cooperative, pictured above, could be expanded or used in combination with DMF sanctuary sites to build a network of sentinel sites throughout the state for monitoring oyster populations and health.

Source: <http://oceanservice.noaa.gov/sentinelsites/pdf/sentinelsite-northcarolina.pdf>

Coming out of the breakout group discussions was an immediate need and possible next step—an educational event focused on the specifics of the NOAA-TNC Handbook. Breakout group participants saw a benefit to going through an in-depth training on the different monitoring parameters and discussion of relevance to North Carolina.

Breakout Session IV: Building and Sustaining Effective Collaborations

Q1: How do we institute more comprehensive and mutually satisfying project and large-scale initiative planning?

Q2: How can we secure increased and continued funding, collaboration and distribution of resources?

Q3: How can we enhance open and frequent communication and sharing of knowledge among all stakeholders, including decision-makers?

Q4: Are there existing partnership models (i.e. Oyster Recovery Partnership) that we should emulate?

During this breakout session all four groups discussed the importance of continued partnering between academia, government (local, state and federal), environmental nonprofits, private businesses and shellfish producers within the state of North Carolina to achieve oyster restoration and enhancement goals. Key to successful partnering is maintaining close communication between and among groups. Breakout group participants detailed examples of partnerships that work, identified possible new funding sources for both on-the-ground activities and research, as well as discussed how to partner effectively to secure funding. A specific need identified was how to keep the oyster shell recycling program viable in the state following sunset of the N.C. General Assembly tax provision. Other ideas expressed universally in all breakout groups were the importance of working on watershed or regional scales and linking oyster restoration with water quality and watershed restoration goals; and of finding ways to mass communicate project successes and general importance of oysters to the general public, legislature and watermen.

All groups expressed that regular workshops and summits will be helpful to foster collaboration and share lessons learned about oyster restoration projects and research. It was suggested that neighboring states should be included in these workshops. It also was recommended that a website be developed or used as a clearinghouse of information on various projects in the state. The public should be encouraged to engage in discussions about oyster restoration and enhancement efforts. To engage the public better, several of the breakout groups requested that a document or paper be drafted that outlines the oyster plan's objectives, goals, and successes. These talking points then could be used to communicate with the public-at-large and politicians.

The discussion then turned to outlining partnerships that function well. All four breakout groups noted that a funding source to keep partners at the table and engaged was critical

to success. The APNEP will provide near-term funding for waters north of the White Oak River through their Comprehensive Conservation and Management Plan implementation process. All four breakout groups also remarked that having a multi-disciplinary structure to a partnership keeps everyone engaged and has proven successful, and highlighted several multidisciplinary partnerships that presently are working well together: the Walking Fish cooperative; N.C. Catch seafood branding and education initiative; Town of St. James' oyster shell recycling and reef building community project; DMF oyster sanctuary program; N.C. Coastal Reserve & National Estuarine Research Reserve Science Collaborative; and the Oyster Recovery Partnership in Chesapeake Bay. The idea of establishing or creating a "governing" entity or organization was introduced but concern was raised that sometimes such entities divert resources and funding away from on-the-ground projects.

