

Extension Education and Applied Research

to

Improve Marine Resource Management

By

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Introduction

Education and the integration of science based research into the management and use of marine resources is essential to insure their sustainable use and conservation into the future. The continual need for education as researchers make new discoveries requires a process that engages the research community, resource managers, and marine industries in a mutually beneficial partnership that guides research, and helps to solve problems faced by marine resource users. This paper will describe how the National Sea Grant Program's extension network is organized to address a broad spectrum of marine resources and engage user groups, managers, and industry. It will also describe through a series of examples how Sea Grant collaborates with other agencies, in particular the U.S. Department of Agriculture's Cooperative Extension Service to improve aquaculture production in the United States. Both programs work primarily through the Land-Grant system at Universities throughout the country.

The Land-Grant system, initiated by a series of legislative initiatives during the mid to late 19th and early 20th centuries, traditionally includes a Congressionally designated university (The 1862 and 1890 Morrill Acts) and corresponding Agricultural Experiment Stations (The 1887 Hatch Act), which generally house the states' Cooperative Extension Service (The 1914 Smith-Lever Act). Collectively, these units engage in teaching, research, and extension primarily to improve agricultural productivity, but also to help solve problems facing the nation's human and natural resources. Extension professionals within this system are responsible for engaging user groups and communicating science-based information to improve their lives and businesses. In addition to serving as a delivery mechanism for new information, those involved in extension constantly interact with their clientele as end users to identify areas where more research is needed and apprise the research community of these needs. This research-extension continuum is a hallmark of the Land-Grant system.

The National Sea Grant College Program was established along this successful Land-Grant model by the 1966 National Sea Grant College and Program Act. The intent was to increase the understanding, assessment, development, utilization, and conservation of the nation's ocean and coastal resources. Housed within the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA,) the National Sea Grant College Program "Enhances the practical use and conservation of coastal, marine and Great Lakes resources to create a sustainable economy and environment." What is unique to Sea Grant is that it engages top researchers at universities and delivers the results of their discoveries to end users through extension, education, and communication programs that are required components of a Sea Grant College Program. As with the Land-Grant system, Sea Grant is usually a partnership with Land-Grant universities and Cooperative Extension in coastal and Great Lakes states, and shares the same commitment to teaching, research and extension.

Sea Grant invests in high priority program areas such as coastal communities and economies, coastal hazards mitigation, ecosystems and habitats, aquaculture, fisheries and seafood technology, marine biotechnology, the urban coast, and ocean technology. Educational components are incorporated into each of these thematic areas.

The Sea Grant Extension Program's mission is to effect change through outcome-based education and demonstration. This mission is supported through the conduct of targeted basic and applied research. Extension professionals create opportunities for effective, two-way communication between producers and users of information and translate complex scientific information for decision makers and citizens. This facilitates the rapid transfer of scientific

information in forms that are readily understood by user groups, coastal communities and decision makers. Approximately 383 agents and staff form a National Extension Network to connect community residents and coastal businesses to the resources of the nation's top universities to address locally identified problems. Integrated teaching, research, and extension education enables rapid research-based responses to critical, emerging issues.

Extension Methodology: Engaging Marine Resource Users

There is a diverse array of methods available to extension personnel to educate marine resource user groups and identify problems they are facing. The first step is often to conduct a needs assessment to ascertain what educational needs exist and which are the highest priorities. Needs assessments can be formal as in the case of a facilitated focus group or formal survey, or they can be informal involving meetings and contact with individuals in particular businesses or activities that use or depend on marine resources. The results of the needs assessment can then be used to guide the development of an extension education program addressing the highest priorities and the methodologies employed will be customized based on the need.

