Best Management Practices for Shellfish Restoration

Prepared for the ISSC Shellfish Restoration Committee

Dorothy Leonard and Sandra Macfarlane

10/1/2011

The authors are grateful for the reviews provided by:

Dr. Rob Brumbaugh

Dr. Boze Hancock

Summer Morlock

Dr. Robert Rheault

Thank you to those who provided financial and administrative support:

The ISSC Executive Office

Partnership between The Nature Conservancy and the NOAA Community-based Restoration Program

Table of Contents

Executive Summary

The objectives of the Best Practices for Shellfish Restoration (BMPs) project are to establish methods which include protocols for educational programs and safeguards to ensure that shellfish grown in unapproved areas do not reach the market. The project was recommended by the Shellfish Restoration Committee of the Interstate Shellfish Sanitation Conference (ISSC) at their biennial meeting in 2009. The Nature Conservancy (TNC), through a National Partnership with the NOAA Restoration Center, is working with ISSC on this project to guide future shellfish restoration projects that incorporate educational components designed to protect public health.

The project was designed around seven workshops at regional ISSC and other professional shellfish management meetings, drawing together stakeholders representing state regulatory agencies and public health officials, extension specialists, shellfish industry, non-government organizations, representatives of shellfish gardening programs and other appropriate parties to identify critical issues and solutions.

The workshops brought together those who had, at times, differing views to agree upon best practices for restoration to restore critical shellfish areas while protecting public health. The goal was to use workshop results to provide guidelines that address the needs of stakeholders while establishing protocols for the biosecurity of restoration projects, including educational outreach, and to encourage consistency from state to state. The results of the workshops were incorporated in the report that was recommended for incorporation into the NSSP at the 2011 meeting of the Committee.

The BMPs recommended by workshop participants are grouped under 5 headings:

- protect public health while restoring the environment;
- define goals and objectives of restoration projects;
- expand communication and education;

- expand community-wide restoration and,
- when practical, use noncommercial species in restoration efforts.

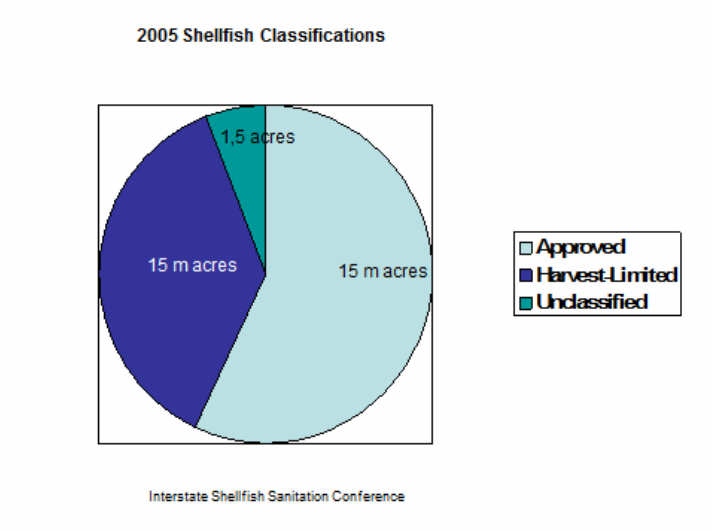
A theme identified throughout the workshop sessions was the need for better planning and earlier communication among all parties. Participants suggested forming partnerships among restoration proposers, regulators, funding agencies, academic institutions and non-government organizations to promote restoration of native shellfish and ecosystem services and to conserve and restore coastal water quality. Although most regulators preferred that restoration activities were only sited in approved waters it was agreed that activities could occur in unapproved waters but would require additional plans for the biosecurity of projects and an education component (biology, growing methods, pests competitors, diseases and public health) for restoration programs using volunteers .

Many of the current and planned projects encourage restoration in community associations where people can work together to improve the environment in their own back yard often by growing shellfish on their own property or in community "plots". The community volunteers help shellfish control agencies conduct water sampling, provide education and protect the security of the site. They often share knowledge through lectures, written articles, and as guest speakers at civic association meetings and other community events. These local education efforts start shell recycling programs, expand the understanding of the local environment and form a cadre of individuals who protect and ensure the security of the restoration site. Emerging are more efforts to use noncommercial species in restoration efforts, particularly if biosecurity of the sites are a major concern.

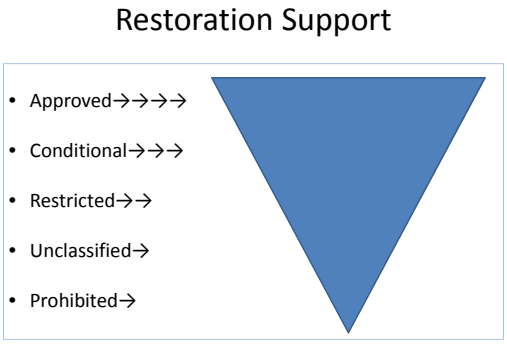
Recommendations for Best Management Practices for Shellfish Restoration

1. Protect public health while restoring the environment

Restoration of shellfish should be conducted in approved waters if possible. The information presented in this report indicates that there is sufficient acreage to conduct numerous restoration projects without using waters that have not been surveyed, or areas that are restricted or prohibited for shellfish harvest. However, in some projects the objective is to "clean up" the body of water. Although often interpreted as reducing fecal coliform levels the goal may be quite different. For example, drawing attention to a compromised body of water will encourage the community to identify and clean up sources of pollution. In other cases, the job of the shellfish is to filter the system providing more clarity for submerged aquatic vegetation. The restoration specialists should recognize that the shellfish control officers are charged with protecting public health and preventing illness. They are responding to an industry that wants to protect their reputation for providing safe and wholesome shellfish to the public.



One of the major objections to shellfish restoration is the fear that bootlegging may take place allowing uncertified product to reach the consumer. If one person falls ill from consuming shellfish consumer confidence may be eroded, which can cause economic damage to the industry. A plan for biosecurity needs to be included in each project proposal and, if possible, part of the final funding package. Projects may need to hire security personnel – local sheriff's office personnel or private security. Enforcement options can include the use of surveillance cameras, employing retired health inspectors, web cams, and on-board GPS systems and incorporating technological equipment used by other law enforcement agents to prevent poaching or catch and arrest those involved in illegal harvesting. In some states it will be necessary to increase fines and penalties.



On the other hand, the regulators need to work closely with the restoration community. Every effort should be made to upgrade classifications of shellfish waters including additional surveys and sampling of growing waters and expanding monitoring and enforcement. Early planning by the restoration community and regulators can greatly expand restoration efforts while protecting public health and the environment.

BMPs

- Form partnerships among restoration proposers, regulators, funding agencies, academic institutions and non-government organizations to promote restoration of native shellfish and ecosystem services, and to conserve and restore coastal water quality.
- Conduct restoration projects in open waters and those historically suitable for shellfish whenever possible.
- Submit additional plans for biosecurity of projects in non-approved waters working closely with enforcement officials and, when suitable, include funding for security efforts in project cost.

- Submit restoration project information to state resource managers, to provide centralized records and data bases.

Define goals and objectives of restoration projects

There is a need to clearly define goals and objectives for oyster restoration, whether the objective is habitat restoration, resource enhancement or production of shellfish for human consumption. The design of the project, funding level and source, required permits, monitoring of results and keeping track of all the elements of the project are critical to eventual success. Using shellfish for water quality improvement could mean different things depending on the program objectives– nutrient reduction, bacterial reduction or sometimes both. Needed are concurrent programs that trace the pollution sources and apply corrective measures. However, in most recent restoration projects, the goal has been the habitat value of oyster reefs and the ecosystem services provided by filtering shellfish.

BMPs

- Define goals and objectives in project proposals, actions to achieve them, methods to track project results and responsibilities of partners in the project.
- Establish criteria to define project success for: ecological services; harvest – who, when, how much; sanctuary - how long; relay - size, security, harvest requirements; reef-building - structural/ecological stability.

Expand Communication and Education

Early communication should occur between state fisheries agencies/public health officials and project proponents, and universities. Regulators need to make certain that the requirements of NSSP are clearly understood and restoration specialists need to provide key information that the requirements of NSSP will be incorporated into their program. Advance planning and early communication can be the key to a successful restoration project. In some projects such as the Lynnhaven River in Virginia, upgrades in classification are a result of the restoration programs and are successful because they were a collaborative effort from the beginning. Adding the

dimension of agri-tourism can be beneficial as well as community education. Education should include potential disease transmission and destructive invasive species and the risks involved.

BMPs

- Prior to applications and funding, meet with state resource managers to discuss potential issues; include location, participants, duration, project goals, methods, species of shellfish, potential harvest or relay requirements, site maintenance and security measures.
- Discuss shellfish gardening locations and plan for oversight by resource managers.
- Provide education component (biology, growing methods, pests, competitors, diseases and public health aspects of shellfish) for restoration programs using volunteers.
- Demonstrate to health officials that plans to educate volunteers will ensure that shellfish grown in unapproved waters will not be consumed.
- Use project to educate public about estuaries, growing shellfish and the importance of shellfish in maintaining biological health of an estuary.