Much of the discussion within all four breakout groups centered on sources of funding and how to be prepared to act on funding requests in a timely manner. Breakout group participants generated a sizable list of potential funding sources for oyster restoration and enhancement projects. Various Department of Defense agencies (e.g., Navy, U.S. Army Corps of Engineers), must conduct mitigation projects, as well as land management practices against environmental contamination. DMF has had some success partnering with these entities on oyster sanctuary activities. There is potential funding from the U.S. Department of Agriculture's Natural Resources Conservation Service, as oyster restoration falls under their Environmental Quality Incentives Program. A regular funder of projects with agricultural producers within the state, this oyster collaborative should work to get oysters included as a priority for assistance in coming years. Another avenue is partnering with businesses corporations that need good public relations or that have "green" initiatives, such as Duke Energy or PCS Phosphate. Bringing in Clean Water Act Section 319 money and linking oyster restoration to the development of TMDLs calling for the restoration of oyster habitat as a way of cleaning closed waters is another possibility. Clean Water Management Trust Fund also will have clean water criteria in an upcoming funding solicitation. Some rather new funding ideas expressed by breakout group participants included folding in the U.S. Fish and Wildlife Service as a partner in oyster restoration, and linking human health to oysters, as a biomarker of environmental health, and partnering with the National Institute of Standards and Technology. To successfully secure funding, all four groups echoed the importance of partnering early and having a project plan in place ahead of a funding call. Key to the project arrangement is making sure all parties' roles and responsibilities are clearly outlined and communicated, and then, being flexible when funding opportunities arise. Funding conversations naturally turned to talking about the challenge of convincing the North Carolina legislature to fund oyster restoration and enhancement activities. In addition to having to better determine "the value" of oyster reefs, projects need to report on job creation and other benefits to the economy and link to other restoration activities. One breakout group participant noted that wetland mitigation has become an industry in its own right.

Some discussion focused on the sunseting of the oyster shell tax credit and the related topic of the recent state budget cut that limits DMF's ability to operate the shell recycling program. A variety of ideas to keep the program viable or to develop an alternative in its place were discussed. Ideas included a tax on oyster sales, with a deposit returned upon recycling, and a media campaign to promote businesses that participate in recycling.

There was general consensus amongst the breakout groups that restoration and enhancement work should be done on regional and watershed scales, so that it is done holistically. Projects should be part of regional strategic plans and priorities. It will be crucial, however, to communicate small-scale project efforts to a larger audience, so the connection of the small project to the larger initiative remains clear. This will allow projects to be understood by the public-at-large and elected officials in a cumulative nature. It also was discussed that a media campaign should be cultivated, and that project efforts should be featured not only when complete but also several months— even years— later to show the long-term impact and success of the work.

A variety of communication strategies for working with the public, politicians and shellfish producers were generated. The goal of the communication strategies would be to increase the audience's understanding of the importance of oysters and the threats the oyster population in North Carolina faces. An idea was floated that the public would benefit from viewing a documentary that depicts the ramifications of a world without oysters; the public would also benefit from engagement strategies, such as touch tanks, visual aids, and oyster roasts wherein the importance of oysters was communicated. The public, politicians and shellfish growers and harvesters should be encouraged to attend future Oyster Summits, where a set of succinct talking points on the goals for oyster restoration and enhancement in the state could be presented. Specific to the legislature, communication with public "champions" would facilitate communicating the importance of oysters. Another strategy to deliver key messaging on the role that oysters play in a healthy coastal economy to politicians is through a political action committee. Finally, while shellfish producers have a relatively good understanding of the importance of oysters, they could benefit from communications that reinforce the importance of oysters as habitat and their ecological services. It was suggested that a slide or two about this role could be incorporated into the statutory requirement for shellfish culture training ahead of bottom lease issuance or renewal.

Another topic that came up during the breakout group discussions was a need to collaborate and work through DMF's upcoming Oyster Fishery Management Plan (FMP) update process. Specific items that the groups identified that need to be addressed through this FMP process include the need to address DMF financial cuts within the oyster sanctuary program that affect and the state's ability to perform work; dredging and its impact to oyster habitat; and impediments to oyster aquaculture and leasing that have been identified. There was mention in a couple of the breakout groups about tapping into the Coastal Recreational Fishing License Grant Program as a source of monies for

continued sanctuary work. DMF was successful in partnering enhancement efforts with a project to create an artificial reef for improved recreational fishing opportunities.

A tangential topic that was discussed in several of the breakout groups was the need to work better with the rejuvenated N.C. Shellfish Growers Association. A concerted effort to engage growers and harvesters in the Blueprint and with projects is needed. The hatchery at the UNCW could help growers by providing larvae to interested persons. In communicating oyster restoration, enhancement and research priorities to the general public and politicians, it would be beneficial to both groups if the grower's priorities were linked somehow to the larger oyster population goals for the state.