Workshops are effective where there is a need for people to interact and learn, work through a particular conflict or develop a management plan. These are being increasingly used in the U.S. as communities work to develop Ecosystem Based Management Plans (EBM). They provide a good forum for educational programming and insure all participants have a common basic level of understanding of the issues. Printed educational materials such as leaflets, brochures and manuals are effective at reaching large audiences. Electronic delivery of informational materials through the use of CD's, DVDs, websites and web based voice over presentations are increasingly being used for educational programming

Involving clientele and collaborative research are hallmarks of both the Land and Sea Grant programs. Seaman A. Knapp, generally regarded as the founder of the Cooperative Extension System, is quoted as saying: "What a man hears, he may doubt; what he sees, he may possibly doubt; but what he does himself, he cannot doubt." He advocated on-farm demonstration of new agricultural advances working directly with the American farmer developing pilot or demonstration projects. A century earlier in the same vein, the American sage Benjamin Franklin was also quoted as saying "Tell me and I forget. Teach me and I remember. Involve me and I understand.", so the idea of hands-on, experiential learning is hardly a new concept and it is an important extension methodology for effecting change. Working collaboratively with leaders of industry and other clientele to conduct applied research is an effective way to learn what works together, with the added benefit of usually seeing the results being adopted much more rapidly by users as a result of their involvement.

Many advances in the high priority areas mentioned earlier are a direct result of the integration of science-based research linked through the Sea Grant Network of extension educators to end users who consist of resource managers, fishermen, aquaculturists, maritime industries, seafood processors, coastal resource users and others. The people comprising the Sea Grant Extension network are locally based and work closely with local constituents. This insures that national investments are targeted at the highest priority local and regional issues, serving the mission of NOAA, the National Sea Grant Office, Land-Grant Universities and the people they serve. Sea Grant Extension personnel are recognized as a source of unbiased science based information in coastal jurisdictions throughout the United States, providing an important segue

between science-based advances in technology and their adoption by local businesses.

Marine Extension Education: Research - Extension - Industry Collaborations

New industries have been started; old industries have been re-vitalized, and still others have changed their way of doing business due to many factors such as changing laws, regulations and public perceptions; increasing competition for natural resources, market competition, increasing consumer demands for high quality products, invasive species, and declining coastal water quality among others. The following brief scenarios provide a variety of examples of extension education projects that engaged researchers, extension educators and industry partners to collaborate and solve problems.

Fishers and Scientists Compare Methods for Estimating Nearshore Marine Fish Abundance

The California Marine Life Management Act requires the Department of Fish and Game to develop management plans for nearshore fisheries. Fishery managers are challenged to develop fishery plans, however, because information about nearshore fish populations is limited. One way to quickly gather data for management plans is to utilize information from a variety of sources and sampling methods. Yet as information is pooled, it is critical for scientists and managers to understand if and how the different methods of data collection relate to one another. This is critically important to the fishing industry because ultimately this information will be used to regulate fisheries.

To better understand how estimates of fish abundance compare among different survey methods, Sea Grant and Cooperative Extension personnel initiated a collaborative research project in Carmel Bay, Calif. With the combined efforts of UC scientists, commercial fishermen, and the Department of Fish and Game approximately 1,700 fish were tagged and released during an intensive three-week tagging period. In addition to the tagging, trained scientific divers from UC Santa Cruz conducted standardized fish counts using SCUBA in the same areas where fishing occurred. Estimates of the relative abundance of fish from catch statistics and absolute abundance from tag-recapture statistics were compared among three types of surface fishing gear (traps, sticks and handlines), and the standardized SCUBA surveys. Fish length was compared among the different methodologies.

Using a variety of methods, commercial fishermen, research divers and scientists were able to combine their expertise to obtain estimates of the population size and structure of fish in Carmel Bay. While working together to achieve the goals of the study, fishermen and scientists exchanged information and knowledge about the marine environment. The information developed from this study is currently available to resource managers and will greatly improve the nearshore fishery management plans that are under development.

Making Dollars and Sense of Nontoxic Antifouling Strategies for Boats

Plant and animal growth on boat hulls increases drag, which slows sailboats and increases powerboats' fuel consumption and related pollution. Most of the antifouling paints that boaters apply to prevent the problem slowly leach copper, which keeps marine organisms from attaching to boat hulls. However, the copper has accumulated in coastal boat basins to levels that exceed Federal and California standards of 3.1 ppb. The copper is harmful to marine life, especially molluscs, crustaceans, echinoderms and phytoplankton.