Expand community-wide restoration

We need to engage the broader community in restoration efforts. These can include master oyster gardening, annual workshops, tours, speakers' bureaus, kiosks, monthly newsletters and websites. Education should include high school teacher training programs. Keeping volunteers motivated is a challenging aspect of long-term projects. There is often a high turnover and a need to bring new people in, broadening the education of the community.

Many community-based programs begin with the training of volunteers to conduct water quality monitoring augmenting "official" samples. Training by professionals and continued surveillance provides education and expands surveillance. Accuracy could be checked by dual sampling with certified techniques. Volunteers are usually reliable, and feel committed to the maintenance of environmental quality. In some communities a school or private laboratory can allow for the tracking of rain events or find source contamination in the neighborhood that can be later

checked by a certified lab. With volunteers taking water samples and monitoring waters, there are more “eyes on the water” to observe what is going on.

BMPs

- Encourage restoration in community associations where people can work together to improve the environment in their own back yard.
- Share knowledge through lectures, written articles, and as guest speakers at civic association meetings and other community events.
- Start shell recycling programs.
- Provide volunteers to help shellfish control agencies conduct water sampling, provide education and security of the site. State agencies should solicit and accept volunteer help when appropriate.

Use noncommercial species in restoration efforts

The use of alternative noncommercial species is a possible approach to expand opportunities in certain habitats and waters that are not approved. There are many species that may be appropriate for restoration but recognizing the problems associated with the zebra mussel in the Great Lakes, the selected species should be native to the system being restored.

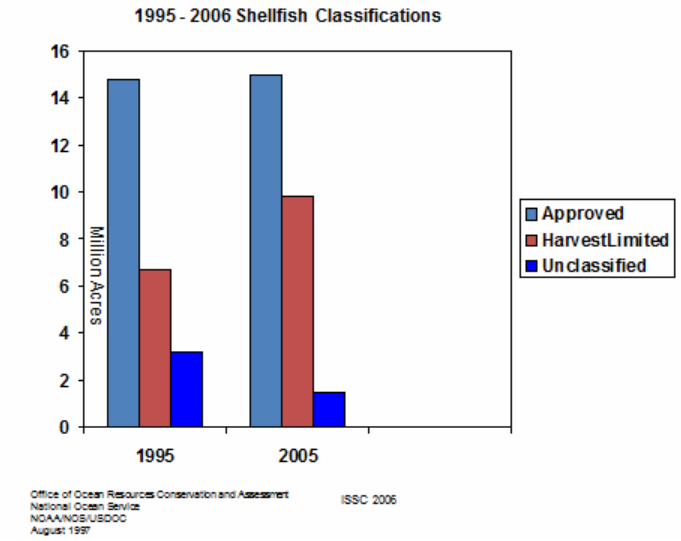
BMPs

- Use commercially important species as a first choice but if biosecurity of commercial species is a concern, consider alternative native species for their filtering capacity and beneficial role in the ecosystem.

Introduction

Molluscan shellfish populations throughout the nation have declined significantly with a precipitous decline occurring during the last half of the 20th century. http://www.st.nmfs.noaa.gov/st1/commercial/landings/annual_landings.html. Shellfish are a highly valuable resource providing a healthy food source, an economic boon to local economies through commercial and recreational harvesting and numerous ecosystem services such as improvements to water quality, habitat for numerous estuarine species and erosion control through reef building (Coen et al., 2007) The combination of the serious population declines and importance of shellfish to coastal states have led to shellfish restoration programs designed to improve the current situation. Most often these programs fall within the requirements of the National Shellfish Sanitation Program (NSSP).

The NSSP requires that the state shellfish control agency classify shellfish growing areas into one of five classifications: approved, conditionally approved, restricted, conditionally restricted and prohibited. A growing area in the approved classification is always in the open status except for an emergency situation such as conditions following a significant rain event or hurricane when a growing area in the approved classification may be placed temporarily in the closed status.



The remaining four growing area classifications all place some type of restriction on shellstock harvesting such as a harvest prohibition for a specified duration or until test results show appreciable improvement in the water quality. For more information concerning the enforcement of these restrictions, see the NSSP Guidance Document, *Growing Area Patrol and Enforcement of Growing Area Restrictions* (ISSC/FDA, 2002).

Project Description

The project to develop best practices for shellfish restoration was recommended by the Shellfish Restoration Committee of the ISSC, (*Shellfish Restoration Committee Report 2009***,** Appendix A)**.** The Interstate Shellfish Sanitation Conference (ISSC) was formed in 1982 to foster and promote shellfish sanitation through the cooperation of state and federal control agencies, the shellfish industry, and the academic community. The ISSC promotes cooperation and trust among shellfish control agencies, the shellfish industry, and consumers of shellfish; and ensures the safety of shellfish products consumed in the United States. Article II, Section 1 of the ISSC Constitution states the objective of the Conference shall be to foster and improve the sanitation of shellfish in this country and to encourage restoration of shellfish growing areas.

The charge to the Shellfish Restoration Standing Committee is to review restoration information that could impact shellfish sanitation and the National Shellfish Sanitation Program (NSSP) and to identify proactive efforts in which Conference involvement would encourage restoration of shellfish growing areas. In October, 2009, the Shellfish Restoration Committee, with the approval of the Executive Board, made the following recommendation: "ISSC consider working with restoration practitioners to develop a set of best practices to guide restoration efforts and provide public health education ." (Appendix A).

The decline of shellfish abundance, coupled with compromised water quality, has spurred the interest in shellfish restoration. While most restoration efforts have also centered on the American oyster, other species such as the native Olympia oyster (*Ostreola conchila*), hard clams (*Mercenaria mercenaria*), soft clams (*Mya arenaria*), mussels (*Mytilus edulis*) and scallops (*Argopecten irradians*) have also received attention of shellfish restoration efforts.

The objectives of the project are to establish best management practices which include protocols for educational programs and safeguards to ensure that shellfish raised in unapproved areas do not reach the market.

The first task was to determine what Best Management Practices are and how they can be applied to shellfish restoration. Wikipedia defines **Best Practices** as generally-accepted, informally-standardized techniques, methods or processes that have proven themselves over time

to accomplish given tasks. Often based upon common sense, these practices are commonly used where no specific formal methodology is in place or the existing methodology does not sufficiently address the issue. The idea is that with proper processes, checks and testing, a desired outcome can be delivered more effectively with fewer problems and unforeseen complications. In addition, a "best" practice can evolve and become more effective as improvements are discovered. Although there are examples in environmental management the closest comparison to best management in shellfish restoration is BMPs for aquaculture.

The Nature Conservancy is working with ISSC on this project to open more opportunities for shellfish restoration while developing education programs that protect public health. The project was designed to organize and facilitate workshops at regional ISSC and other professional meetings, drawing together stakeholders representing state regulators and public health officials, extension specialists, non-government organizations, representatives of shellfish gardening programs and other appropriate parties to identify critical issues and solutions. Handouts (Appendix B) were prepared for each meeting and PowerPoint presentations (Appendix C) used to guide discussions.

This project brought together many differing opinions to agree upon best practices for restoration that restore critical shellfish areas while protecting public health. It was hoped that restoration best practices could provide guidelines to address the needs of stakeholders while establishing consistent education guidelines and protocols for the biosecurity of restoration projects that can be used in all states.

Background

The Nature Conservancy, in partnership with NOAA Restoration Center produced the publication: A Practitioners Guide to the Design and Monitoring of Shellfish Restoration Projects http://www.nmfs.noaa.gov/habitat/restoration/publications/TNCNOAAshellfish_hotlinks_final.pdf which describes shellfish restoration programs and their practitioners. The publication also stresses the need for national best practices for shellfish restoration projects. The Nature Conservancy recently produced another report , Shellfish Reefs at Risk, http://conserveonline.org/library/shellfish-reefs-at-risk-report/@@view.html from an article in BioScience, *Oyster reefs at risk and recommendations for conservation, restoration and management.* (Beck et al., 2011). The authors point out that 85% of reefs have been lost globally and of the remaining, in most bays and ecoregions, the majority is classified as at less than 10% of "prior abundance", and that in many areas of North America, Europe and Australia, reefs are presently considered functionally extinct, lacking the ability to be sustainable.

The US continues to have one of the richest natural oyster resources in the world – the Gulf of Mexico – still productive despite significant declines in numerous bays. The authors state that they believe "despite the continued decline of oyster reefs, their condition may be improved through conservation, restoration, and management of fisheries and nonnative species". They suggest that innovation is needed for oyster reef management for fisheries production, and for providing ecosystem services. They suggest that opportunities exist for restoration in areas of poor water quality but incentives and cooperation and partnerships with managers and other stakeholders are necessary.

Project Process

Why did we use this approach?

We used the process described below because we knew that it had been successfully used for the shellfish aquaculture industry. Both the Pacific Coast Shellfish Growers Association and the East Coast Shellfish Growers Association developed Best Management Practices to address stakeholder concerns. Within the last decade, the shellfish aquaculture industry recognized that differences in growing methods, equipment handling, and the visibility of the industry to the public required that protocols be developed to ensure wise stewardship of coastal waters. Restoration programs have no equivalent set of standards. Their purpose, design, and execution are highly variable, signaling a need for best management practices.