N.C. Oysters: A Workshop to Chart Future Restoration, Learning from the Past

National Oceanic & Atmospheric Administration – Beaufort Laboratory Auditorium
101 Pivers Island Road – Beaufort, NC 28516

March 12-13, 2014

Purpose

The workshop will engage participants in a two-day forum focused on assessing the existing body of North Carolina's oyster research and restoration efforts to highlight lessons learned, identify knowledge gaps and recommend options for future oyster research and restoration. Through poster and oral presentations, facilitated discussions and group consensus-building, participants will produce a set of workshop findings that will help determine future action items, strategies, resources and partnerships to achieve robust and resilient N.C. oyster populations that support a viable fishery and provide valuable ecological services. These findings will be used ultimately to revise and update the existing *Oyster Restoration and Protection Plan for N.C.: A Blueprint for Action*. At an anticipated January 2015 N.C. Oyster Summit, workshop findings will be reviewed, and then, incorporated into a third edition of the *Restoration and Protection Plan* that will guide state research and restoration efforts from 2015 to 2020.

Objectives

- Participants will hear and discuss lessons learned from the last 20 years of oyster research, restoration, harvest and management; and
- Participants will aid in the identification and development of needed actions, strategies and resources to ensure healthy oyster habitats as essential fish habitat, as well as for sustainable recreational and commercial harvest.

Agenda

Wednesday, March 12	
9:00 a.m.	Registration & Coffee
9:30 a.m.	Welcome, Introductions and Meeting Objectives Facilitator: Whitney Jenkins, North Carolina Division of Coastal Management (DCM) & North Carolina National Estuarine Research Reserve (NERR)
9:45 a.m.	N.C. Oyster Blueprint: Summary of Major Accomplishments Todd Miller, North Carolina Coastal Federation (NCCF)
10:00 a.m.	Oyster Workshop Survey Overview Brandon Puckett, North Carolina State University, Center for Marine Sciences and Technology (CMAST)
10:15 a.m.	Lightning Round: Organization Updates on Recent Research and

<p>Restoration Efforts Facilitator: Whitney Jenkins, DCM Speakers:</p> <ul style="list-style-type: none"> • Craig Hardy, North Carolina Division of Marine Fisheries (DMF) • Martin Posey, University of North Carolina Wilmington (UNCW) • Brandon Puckett, CMAST • Niels Lindquist, University of North Carolina at Chapel Hill, Institute of Marine Sciences (IMS) • Carolyn Currin, Center for Coastal Fisheries and Habitat Research, National Oceanic Atmospheric Administration (NOAA) • Aaron McCall, The Nature Conservancy (TNC) • Ted Wilgis, NCCF 	
11:15 a.m.	Break
11:30 a.m.	<p>Keynote Address: An overview of current oyster reef ecology and restoration efforts across the U.S. with a focus on related goals, metrics, and methodologies Loren Coen, Florida Atlantic University (FAU)</p>
12:00 p.m.	Lunch
12:45 p.m.	<p>Introduction to Panel and Breakout Session Structure Erin Fleckenstein, NCCF</p>
12:50 p.m.	<p>Panel I: Scaling-up Restoration and Enhancement Efforts - Where are we going and how are we going to get there?</p> <ul style="list-style-type: none"> • Objective: Speakers will discuss setting goals and targets for oyster restoration by identifying the status of the current and/or historical oyster population, setting future population goals, and determining how restoration and enhancement will be used to meet identified goal(s). • Facilitator: Erin Fleckenstein, NCCF • Speakers: <ul style="list-style-type: none"> ○ Mike Marshall, DMF ○ Brandon Puckett, CMAST ○ Jay Styron, UNCW ○ Ami Wilbur, UNCW ○ Lindsey Smart, Albemarle-Pamlico National Estuary Partnership (APNEP) ○ Bryan DeAngelis, TNC
1:50 p.m.	<p>Breakout Groups I: Scaling-up Restoration and Enhancement Efforts</p> <ul style="list-style-type: none"> • Objective: Participants will discuss setting goals and targets for oyster restoration by identifying the status of the current and/or historical oyster population, setting future population goals, and determining

	how restoration and enhancement will be used to meet identified goal(s).
2:50 p.m.	Break
3:05 p.m.	<p>Panel II: Implementing Restoration, Research, and Enhancement Projects</p> <ul style="list-style-type: none"> • Objective: Speakers will provide guidance on the development of a project decision-support tool, which would help identify and support site selection, project design, coordination and construction, as well as site-specific best management practices. • Facilitator: Brandon Puckett, CMAST • Speakers: <ul style="list-style-type: none"> ○ Jessie Baker, DCM ○ Raleigh Bland, USACE ○ Craig Hardy, DMF ○ Martin Posey, UNCW ○ Niels Lindquist, IMS ○ Loren Coen, FAU
3:50 p.m.	<p>Breakout Groups II: Implementing Restoration, Research, and Enhancement Projects</p> <ul style="list-style-type: none"> • Objective: Participants will provide guidance on the development of a project decision-support tool, which would help identify and support site selection, project design, coordination and construction, as well as site-specific best management practices.
4:50 p.m.	Closing Remarks
5:00 p.m.	Adjourn
5:30 p.m.	<p>Poster Social Duke University Marine Lab Auditorium – Hors d'oeuvres & Cash Bar</p>
7:00 p.m.	Adjourn Poster Social
Thursday, March 13	
8:00 a.m.	Coffee
8:30 a.m.	Welcome Back and Announcements
8:40 a.m.	Breakout Groups Report-out
9:40 a.m.	<p>Panel III: Project Evaluation and Monitoring</p> <ul style="list-style-type: none"> • Objective: Speakers will discuss developing North Carolina "universal" monitoring procedures and metrics so that data collected in the state can be evaluated & shared in a standard format. • Facilitator: Ted Wilgis, NCCF • Speakers: <ul style="list-style-type: none"> ○ Loren Coen, FAU

Appendix A: Workshop Agenda

	<ul style="list-style-type: none"> ○ Bryan DeAngelis, TNC ○ Troy Alphin, UNCW ○ Craig Hardy, DMF ○ Patti Fowler, Shellfish Sanitation & Recreation Water Quality Section, DMF ○ Tony Rodriguez, IMS ○ Mike Piehler, IMS
10:30 a.m.	Break
10:45 a.m.	Breakout Groups III: Project Evaluation and Monitoring <ul style="list-style-type: none"> ● Objective: Participants will discuss developing North Carolina "universal" monitoring procedures and metrics so that data collected in the state can be evaluated & shared in a standard format.
11:40 a.m.	Panel IV: Building and Sustaining Effective Collaborations <ul style="list-style-type: none"> ● Objective: Speakers will discuss what is needed for continued collaboration and coordination to build on momentum from current restoration efforts and to implement workshop recommendations. ● Facilitator: Ted Wilgis, NCCF ● Speakers: <ul style="list-style-type: none"> ○ Taylor Ryan, Town of St. James ○ Craig Hardy, DMF ○ Bill Crowell, APNEP ○ Bryan DeAngelis, TNC ○ Todd Miller, NCCF ○ Loren Coen, FAU
12:30 p.m.	Lunch
1:15 p.m.	Breakout Groups IV: Building and Sustaining Effective Collaborations <ul style="list-style-type: none"> ● Objective: Participants will discuss what is needed for continued collaboration and coordination to build on momentum from current restoration efforts and to implement workshop recommendations.
2:15 p.m.	Breakout Groups Report-out
3:15 p.m.	Oyster Restoration News Items <ul style="list-style-type: none"> ● Objective: In this informal group discussion, participants can share updates on projects not covered during the workshop, including political/policy updates. ● Facilitator: Whitney Jenkins, DCM
3:45 p.m.	Workshop Wrap-up and Next Steps Facilitators: Erin Fleckenstein & Ted Wilgis, NCCF
4:00 p.m.	Adjourn