The East Coast Shellfish Growers Association-sponsored project held workshops throughout the East Coast, inviting stakeholders to convene and discuss concerns relative to their particular perspective. Team members presented a short introductory program identifying issues known to be problematic to some sectors and describing what BMPs were. Participants were asked to comment on those issues or others they thought germane to the task at hand. Results were analyzed and through the process, the team identified specific actions related to issues that were, in fact, best practices. The process used for the ECSGA project, the number of people participating and the results suggested that a similar format was appropriate for the shellfish restoration project

The shellfish restoration project team organized and facilitated six well-attended meetings in conjunction with three annual regional ISSC meetings – PacRim, Gulf and South Atlantic Shellfish Sanitation Conference (GSASSC), and Northeast Shellfish Sanitation Association (NESSA), the International Conference on Shellfish Restoration (ICSR), the Pacific Coast Shellfish Growers Association/National Shellfisheries Association West Coast Chapter and the Milford Aquaculture Seminar. A total of 320 people attended these workshops. Brief descriptions of these meetings follow and the original notes can be found in Appendix D.

Workshop Locations and Key Discussion Points

PacRim: The regional PacRim shellfish sanitation meeting held in Stevenson, Washington was selected as our first workshop venue (Appendix D1). Representation from Alaska to California and Hawaii included regulators, Sea Grant, and Cooperative Extension agents and industry. About 40 participants made recommendations on a broad set of issues including: water quality and land use mitigation, private ownership of tidelands; Native American tribal rights and the amount of classified growing waters relative to entire shoreline.

GSASSC: The second meeting, Gulf and South Atlantic Shellfish Sanitation Conference (GSASSC), took place in Orange Beach, Alabama, (Appendix D2) in the Gulf of Mexico/South Atlantic region with a similar mix of people as PacRim. Although regional differences were evident, the 50 attendees addressed similar issues: the fact that states use different approaches to restoration; inter-agency regulatory conflict, for example the Endangered Species Act and the need for better education for oyster gardeners.

PCSGA/NSA: The Pacific Coast Shellfish Growers Association (PCSGA) and West Coast Section of the National Shellfisheries Association (NSA) (Appendix D3) invited us to hold a workshop at their annual meeting in Tacoma, WA. This meeting was attended by 50 people, predominantly industry representatives and scientists with very few regulators. Discussion was lively with the identification of issues including: the cautionary tale of the NJ Baykeeper

program; the use of sophisticated surveillance techniques; the possible inclusion of enforcement in restoration funding and the need for and advisability of advance planning for restoration projects.

ICSR: The International Conference on Shellfish Restoration, held in Charleston, SC (Appendix D4) attracted 50 restoration specialists with fewer industry and regulatory representatives. Issues identified by the attendees included: the possible need for a risk assessment and whether there was an actual risk with restoration in closed areas; the difference between unclassified and unapproved areas; the filtration capacity of shellfish to clean up a system and the number of shellfish required to do so and harvest versus sanctuaries.

MAS: The Milford Aquaculture Seminar is a meeting sponsored by the NOAA Milford Laboratory, Milford, CT (Appendix D5), reflecting the joint interests of scientists, managers, industry and some regulators from the Northeast states. It has been held annually for over 30 years. Fifty people discussed two main themes of restoration including the use of alternative species and education. Issues included: the difference between New Jersey and New York restoration programs in closed waters; programs using alternative species such as *Geukensia demissa*, ribbed mussel ; what elements of an education program were most needed for public programs such as shellfish gardening; why there was a perceived difference in the way regulators treated the enforcement of naturally productive closed areas and restoration projects; whether spawning stock in sanctuaries promote disease resistance or disease and subsistence harvest in closed areas.

NESSA: Our sixth and last meeting in Portsmouth, New Hampshire (Appendix D6) presented new challenges to the workshop format as three states, New Jersey, New York and Connecticut could only participate through teleconferencing. Altogether nearly 60 people participated in the workshop providing the greatest mix of regulators and restorers in the same room. As a result, the discussion provided an opportunity for a lively exchange of viewpoints, especially with respect to restoration in closed areas. Issues discussed were:

1) The inability of states to manage the number of people and locations of individual efforts such as gardening and therefore their reticence to approve such programs
2) The desire to promote commercial aquaculture and avoid permitting of projects that might jeopardize the industry
3) The difference in educational levels of restoration practitioners and volunteers
4) Inadequate funding of marine patrols to provide surveillance for the extensive amount of shoreline they are responsible for
5) The need to rank habitat projects based on importance of services they provide
6) The differences in water quality mitigation between reduction of nutrients and reduction of bacteria.

We were unable to address issues in the Mid-Atlantic region as there was no room on the agenda of the annual Interstate Seafood Seminar held in Ocean City, MD. We attended the meeting, discussing restoration issues on a one-to-one basis.

For those interested in a summary of each workshops and original notes from the workshops, please see Appendix D.

General Workshop Themes:

- Restoration practitioners felt that shellfish restoration was a method to improve water quality, increase habitat, provide shoreline stability, increase diversity and generally improve the estuarine environment. Many felt that projects could be sufficiently planned and executed to prevent consumption of shellfish raised in prohibited waters but acknowledged that surveillance was a must. Identifying appropriate persons for surveillance was a discussion point.
- Shellfish gardening in prohibited areas was seen as a small enough endeavor, especially where shellfish was contained, that harvest would not be an issue but they acknowledged that education was a key ingredient for any successful program.

- Industry, for the most part, was disinclined to favor restoration programs in prohibited waters for fear of shellfish from unapproved areas reaching the consumer one way or another, sometimes resulting in bad press; a situation that is difficult to recover from. However, industry was in favor of restoration in all other waters for the beneficial aspects of restoration programs that positively affect the entire industry. (See additional information on a change to industry responses/perspectives, p. 23)

- Shellfish managers were not overly enthusiastic about restoration programs, especially in prohibited waters, because of enforcement, lack of oversight in locating projects, the number of individuals participating (especially with shellfish gardening), lack of communication with practitioners and lack of funds and personnel to keep track of the projects. However they were cognizant of the potential positive attributes to some of the programs especially with respect to ecosystem services provided and welcomed an opportunity to seek solutions.

- Enforcement was a key issue. Shellfish restoration projects could require additional surveillance and enforcement capabilities currently stretched thin in all states. Prohibited areas already present challenges to enforcement personnel without adding restoration projects. Classifying areas currently unclassified will require additional enforcement personnel and an on-going program in areas that are classified as less than approved to maintain compliance with the NSSP.

- Communication was seen as a key ingredient for all restoration projects and it was emphasized that communication should start early in the process to avoid potential problems once a program is underway. Educating the public about the problems of estuaries in general and the specifics of individual species culture can go a long way toward improving the health of estuaries. It was felt among most participants that an educational component should be required of all restoration programs prior to implementation.

- Private land ownership in Washington provided specific challenges that are not experienced elsewhere.

- The use of alternative non-commercial species may help with water quality but it was seen as an impractical approach from a funding point of view when commercial species can do "double duty" as mitigating water quality issues and then, if safe, as a food item.

Results

The focus on shellfish restoration has increased steadily over the last decade. Shellfish reefs and beds are now recognized as a priority habitat type within NOAA, NFWF and the EPA because of the ecosystem services they provide, including their classification as Essential Fish Habitat. There is also increasing use of oyster reef as a 'Natural Engineering' alternative for shoreline protection, sometimes referred to as "living Shorelines". The scale of shellfish restoration projects has increased in parallel with the recognition of the importance of shellfish habitat in the marine environment.

However, shellfish restoration is not determined by shellfish habitat alone. As described in the definitions listed in Appendix E, there are many types of shellfish restoration and many different groups conducting shellfish restoration programs. Restoration can be practiced as a bioremediation of nutrient loading to estuaries, it can provide ecosystem services not readily attainable by other means, it can provide food, jobs and recreation, and a valuable though incalculable means of educating the public about estuaries.

Types of shellfish restoration include:

- Repletion: adding stocks and/or addressing habitat issues to try to get shellfish populations more in line with historic abundance;
- Reclamation: reclaiming an area that has changed over time such as creating hard bottom from soft organic muds;
- Enhancement: addition of shellfish to existing populations;
- Mitigation: improving a situation produced by disturbance by land uses (stormwater, wastewater, agricultural runoff) or marine disturbances (dredging or oil spills);

- Aquaculture: commercial rearing of shellfish species, both on and off-bottom;
- Return of native species: Olympia oyster as an example;
- Elimination of invasive species, diseases, exotics, predators, fouling organisms.

Groups involved in shellfish restoration include the following examples:

- Federal agencies: research (NOAA Milford Laboratory), funding and regulations (see Appendix F for Regulatory Landscape) (NOAA, FWS,USCOE, USDA), education/outreach (Sea Grant, Extension);
- States: Departments of Natural Resources (resource management, law enforcement, permitting), Departments of Public Health;
- Non-Government Organizations/Groups: TNC, NFWF, Regional Environmental Groups, Audubon, Community Action Groups, Native American tribes;
- Education: Universities, Public Schools, Vocational High Schools.