Participant Information

In alphabetical order by last name, the workshop attendees were:

First Name	Last Name	Affiliation
Troy	Alphin	University of North Carolina Wilmington- Center for Marine Science
Jessi	Baker	NC Division of Coastal Management
Eugene	Ballance	Commercial Fisherman
Tere	Barrett	NC Division of Marine Fisheries
Raleigh	Bland	US Army Corps of Engineers / Washington Regulatory Field Office
Gregg	Bodnar	NC Division of Marine Fisheries
Michelle	Brodeur	UNC Chapel Hill - Institute of Marine Sciences
Matthew	Butler	Pamlico-Tar River Foundation
David	Cessna	Commercial Oysterman
Scott	Chappell	U.S. Navy (civilization environmental staff)
Loren	Coen	Department of Biological Sciences and Harbor Branch Oceanographic Institute, Florida Atlantic University
Brian	Conrad	NC Division of Marine Fisheries
Bill	Crowell	Albemarle-Pamlico National Estuary Partnership
Carolyn	Currin	NOAA NCCOS
Anne	Deaton	NC Division of Marine Fisheries
Bryan	DeAngelis	The Nature Conservancy
Jennifer	Dorton	University of North Carolina Wilmington
Joe	Facendola	NC Division of Marine Fisheries
Stephen	Fegley	UNC Chapel Hill - Institute of Marine Sciences
Erin	Fleckenstein	NC Coastal Federation
Patti	Fowler	NC Division of Marine Fisheries, Shellfish Sanitation & Recreational Water Quality
Rachel	Gittman	UNC Chapel Hill - Institute of Marine Sciences
Rodney	Guajardo	UNC Chapel Hill - Institute of Marine Sciences
Denise	Halminski	independent
Michael	Halminski	independent
Craig	Hardy	NC Division of Marine Fisheries
Joey	Hester	NC Division of Soil & Water Conservation
James	Hunt	
Shannon	Jenkins	NC Division of Marine Fisheries, Shellfish Sanitation and Recreational Water Quality
Whitney	Jenkins	NC Division of Coastal Management, National Estuarine Research Reserve