Special Categories of Groups

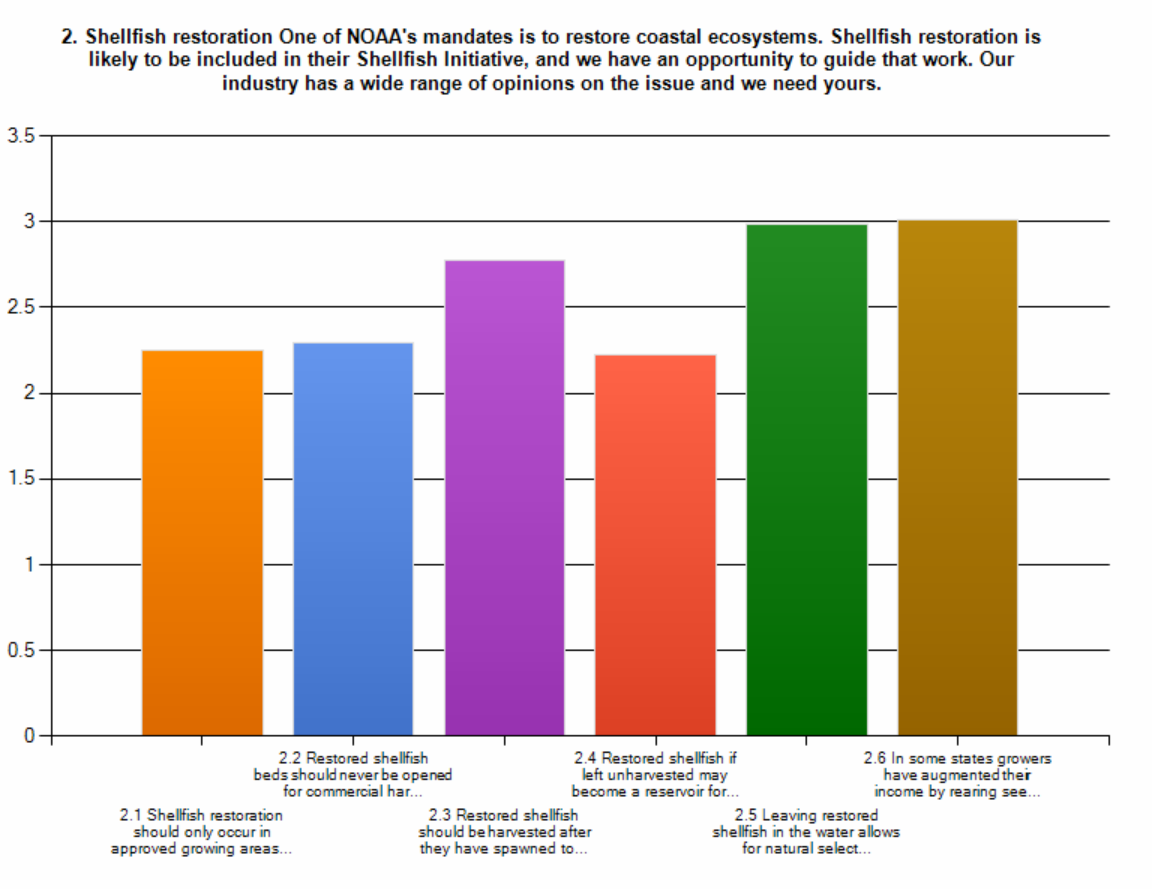
Shellfish Gardening/Community Action: Shellfish gardening and community action programs may involve many types of restoration and numerous groups as described above. In its most basic form, shellfish gardening includes a cadre of individuals who grow shellfish in small batches – cages or bags floating under docks in front of their house, bottom plots along the shore, or "garden plots" where individuals "tend" their crop and are responsible for the nursery culture of shellfish. In these programs that vary widely in their approach, there is usually a state extension agent or state natural resources official who oversees the volunteer programs and coordinates their activities. Shellfish gardeners obtain the seed shellfish from publicly-run hatcheries or from commercial hatcheries contracted by the organizing entity to supply the seed. An essential element of these programs is an initial education component to introduce participants to the goals of the program, the biological requirements of the shellfish and the local regulations. In Virginia, a portion of the program was developed for water quality mitigation where individuals grew oysters but not for human consumption. In New York, half of the oysters grown can be for the grower's consumption while the other half is returned to the community for restocking. In each case, participants enroll in a training program prior to participating in the restoration effort. Also in both cases, there is logistical support for the

education and training through Sea Grant and Cooperative Extension offices. Individuals engaged in shellfish gardening often become stewards of their region, "spreading the word" about shellfish and the associated benefits to the area of shellfish culture. They often participate in other community action programs aimed at improving water quality, participating in habitat restoration or educating others.

Industry Perspective: Although the perception is that industry is opposed to shellfish restoration, recent policies and survey by the East Coast Shellfish Growers points to a more balanced attitude (http://www.ecsga.org/Pages/News/ECSGAnewsletters/ECSGA_NL_v3-11.pdf). The survey indicates that they are in favor of efforts aimed at improving water quality and programs aimed at educating the public about both water quality and the role of shellfish in estuarine health. Industry must have clean water to grow shellfish to sell shellfish in interstate commerce. With shellfish aquaculture emerging as a growth industry, those involved are cognizant of the larger issues involved and of the requirements of the NSSP.

However, many participants expressed the same concerns of resource managers when restoration programs involving shellfish stock were conducted in prohibited waters. Any illness traced back to shellfish harvested from prohibited waters would have severe rippling effects on the entire industry. Yet, despite the concerns, in a post-workshop survey (see below), a majority of respondents wanted restoration efforts to continue in prohibited waters.

In an effort to help frame NOAA's aquaculture policy, the East Coast Shellfish Growers Association sent an electronic request for completion of a short survey. Eighty individuals split evenly between growers and related fields (dealers, extension, and research) completed the survey.



High ranking priorities of actions to document ecological benefits, research ecological concerns, implement BMPs, establish marine spatial planning and pre-permitting zoning. Of medium priority was supporting oyster gardening.

Most respondents (67%) felt that efforts in closed waters should continue; about one third felt that restored beds should never be harvested; 68% did not fear sanctuaries as disease reservoirs while 86% believed that sanctuaries led to disease resistance. Growers (80%) wanted to be active participants in restoration programs.

Additional questions in the survey concerned marketing, post-harvest treatment especially as it related to cost of doing business, NOAA's role in preserving working waterfronts and conducting outreach on the ecological benefits off shellfish aquaculture. While of interest, they were not applicable to this project. However, there was a final section dealing with ecological questions. (Survey results compiled by Robert Rheault, Executive Director ECSGA).

Growers and restorers also differed in their approach to the harvest of shellfish in restored areas. If an area is "restored", at what point does the restoration project signal that it is time to harvest the shellfish? If an area is set aside as a spawning sanctuary, is it considered part of a restoration project or the primary reason for restoration? For the spawning sanctuary to continue to produce seed in adjacent waters or throughout an embayment it may not be advisable to harvest at all within the sanctuary. However some states require harvest after a specified amount of time. At some point, a decision has to be made about harvest and it would be wise to set the bar early in the process. The goal of any restoration program should be defined in the beginning to avoid harvesting conflicts after a program has gotten off the ground.

Concerns Expressed at the Workshops

The following concerns (**bold underlined**) voiced at discussions will be dealt with individually and may include subtopics (***bold Italics***) and a case study where the concern has been addressed and a positive outcome occurred.

Protect public health while restoring the environment

Among the most controversial issues identified in the workshops was the use of prohibited areas for any type of shellfish restoration program. Concern that shellfish grown in unapproved areas may enter the open market worried both regulators and industry. The potential threat of illness from shellfish harvested from unapproved waters could prevent a state from participating in interstate commerce and possibly cause severe economic damage to the entire industry.

Shellfish managers were clear on their responsibility to protect the public health. As a result, there is the need to develop safeguards to prevent shellfish grown under those conditions from reaching the market.

However, the marketplace was not the only concern. There was also a strong desire to ensure that individuals do not consume shellfish grown in unapproved areas. Shellfish grown under private docks or on private property fit that category as does subsistence harvest. If an illness

occurs and can be traced back to a restoration program, that illness will also devastate both the industry and the future of restoration programs.

Case Study: Soft shell clam project in Boston Harbor. In this particular case the State of Massachusetts is involved in a restoration project in conditionally restricted waters. The soft shell clam enhancement program began in 2006 as a remediation project. There had been major disruptions to native softshell clam (*Mya arenaria*) populations in Boston Harbor resulting from installation and operation of the HUB natural gas line. All the subsequent planting activities continue to be coordinated with local municipal authorities and the harvest of soft shell clams within Boston Harbor is tightly regulated by Massachusetts Marine Fisheries, MA Environmental Police and participating municipal shellfish departments. All commercially harvested soft shell clams must be harvested by a certified Master or Subordinate Digger, and all of the clams must be delivered to the State Shellfish Depuration Plant in Newburyport via a pre-described route. Recreational shellfishing is not permitted within Boston Harbor. There are numerous restoration sites in Boston Harbor as shown in this graphic.

Define goals and objectives of restoration projects

A lack of consistency in how restoration programs are developed, implemented and monitored was brought out in almost all workshops. In many cases, public funds are used for the programs but metrics to evaluate the effectiveness of the programs have been lacking. Evaluations based

on harvest statistics fail to take into consideration ecosystem services or public education benefits, both of which can be difficult to accurately measure.

Coordination begins with planning and the onus is on the restoration group. When designing a project in preparation for funding, even if there is a short window of time for proposal preparation, there should be an initial meeting between the proposal principal investigator and the state shellfish management team to lay out the plan. Project goals, methods and location are all necessary ingredients to a successful partnership and can lead to smoother relationships especially if permitting is required. Even if a permit is not required for a restoration project, tacit approval from the regulatory agencies is highly suggested to avoid problems as the project continues through several years.

Requirements and realities of shellfish in the field

Long-term planning is imperative. Shellfish take time to grow, mature, and spawn to produce a sustainable population. As an example, building reefs requires three-dimensional structure, either provided by constructed materials – concrete balls, towers or other similar systems, shell-filled bags, or combinations of substrates. Not only do oysters have to attach to the substrate successfully, they have to attract future generations of oysters to also settle in that particular area. Hard clam restoration often follows a slightly different path because hard clams do not strongly exhibit gregarious setting as oysters do. In that case, large numbers of hard clams are usually produced and planted in "sanctuaries" to encourage fertilization and larval development (Macfarlane, 1998, Kassner and Malouf, 1982,). Hard clams typically, though not always, take longer to grow to maturity than oysters, and the length of time to maturity must be considered. Soft shell clams have certain requirements and challenges that differ from either oysters or hard clams (Beal,2009, Maine DMR, 2001, Maine/New Hampshire Sea Grant, 1998, Newell and Hidu, 1986, Belding, 1912,). Bay scallops have a short life-span and are more highly susceptible to natural perturbations as a result (Tettelbach and Smith, 2009; Goldberg, 2000, Leavitt and Karney, 2005, Macfarlane, 1999). Mussels, while prolific, can be plagued by pea crabs and by "grit" that turns into tooth-breaking pearls when the mussels are grown on substrate rather than off-bottom. (Newell et al, 1982, Pearce, 1964, 1966).

Harvestability of shellfish from restoration projects

Project proponents need to clearly define goals and objectives for shellfish restoration including such items as harvestability of the stock "down the road". If the project is primarily aimed at developing habitat, do the project proponents see a time when the habitat will be stable enough to allow harvest and if so, at what level. If it is not to be harvested, who makes that decision and who will enforce the ban on harvesting? Since states have full responsibility for resource management, they may have different perspectives than restoration specialists with respect to fishing a public resource. Funding agencies such as NOAA have agreements with their funding partners that restoration investment should have adequate assurances that the project would be protected through fishery closures. Some states, however, have statutory requirements that require areas be opened for harvest at a future date.

At issue is the timeframe for closures and/or criteria that would satisfy both funders and resource managers – whether or not a restored area could sustain both habitat reclamation and a fishery. Communication between proposal principals and resource managers in advance of funding and implementation could resolve the issue at the beginning of the project.

Harvest is merely one example of the types of issues that surround a project proposal that long-term planning and communication among the parties can resolve beforehand. Successful communication among parties can lead to successful projects where both project proponents and management professionals have a stake in a positive outcome.

Early and continued coordination among all groups in projects

Different types of groups promote and implement restoration projects. Academic institutions, environmental non-government organizations (NGOs), and state/municipal/county entities may all be involved. Academic institutions often do not have much interaction with shellfish regulatory/management personnel. Academic institutions or NGO's may be looking for a particular set of circumstances or environmental parameters in the field to answer a specific suite of questions without knowing the reason for a particular water quality classification. That knowledge is crucial for a positive outcome. If, for instance, a project is proposed to reduce the nutrient load to a specific area but there are also bacterial issues, using shellfish and the filtering

capacity of shellfish to achieve the goal of nutrient reduction may be modified or prohibited because of the bacterial issues. Early communication and coordination with the regulatory community by the project proponent will alleviate problems later. Academics who are trying to answer specific questions must look beyond their immediate research to potential consequences of their project of which they may be completely unaware.

> Case Study: Raritan Bay, a story of planningOn August 19, 2010 the headline of the local New Jersey paper, Atlanticville reads, "It's a sad day for Raritan Bay. An effort to restore the eastern oyster population to the Keyport Harbor officially came to a close on Aug. 9, a day that marked the shutdown of the largest shellfish restoration project in New Jersey and New York." Under orders from the New Jersey Department of the Environment the NY/NJ Baykeeper removed more than 50,000 oysters from a reef in the Raritan Bay because the commercial sized oysters were located in waters classified as prohibited. The state decision was based on their mandate to protect public health and New Jersey's $790 million shellfish industry.
>
> http://atl.gmnews.com/news/2010-08-19/Front_Page/A_sad_day_for_Raritan_Bay.html
>
> Fortunately the story does not end there. The headline only one year later, July 29, 2011, in the NY Baykeeper newsletter reads "Baykeeper and Rutgers Complete Historic Raritan Bayshore Mapping Project". --we are doing valuable alternative research such as this mapping project and identifying a site that DEP considers safe for oyster research…." The U.S. Army Corps of Engineers' Hudson-Raritan Estuary Comprehensive Restoration Plan (CRP) calls for 500 acres of oyster restoration in the Hudson-Raritan Estuary, where "the Eastern oyster is 'ecologically extinct' so reviving its population requires unique and creative approaches that will be guided by this map." The map is part of a planning process that will identify existing shellfish populations, potential pollution sources and other important environmental factors. If NJ DEP works closely with the organization the result may very likely meet the objectives of the CRP.
>
> http://www.nynjbaykeeper.org/index.php?option=com_content&view=article&id=119%3Abaykeeper-and-rutgers-complete-historic-raritan-bayshore-mapping-project&catid=1%3Alatest-news&Itemid=79

Expand communication and education

The lack of communication between restorers and managers was mentioned at every workshop. Often, the resource manager finds out about a project only when there is a request for a permit or when there is a reported problem as a result of the restoration activity.

The dichotomy between restoration practitioners who propose and execute projects to ameliorate the ecologically damaging effects of habitat degradation from low shellfish abundance, or high nutrient loading and state resource managers who are required to protect the public health by preventing shellfish grown in prohibited waters from reaching the consumer, is an ever-present theme in developing best practices for shellfish restoration. Throughout the workshops, individuals from both sides of the issue commented on the need for broad-based communication and education for all parties involved in either effort. The report mentioned earlier, "Oyster Reefs at Risk" suggests best practices for shellfish restoration to resolve this dichotomy. Usually people involved in shellfish restoration focus on their individual project. Keeping track of all the elements of the project (designing the project, obtaining funding, obtaining permits if required, execution, monitoring results) is critical to the eventual success. Issues may arise during the course of the project that require a change in the execution or may not be feasible for a variety of reasons. Restoration specialists are focused on their restoration goals. Resource managers must focus on the requirements of the National Shellfish Sanitation Program: coordinating efforts of water quality monitoring, classification of growing areas, and enforcement. The workshops illuminated a lack of coordination between the two groups of people.

Need for Central Repository of projects: who, where, what and why

Because there are so many people and entities working in the nation's bays with many different funding mechanisms, it is almost impossible to know who is doing what where and why. There is no over-arching entity that keeps track of projects and there is no clearinghouse to coordinate all the activities. Academic institutions generally act independently of one another and even within the same institution; departments are often segregated in their research work. Multiple NGO's and government entities working in the same bay may work independently. Consequently, there is the possibility of duplication of effort, as well as projects that actually may be at cross purposes. State regulators have a responsibility to ensure that shellfish reaching consumers meet the highest health standards and they need to know what projects are taking place within their jurisdiction. If the waters are classified as approved, the conversation should

be rather routine, but as the classifications become more restrictive based on public health, there must be more scrutiny.

Role of volunteers

Another aspect of communication concerns the people involved in the project. Academic institutions, NGO's and government entities all use volunteers to some degree. Communication and education cross boundaries here but one aspect identified in the workshops was the necessity for all people involved in a shellfish restoration project to have some working knowledge of the National Shellfish Sanitation Program (NSSP) and the reason for its importance. Many of the restoration projects already have education programs to train volunteers on techniques. However, shellfish are highly regulated for public health reasons and vigilance by all individuals involved in shellfish restoration in whatever capacity must adhere to the NSSP program for the benefit of the entire industry.

Work in multiple jurisdictions – need for consistency

Because individual states administer the NSSP and Model Ordinance, there is a certain amount of variation, causing problems for practitioners who perform their work in multiple jurisdictions. Workshops identified a need for consistency in interpreting and administering the NSSP and Model Ordinance but short of requiring such consistency, pre-project planning and communication with regulators would again alleviate many of the problems encountered with NSSP interpretation by the states.

Education

Education and communication are intricately linked but there are certain aspects of shellfish restoration that are more specific to the broad topic of education.