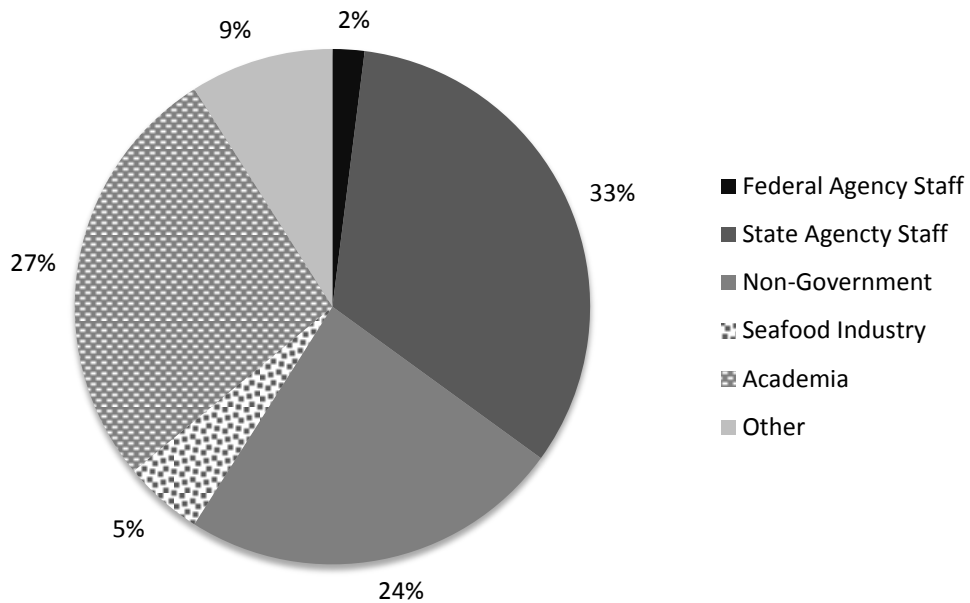
Appendix B: Workshop Participants

Chris	Jensen	NC Division of Marine Fisheries
Christine	Jensen	NC Division of Marine Fisheries
Jimmy	Johnson	Albemarle-Pamlico National Estuary Partnership, NC Division of Marine Fisheries
Michael	Jordan	NC Division of Marine Fisheries
Danielle	Keller	UNC Chapel Hill - Institute of Marine Sciences
Ashlee	Lillis	North Carolina State University
Niels	Lindquist	UNC Chapel Hill - Institute of Marine Sciences
Mike	Marshall	NC Division of Marine Fisheries
Wayne	Mathis	Cape Hatteras Anglers Club (Director); Outer Banks Preservation Association (Director)
Aaron	McCall	The Nature Conservancy
Todd	Miller	NC Coastal Federation
Will	Morgan	The Nature Conservancy
James	Morris	National Oceanic and Atmospheric Administration
Jason	Peters	NC State University, NC Division of Marine Fisheries
Mike	Piehler	UNC Chapel Hill - Institute of Marine Sciences
Martin	Posey	University of North Carolina Wilmington
Brandon	Puckett	NC State University- Center for Marine Science and Technology
Justin	Ridge	UNC Chapel Hill - Institute of Marine Sciences
Amy	Ringwood	UNC-Charlotte
Tony	Rodriguez	UNC Chapel Hill - Institute of Marine Sciences
J. Taylor	Ryan	St James Oyster Shell Recycling & Reef Building Project
Allie	Sheffield	NC Coastal Federation, Pender Watch
Tracy	Skrabal	NC Coastal Federation
Lindsey	Smart	Albemarle-Pamlico National Estuary Partnership
Jay	Styron	University of North Carolina Wilmington
Natalie	Taylor	UNC Chapel Hill - Institute of Marine Sciences
Seth	Theuerkauf	NC State University
Jack	Thigpen	NC Sea Grant
Adam	Tyler	Commercial Oysterman
Lexia	Weaver	NC Coastal Federation
Curtis	Weychert	NC Division of Marine Fisheries
Ami	Wilbur	University of North Carolina Wilmington, Shellfish Research Hatchery
Ted	Wilgis	NC Coastal Federation
John	Zimmerman	Shellfish Gardeners of NC