Water quality monitoring

Water Quality monitoring requires strict adherence to field and laboratory procedures and protocols. Generally volunteers are trained in the field by qualified personnel from an approved laboratory or agency. They are well versed in the equipment, methods and data entry procedures. Often duplicate samples are taken simultaneously by volunteers and qualified

personnel to ensure accuracy for later samples. When sample results match, there is greater confidence in the results obtained by the volunteers. Sometimes there is a hand-out or series of handouts for reference in the field. Sometimes a group will establish their own laboratory to augment the official certified lab. Such a facility can be enormously useful to track rain events outside normal work-week schedules or to find source contamination that can be later checked by a certified lab. In such cases, the lab can become certified but many are not. Again, duplicate sampling can increases confidence in the non-certified lab results. In both field and laboratory, the education component is straight-forward because protocols have been established and standardized.

Habitat enhancement

SCORE, an example of a successful South Carolina reef-building program, gives volunteers a 15-20 minute orientation on oysters - life cycle, need for substrate, environmental services. They conduct two or more Coastal Discovery Workshops each year which have a longer presentation (PowerPoint) and they have a classroom lesson about habitat and biodiversity which they can do in the schools or at the Department of Natural Resources (DNR) headquarters. They also have a water quality training program and are working towards creating additional lessons.

Shellfish gardening

Shellfish gardening, where individuals grow a relatively small number of seed shellfish on their own property or in a community "plot" requires education to be successful. In most cases, all or a portion of the shellfish grown is returned to the community for restoration projects including those for habitat restoration. One of the benefits of these programs is the information the gardeners gain about oysters and the environment in which they grow. There is no real way to quantify this benefit but the people involved take pride in what they are doing and want to protect their own back yards.

However, the number of people involved in shellfish gardening, while considered a positive aspect among gardening administrators, is considered a negative among resource managers because of a perceived/real lack of oversight and a fear that the gardeners do not fully understand the rigors of the NSSP and the consequences if shellfish is consumed from unapproved waters.

Two programs have been in existence the longest and have been held up as examples of highly motivated groups: SPAT and the VA program. Both have comprehensive educational programs.

Case Study: The **SPAT (Southhold [NY] Project in Aquaculture Training**) program began in 2000. The SPAT manual states:

- 500 families have been involved in the program,
- Volunteers logging in excess of 15,000 hours of time each year
- 3 species of shellfish (clams, oysters and scallops) cultured,
- Maintaining a hatchery, nursery and grow out systems that they built, build boats and generally have a rewarding time.
- Members as a vital part of the seaside community

The objective of the program is to encourage members of the community to become stewards of the environment and to restore shellfish in local waters to pre-brown tide levels. Participant fees, federal grants, corporate sponsorships, county and foundation support finance the SPAT program.

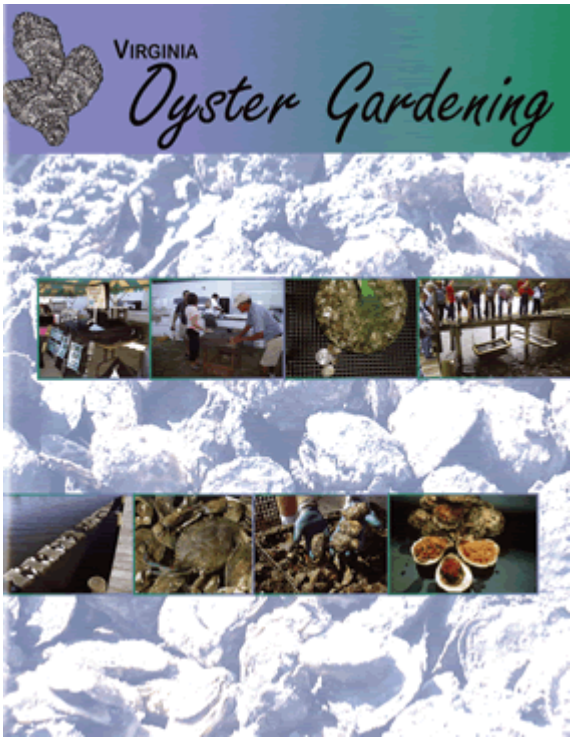
The manual covers oyster biology, (including descriptions of various species and their distribution and moving on to oyster anatomy, growth, reproduction and life cycle, predators, diseases and parasites, and fouling organisms as competitors), hatchery and hatchery techniques, nursery techniques, and grow-out. Kim Tetrault, the program director, points out that there are many ways to grow oysters, several reasons for growing oysters and it is a major component of the program to match the correct method for the appropriate reason. The manual discusses stocking density, culling and sorting, and over-wintering. The manual concludes with appendices including more detailed description of algal food production and nursery methods, triploidy, remote setting, and growing area classification.

The **Virginia** program differs from the SPAT program. Their introduction states up front that the ecological contribution of oysters is through their filtering ability and how oyster gardening can help. They state that there are over 2,000 oyster gardeners “cultivating” oysters in Virginia waters, many of whom are

growing oysters to improve water quality. They state that oysters can filter up to 50 gallons of water daily and the explain the filtering mechanisms involved, either using the filtered water as food or excreting the excess and non-food particles, clarifying the water in the process. They point out that the individual efforts of the gardeners help to improve water quality and biodiversity along the coast. They explain the role of nitrogen in the estuary, causes of excess nutrients and problems in the estuary as a result.

The manual discusses:

- Site selection and its importance for growing oysters
- Important environmental parameters for growing oysters successfully
- Water classification relative to food safety and maps of classified areas
- Seasonality, oyster growing methods and gear
- Purchasing supplies, setting up and maintaining the "garden"
- Pests, parasites and fouling
- Decisions relative to harvesting, vibrios and other considerations
- Oyster diseases, commensals, competitors, pests and predators



There is a special section on schools and oyster gardening that discusses a program called "Schools Restoring Oysters to the Chesapeake. "The program engages 7,250 students from 145 K-12 grade classes each year in a Bay-wide effort to restore the oyster population. As of 2005, 48,500 students have contributed a remarkable 2.7 million oysters to sanctuary reefs in Virginia. This project takes a hands-on approach to education, allows students to execute authentic science, is based on scientifically sound restoration strategies, and meets multiple Virginia Standards of Learning."

While both programs provide a manual for their gardeners, they differ in approach. A large part of the SPAT program in NY is their hatchery and they devote considerable emphasis to the hatchery process. Both manuals focus on oyster biology and grow-out methods since that is the most important education element for individuals. The Virginia manual describes public health aspects more than the NY version but NY does explain the NSSP classification system.

The workshops revealed that shellfish gardening specifically has several issues causing problems for resource managers.

- The shellfish grown is not considered interstate commerce and therefore does not come under the requirements of the NSSP; the controls are under the jurisdiction of the individual states and the ISSC restoration committee has concurred.

- Some states require gardening only in certified approved waters (NY, NJ) although there was disagreement in New York where some participants said that gardening is allowed in unapproved waters with an educational component but others said that was no longer the case. There are also projects planned or being executed to plant shellfish for water quality improvement in prohibited waters.

- Some states have a good "handle" on where gardening is taking place while other states expressed exasperation with gardening and other restoration projects because they did not have full knowledge of the project or locations and they felt they could not adequately track public health aspects.

- Some states allow shellfish gardening in prohibited waters for seed growth but the shellfish must be relayed to certified waters for eventual harvest. In some states, growers must sign a waiver that they will not consume shellfish grown in unacceptable waters.

- Some states have an educational component similar to the ones described above. Others have a pared-down version or hand-outs and training sessions. One state has attempted to include an educational component but cannot get people to actually attend the sessions.

- Some states do not allow gardening at all because of the difficulty of policing the activity.

- Many states expressed a concern that if an illness occurred from consumption of shellfish from gardening in prohibited waters it would reflect badly on the entire shellfish aquaculture industry.

What seems to be most troublesome is a lack of coordination between gardening administrators and resource managers and a perceived/real lack of oversight. Experience in Virginia and New York (SPAT) programs indicate that education is a key ingredient. The Virginia manual

carefully points out the reasons behind the NSSP, shellfish classification of growing waters and the risks associated with consuming shellfish from unapproved waters. The New York manual mentions these aspects but does not dwell on them; there may be additional information provided at workshops and training sessions. Neither program suggested that there had been a problem with people consuming shellfish grown in unapproved waters. Those individuals who grew shellfish for water quality mitigation were cognizant of the contribution the shellfish made and were aware that the shellfish they were growing was not to be used for consumption. They agreed to grow the shellfish for the benefit of the community rather than for themselves.

Resource managers were clearly uncomfortable discussing shellfish gardening in a public forum. Many knew of and applauded the reason for shellfish gardening but their responsibility to public health was an over-riding consideration. Although the number of participants in these programs is impressive, the numbers just reinforced the reticence by the managers to say with certainty that people in these programs were adhering to public health concerns.

Public Education

Several states had programs in coastal communities where high schools are adding shellfish cultivation and estuarine ecology to their curriculum. Ensuring that these programs also include information on the NSSP is imperative but the schools do not always communicate with the state about their programs and a lack of coordination was again pointed out. However, the fact that schools are paying attention to this topic was viewed as a very positive sign for the future.