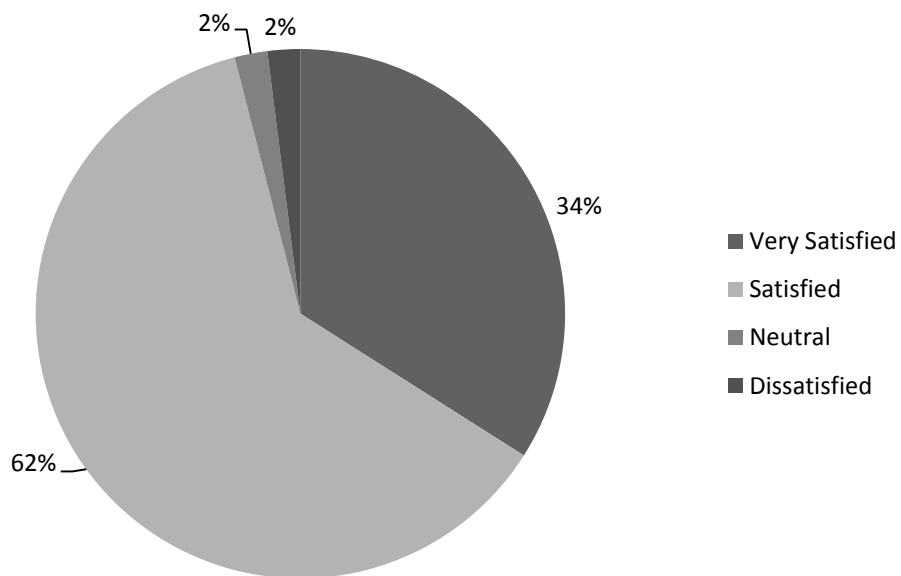
Exit Survey Results

Forty-five of 61 total workshop attendees submitted surveys and responded as following:

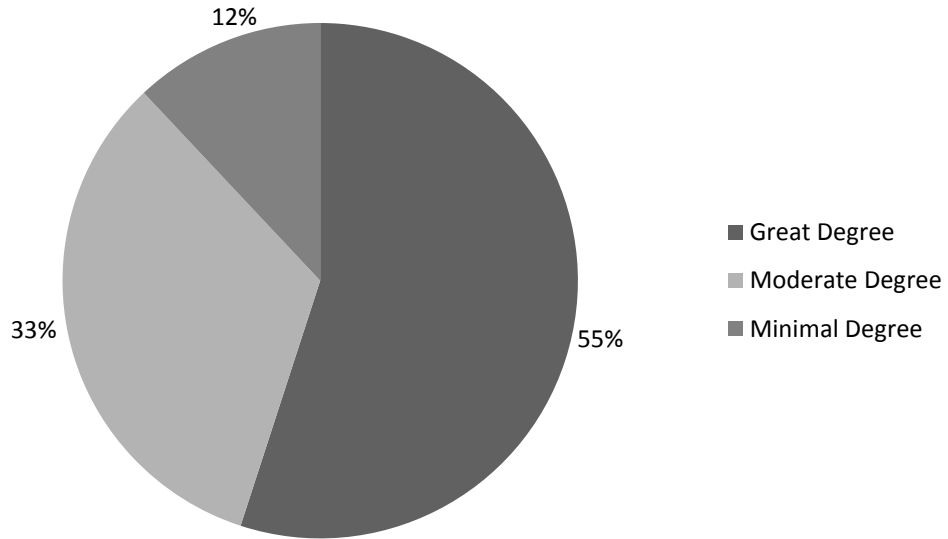
Q1 Please indicate your affiliation.



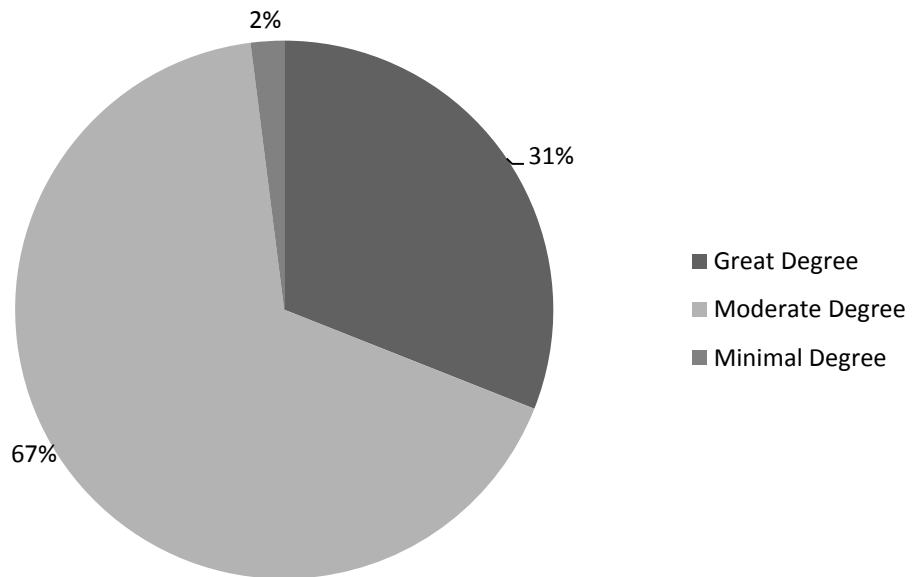
Q2 How satisfied were you with the information available overall at this workshop?