> **Case Study**: ReClam the Bay. In New Jersey a group of volunteers led by cooperative extension agents have developed an extremely successful education program. While restoring millions of clams to Barnegat Bay their major impact has been their education and communication activities. “We want to involve the business community and the people who visit their establishments. Our plan is to have business display a ReClam The Bay plaque and to provide simple hand out material telling of the ReClam The Bay activities, the educational programs that we provide, how they can see where the ‘babies’ grow and to visit the web site for more information.” Volunteers attend a variety of festivals and events, take along some of the "babies" and display a story board. The organization has developed class outlines and materials to support their reclam activities. Volunteers are outfitted with kits of: hands-on activities, visual aids, handout material and simple class projects to supplement a variety of class room, vacation and after school activities. Lesson plans and support materials are available to any group or organization teaching about

marine life. The story board shows, in easy to understand text and graphics, the relationship of shellfish to the environment and what ReClam The Bay is are doing to repopulate the bay. The same kind of display is used at the upwellers where the public can observe clam care and feeding. ReClam has established a web site to provide some of the organization's information including water quality and other data that our volunteers monitor as part of the clam care. The information is available in graphical form so that individuals, students and teachers can review it. “Some of the most enthusiastic volunteers feel that they are ensuring a healthy bay for their future.” http://www.reclamthebay.org/

What we have personally enjoyed is the clam trails, a fun and educational activity to help young and old to understand Barnegat Bay and how they can enjoy and improve it. People who follow the trail will find "clam clews" and "water wisdom" about shellfish, and how they improve the bay. Kids and adults will learn what everybody or anybody can do to help the clams help the bay. The entire clam trail is divided into sub-trails: LBI South, LBI North, Waretown and North, Manahawkin and South.

Expand community-wide restoration

A major theme of the workshops was education as it relates to public outreach. People who work in the field of shellfish restoration have varying degrees of knowledge about, or understanding of, shellfish biology and ecology. Principal investigators and program directors are generally well-informed but since shellfish restoration is labor intensive, and since many programs are community efforts, volunteers are often recruited to carry out the programs. Once people get involved in a program, they tend to form an emotional attachment to the environment around them and they begin to understand it. Whether filling bags with shells to build reefs or growing shellfish in individual cages for programs such as shellfish gardening, the result is groups of people with an appreciation of the value of estuaries and the services shellfish provide for all of us. While the benefit of an educated population seems obvious, the true value is really

incalculable, but for resource managers and restoration specialists alike, one of the primary benefits of educational programs is to "spread the word" about shellfish and its role in normalizing conditions of estuaries.

Many community-based programs began with water quality monitoring. Agencies and communities discovered that individuals, properly trained in appropriate techniques, could produce data conducted with quality assurance, saving a tremendous amount of scarce resources. They also found that the volunteers were most often reliable, enjoyed taking the samples and that the monitors felt committed and useful, an aspect difficult to quantify. Once state resource managers gained trust in volunteer water quality monitoring as an augment to their own sampling protocols or as a means to discover causes of water quality degradation, resource managers began to ask for assistance with other projects.

Habitat restoration such as reef-building became a program that beginning modestly, often morphed into larger projects. The statistics for the SC SCORE program (see p.38) are impressive in the number of people involved, the amount of reefs built, and the restorative components of the program, tracked over a decade or more.

Reef building and shellfish gardening are only two examples of activities that utilize volunteers. There are many more. A water quality program that has become a model for communities is the Puget Sound Restoration Fund. Spearheaded by Betsy Peabody, it is a multi-community effort aimed at land-based initiatives to clean up waters or protect waters that are approved for shellfish harvest. A combination program of water quality mitigation and shellfish growing is the Lynnhaven River in VA.

All these examples have several things in common:

- A lead agency or entity to shepherd the project through the funding mechanisms and administer the program;
- An educational institution nearby where Sea Grant Extension, USDA Extension or state DNR offices are involved in the project;

- A dynamic individual or group of individuals who can “marshall the troops” by providing technical expertise and encouragement;
- A clearly identified need and goal articulated to volunteers who develop an “ownership” in the work they do.

Readily apparent through these examples is the diversity of approach and execution of the programs. One of the most impressive programs is the multifaceted SCORE Program mentioned earlier in this report. The South Carolina Department of Natural Resources (SCDNR) is responsible for managing the state's oyster resources. They feel that appropriate management includes the planting of material to provide substrate, known as cultch, for recruitment of juvenile oysters. Unfortunately, there is a nationwide shortage of oyster shell to be used as cultch. That which is available is often not readily accessible because it is spread out in many locations. SCDNR has initiated an effort to encourage the public to recycle oyster shell for use in resource management. Recycling centers have been established along the coast. Consumers are encouraged to deposit clean shell at the recycling centers, which are periodically emptied by SCDNR. The shell generated in this fashion is used for restoration and enhancement of shellfish resources, reducing the costs of these activities. There are two major components to the SCORE program: oyster shell recycling and community-based restoration. By working together, community members and biologists can restore oyster populations while 1) enhancing habitat for fish, shrimp, and crabs, 2) improving water quality of estuarine areas, and 3) informing and educating children, industry, and the general public.

There is also a large community-based restoration element in which more than 8000 volunteers have used more than 500 tons of shell to build 188 reefs at 35 reef sites along the South Carolina coast. http://score.dnr.sc.gov/deep.php?subject=1

Case Study: The South Carolina Department of Natural Resources established the South Carolina Oyster Restoration and Enhancement program (SCORE) ten years ago, in late 2000, with the goal of enlisting volunteers to recycle oyster shell and construct oyster reefs. By using volunteers to build the reefs, the SCORE program educates the public on the ecological benefits provided by oysters while also restoring valuable habitat. To date, the SCORE program, working with over 80 community partners, has enlisted over 13,000 volunteers who have contributed 36,000 hours to the project. These volunteers, ranging in age from 8 to 80, have participated in shell recycling, shell bagging, reef building, reef assessments, and water quality monitoring. Over the past 10 years, these volunteers worked to fill over 35,000 mesh bags with 500 tons of recycled oyster shells. Those bags have been deployed to build more than an acre of oyster habitat at 40 sites spanning 200 miles of coastline. Due in part to the stability afforded by the mesh bag and in part to careful site selection, SCORE reefs have a remarkable success rate, with at least 80% of SCORE reefs comparing favorably to natural oyster reefs after only 2-4 years. SCORE reefs have also been demonstrated to stabilize shorelines and foster marsh grass expansion. Because of the continued support of volunteers and overall success of the program, in 2010, SCORE was able to celebrate its 10^{th} anniversary by undertaking its largest project to date. In just one summer, 174 volunteers contributed 520 hours to deploy 4,310 shell bags at one site on Daniel Island, SC, and have created the largest uninterrupted SCORE reef which covers 6,200 ft^2 (0.15 acres) of shoreline.

Ensure the security of the restoration site

One of the biggest obstacles for shellfish restoration in unapproved areas is the issue of security. While the ecological services provided by shellfish can certainly help alleviate or lessen nutrient loading to estuaries and possibly reduce bacterial loads as well, a land-use strategy is imperative to truly clean up an estuary. Effort may be better placed in upgrading less severe classifications rather than working in prohibited areas. Virtually all resource managers mentioned lack of funds and personnel resources to adequately address additional shellfish projects. Surveillance takes funds and while technological advances have made remote surveillance a possibility, surveillance also requires “boots on the ground” and “boats in the water”, both of which require ample funds.

Restoration specialists are not enforcement personnel and are generally not trained at all in enforcement. However, if enforcement is necessary to carry out a restoration program, the cost should be paid for by the project proponents or at least shared with them. They should also be required to report any problem they see while out on the water to the proper authorities.

If shellfish gardening takes place in unapproved areas, the project organizers/directors should submit their education protocols to reduce anxiety among resource managers that people growing the shellfish are not consuming them and no one else is either.

Whereas enforcement professionals keep their techniques as closely guarded secrets for obvious reasons, we do not have a case study for ensuring the security of the restoration site.

Encourage volunteer monitoring

Volunteers can provide many eyes on the restoration sites. The successful application of volunteer services to collect and analyze water quality samples is one example of an activity, originally met with skepticism, that has been successful in numerous locations around the country. Agency professionals were skeptical that volunteers could be properly trained to carry out strict protocols on a consistent basis. What surfaced was not only a willingness on the part of volunteers to learn and participate but an enthusiasm to give something back to their community. They saw their actions as one small step in a larger effort to protect water bodies from degradation or to clean up existing problems. Some projects are relatively recent while others have been continuing for several decades, amassing incredible data sets.

While water quality has received the most attention, it is not the only area where volunteers have gotten more involved. Projects have sprung up where people monitor their surroundings for trends – making observations about local conditions such as when certain animals – marine, avian, terrestrial – arrive or leave; tracking weather events; measuring salinity, temperature, tidal heights, and importantly now, pH and other physical parameters. They can identify potential bootleggers and are protective of their sites. Each time someone gets involved, he/she tells someone else and the community education of the population increases, reducing the opportunity for illegal harvest.

Encouraging this type of individual involvement is vitally important for restoration.