Q3 To what degree were the resources available in the registration folder (e.g., abstracts, survey summary, resource list) of educational value?



Q4 To what degree has this workshop given you new viewpoints and insights?



Q5 Please rate the usefulness of oral presentations, from "Very Useful" to "Of No Use."

Presentation	Results		Raw scores				
	Percent Very Useful or Useful	Percent Minimal Use or Of No Use	Very Useful	Useful	Some-what Useful	Minimal Use	Of No Use
Organization Updates on Recent Research & Restoration Efforts	98%	0%	15	25	1	0	0
Keynote: Overview of Current Oyster Reef Ecology & Restoration Efforts in U.S.	76%	7%	10	21	7	3	0
Panel 1: Scaling-up Restoration & Enhancement Efforts	88%	2%	10	26	4	1	0
Panel 2: Implementing Restoration, Research & Enhancement Projects	83%	2%	12	22	6	1	0
Panel 3: Project Evaluation & Monitoring	90%	2%	13	24	3	1	0
Panel 4: Building & Sustaining Effective Collaborations	85%	0%	15	19	6	0	0

Appendix C: Exit Survey Results

Q6 Please rate the effectiveness of the workshop format, from "Very Effective" to "Ineffective."

	Results		Very Effective	Moderately Effective	Minimally Effective	Ineffective
	Percent Very Effective or Moderately Effective	Percent Minimally Effective or Ineffective				
The lightning round style of presentation was effective in transmitting key points.	98	2%	24	17	1	0
The time allotted to the different presentations was effective at keeping the meeting fast-paced and engaging	95%	5%	27	13	2	0
The poster session allowed for effective networking and discussions with peers on a broader range of topics	88%	12%	11	19	4	0
The breakout sessions were effective at offering opportunities to expand on presented topics, share additional information, and develop take home messages	95%	5%	17	22	3	0

Q7. Were your expectations met for the workshop? Why or why not?

The majority of respondents felt that their expectations of the workshop were met (30); five respondents expressed dissatisfaction or only mild satisfaction from the workshop.

Comments

(Number indicates respondents who identified with each issue)

- Allowed networking and diffusion of information of work being done across NC. 8
- Lightning round was a good concept but presenters needed clearer instructions on length of presentation 4
- More time for discussion 2
- No breakthrough moments 1
- Goals of the workshop unclear 1
- Would have liked presentations from mariculture and U-dock oyster gardeners 1
- Would have liked more science-related results (particularly in keynote address) 1
- Was expecting the group as a whole to settle on a few tangible, accomplishable goals in the field of oyster restoration that could be achieved 1

Q8. What was the most beneficial part of the workshop?

- Networking with other oyster oriented people and learning what others are doing 13
- Breakout Sessions 9
- Information sharing 5
- Breadth of presentation/information 4
- Keynote/Overview 2
- Lightning Round style of presentations 2
- Poster Session 1

Q9. In what ways would you improve this workshop for the future?

- More structured breakout groups & discussion points, address different topics 7
- More diversity in participants and presenters (i.e. out of state--Chesapeake Bay, industries, more graduate students) 5
- More time for whole group discussion (less breakout time) 5
- Longer conference 4
- Liked the conference as is 3
- Make poster session more easily accessible (regarding scheduling and location) 2
- More equity between presenter podium time 2
- Have presenters use microphone and repeat audience questions 1
- Clarify the concept of lightning round to the presenters 1
- Establish Action Items 1
- Field trip 1
- Include power points in the notebook 1

Q10. Are you interested in being a part of the 2015 Oyster Summit planning process?

Nearly 60% of the workshop participants expressed interest in being a part of the planning.

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