> **Case Study**: The Clean Water program of the University of Maine Cooperative Extension was established in 1988, and provides organizational and technical support to water quality monitoring groups from Kittery to Calais (approximately 1,000 volunteers). The Clean Water program works in partnership with the Maine State Planning Office Partners in Monitoring Program and the

Maine Department of Marine Resources. Water Quality groups study the health of estuarine water by monitoring for dissolved oxygen, temperature, pH, salinity, and fecal coliform bacteria. As a result of successful monitoring efforts in Maine, thousands of acres of clam flats have been opened. High school students have been inspired to go on to study environmental science in universities and to become involved in community conservation efforts. Various watersheds have begun working together, and hundreds of citizens have become active in environmental education and conservation efforts. These efforts , have been integrated into the activities of their local schools.

The Clean Water program builds on the strengths of communities by providing water quality and marine resources and by assisting with environmental issues. Citizens involved in the program are able to make their communities stronger by working collaboratively on marine environment projects. Volunteers increase their knowledge and continue to be stewards of their coastal waters.http://extension.umaine.edu/programs/natural-resources/marine/maine-shore-stewards/volunteer-opportunities/clean-water/

Noncommercial species in restoration efforts and transplant

The filtering ability of shellfish is well documented with oysters filtering up to 50 gallons per day. Other species are not as efficient but they still provide a valuable function. If a restoration project is slated to take place in prohibited waters and there is no other acceptable alternative, using noncommercial species may be viable. Presently experiments with *Geukensia demissa*, ribbed mussel, are planned for the Bronx River in NY, a highly compromised area.

There are already serious concerns regarding commercial species in prohibited waters because of the enforcement issues. Enforcement agencies are concerned about their ability to ensure that none of those shellfish reach consumers. One suggestion was to use seed shellfish for their filtering capacity and transplant them to clean waters when they were still sub-legal. The question arises as to when to transplant the shellfish from a restoration project. Some states carry out relay programs under strict state supervision. The shellfish are not harvested until the state gives the clearance and permits to do so. Each step of the process requires surveillance and is therefore an expensive program but the states that use the method suggest that allowing the

shellfish to remain in the approved waters over a spawning period, increases the chances of natural propagation in the transplanted area and is, therefore, a method of restoration.

Some suggested that using alternative species was counterproductive because there would most likely be little public support for a program that used shellfish for ecological services without the benefit of utilizing the shellfish in the foreseeable future. However, shellfish, commercial or noncommercial planted in a prohibited area can not be utilized for human consumption purposes. The only benefit of noncommercial species is the fact that they could be used for their ecological clean up services but would not be consumed. As a relatively new concept, the issue was not resolved.

Case Study: Magothy River Association and the Dark False Mussel: The Magothy River is a tributary of the Chesapeake Bay. For more than fifteen years volunteers from the Magothy River Association, with the help of Team Divers, monitored the ecosystem parameters while they restored oyster populations to historic reefs. In 2004 an explosion of dark false mussels (DFM) or Conrad's mussel followed hurricane Isabel (2003). Team Divers developed a protocol for sampling the mussels and results showed sufficient biomass existed in Cattail Creek to clean the water in 46 hours. In the Magothy River this explosion dropped off to almost nothing at the junction of the creeks with the main portion of the river. Millions of these mussels covered pier pilings and boat bottoms. Since 2005 these mussels have almost disappeared. The mussel is similar in size and looks much like the zebra mussel.

The actual cause for demise of the DFM population is not clear. DFM reportedly survive in salinities 1.4-12 parts per thousand. Occasional minor reoccurrence in creeks tends to indicate significant recruitment has not occurred because salinity levels have recovered or dissolved oxygen is too low and conditions may not be conducive to a spawn. Commercial methods used for spawning and raising blue mussels for consumption are being investigated for collection and to transfer these mussels. This method consists of using fuzzy rope and socks including suitable devices to suspend the mussels. In 2011 there has been a re-emergence of the dark false mussel and this, in combination with enhancement activities may lead to cleaner creeks and an improved Magothy River system.

Concluding Remarks

Comments from the project team:

First, we would like to thank all the participants in this project. Without their willingness to discuss difficult issues and provide candid comments, the project could not have been accomplished. We think that the compilation of ideas and strategies used for shellfish restoration will help resolve differences of opinion of how best to practice shellfish restoration while protecting public health.

Second, some of the suggestions can serve as a starting place for further dialogue. We provided two models of public education (SPAT program and VA Oyster Gardening Program). Participants suggested that Sea Grant and/or Cooperative Extension should develop an education program that can be adapted for specific regional circumstances but still provide the core concepts necessary to understand the restoration environment. We think this is an idea that should be explored.

Third, while there are still expressed differences between managers and restoration practitioners regarding the use of prohibited areas for shellfish restoration and the role of volunteers, the fact that the discussion occurred is a major breakthrough in communication. We believe it is essential that the dialogue continue.

References

Beal, B. 2006. Biotic and abiotic factors influencing growth and survival of wild and cultured individuals of the softshell clam (Mya arenaria l.) In eastern Maine. Journal of Shellfish Research 25(2):461-474

Beck, M.W., R. D. Brumbaugh, L. Airoldi, A. Carranza, L. D. Coen, C. Crawford, O. Defeo, G. J. Edgar , B. Hancock, M. Kay, H. Lenihan, M. W. Luckenbach, C.L. Toropova, G. Zhang, 2011. Oyster reefs at risk and recommendations for conservation, restoration and management 2011. BioScience 61: 107-116

http://conserveonline.org/library/shellfish-reefs-at-risk-report/@@view.html

Coen, L.D., R.D. Brumbaugh, D. Bushek, R. Grizzle, M.W. Lukenbach, M. H. Posey, S.P. Powers and G.S. Toffey, 2007. As We See It: Ecosystem Services Related to Oyster Restoration. Marine Ecological Progress Series, 341:303-307.

Flimlin, G., S. Macfarlane, E. Rhodes, and K. Rhodes, 2010. Best Management Practices for the east coast shellfish aquaculture industry. East Coast Shellfish Growers Association, 77 pp.

http://www.ecsga.org/Pages/Resources/ECSGA_BMP_Manual.pdf

Goldberg, R., J. Pereira and P. Clark, 2000. Strategies for enhancement of natural bay scallop, Argopecten irradians irradians, populations; A case study in the Niantic River estuary, Connecticut, USA, Aquaculture International, 8(2-3):139-158

Gulf of Maine Aquarium, 2001. Coastal Fishery Research Priorities: Soft-shell clams, Maine Department of Marine Resources.

http://www.maine.gov/dmr/research/soft_shell_clams.htm

Kraeuter, J.N., J.M. Klinck, E.N.Powell, E.E. Hoffman, S.C. Buckner, R.E. Grizzle, and V.M. Bricelj, 2008. Effects of the fishery on the northern quahaug(=hard clam Mercenaria mercenaria population in Great South Bay, NY: a modeling study. Journal of Shellfish Research 27(4) 653-666.

Kraeuter, J.M., E. N. Powell and S.E. Buckner 2005. A note on spawner-recruit relationship for a heavily exploited bivalve: the case of the northern quahogs (hard clam) Mercenaria mercenaria in Great South Bay, NY. Journal of Shellfish Research 24:1043-1052.

Leavitt, D.F. and R. C. Karney, 2005. Cultivation of the bay scallops. Pp. 25-109 in A.M. Kelly and J. Silverstein (eds.) Aquaculture in the 21st Century, American Fisheries Symposium 46. Baltimore, MD.

Macfarlane, S., 1998. The evolution of a municipal quahog (hard clam), Mercenaria mercenaria management program, a 20-year history:1975-1995. Journal of Shellfish Research 17(4):1015-1036.

Macfarlane, S., 2001 (unpublished), Review of Codes of Practice and Best Managemetn Practices for the Aquaculture and Related Industries: A Report Prepared for the Maine Aquaculture Innovation Center.51 pp.

Maine/New Hampshire Sea Grant College Program, The Clam Handbook, 1998, 77 pp.

Newell, C.R., and H. Hidu. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic)-soft shell clam. U.S. Fish Wild. Serv. Biol . Rep. 82(11.53). U.S. Army Corps of Engineers, TR EL-82-4. 17 pp.

Newell, R.I.E., T.J. Hilbish, R.K. Koehn, and C.J. Newell, 1982. Temporal variation in the reproductive cycle of Mytilus edulis L. from localities on the east coast of the U.S. Biol. Bull., 102:299-310.

Pearce, J.B., 1966. The biology of the mussel crab Fabia subquadrata from the waters of the San Juan Archipeligo, WA. Pac. Sci., 20: 3-35.

Pearce, J.B., 1964. On reproduction in Pinnotheres maculates. Biol. Bull., 127:384.

Tettlebach, S. and C. Smith, 2007. Bay scallop restoration in NY. Ecol. Restor. 27(1) 20-22.

The Nature Conservancy, A Practitioners Guide to the Design and Monitoring of Shellfish Restoration Projects (http://www.nmfs.noaa.gov/habitat/restoration/publications/TNCNOAAshellfish_hotlinks_final.pdf

Tucker, C.S. and J.A. Hargreaves (eds.) 2008. Environmental best management practices for aquaculture. Blackwell Publ. Ames Iowa 50014, 592 pp.

Virginia Oyster Gardening Manual: http://www.coonamessettfarm.com/sitebuildercontent/sitebuilderfiles/vaoystergarden.pdf