Regulatory agencies began exploring options to reduce copper pollution in these bays and

harbors, raising concerns among the boating community about potentially costly new regulations. In 2002, extension personnel collaborated with researchers and boat owners to evaluate the costs of using copper versus nontoxic boat bottom coatings. They determined that, because of costs for stripping old paint and given boat repair yard capacity, it would take at least seven years and \$20 million to convert all San Diego Bay boats to nontoxic paint. Typically, old layers of paint must be stripped after 15 years. Extending the conversion period to 15 years would allow old paint to be stripped when it was ready, reducing the total conversion cost to \$1 million -- a 95 percent savings. These findings were submitted to California Department of Boating and Waterways, which forwarded them to the California Legislature.

These findings have been used to educate 3,400 boat owners, boating and coating businesses, agency staff, policy makers and other scientists. In 2006, the California State Water Resources Control Board approved a Total Maximum Daily Load program for copper from boat hulls in Shelter Island Yacht Basin of San Diego Bay. Discharges of copper from boat bottom paints must be reduced by 76 percent over the next 17 years. Instead of a short and expensive timetable for converting to nontoxic hull coatings, boat owners will have a 2-year education period, followed by a 15-year conversion period as recommended by the results of this collaborative research. This should cut costs to convert to a nontoxic system for protecting boat bottoms by 95 percent while improving coastal water quality. For additional information see <http://seagrant.ucdavis.edu>.

Russian River Tributary Restoration and Landowner Outreach Program

California's Russian River salmon and steelhead populations have declined drastically in recent years due to habitat loss and degradation. Such devastation has landed coho, Chinook salmon and steelhead on the endangered list under the Federal Endangered Species Act and California law. This loss of fish has concerned fishermen, and water agencies fear that unless fish populations rebound there will be regulatory restrictions on water availability from the river for agricultural and urban uses. In some watersheds, the vast majority of fish habitat is privately owned, 89 percent for salmon in the Russian River. Landowners must recognize the importance of restoring habitat and fishery resources, in order to maintain reasonable access to water for drinking and irrigation.

Extension personnel from Cooperative Extension and California Sea Grant developed the Russian River Tributary Restoration and Landowner Outreach Program to educate landowners. The program encompasses several elements:

- Workshop series to train landowners in salmon habitat requirements and hone their skills to protect and restore watersheds. Over 300 landowners received 40 hours of instruction in class and the field.
- Extensive stream habitat assessments conducted by the California Department of Fish and Game, with Sea Grant assistance. More than 200 landowners received stream reports with restoration-priority recommendations.
- Over 44 successful restoration projects on 11 streams were completed by project designers in collaboration with riparian landowners. Design and engineering support has sparked additional landowner projects for the future.

Enthusiastic landowners themselves have implemented over 60 habitat restoration projects on 40 streams, adding to the 44 collaborative projects. Since 1995, more than 800 miles of Russian River tributaries have been identified as high priorities for salmon restoration by Fish and Game,

with Cooperative Extension and Sea Grant assistance. Knowledge gained by these landowners is being shared in their families and the greater community at large.

Staying Afloat with Nontoxic Antifouling Strategies for Boats

Boat owners use copper paints to control hull fouling that slows sailboats and increases powerboat fuel consumption. Copper leached from these paints harms marine life. The Regional Water Quality Control Board's Total Maximum Daily Load regulations require 2,000 San Diego Bay boat owners to cut 76 percent of copper discharges by 2022. In addition, regulatory agencies are sampling marinas statewide for copper. Boat owners and businesses need effective alternatives to maintain California's \$16 billion per year boating business, while protecting water quality.

Demonstration trials were conducted in San Diego Bay to evaluate nontoxic epoxy and ceramic-epoxy hull coatings in 2002 and 2003. The nontoxic coatings were placed on two powerboats and two sailboats. The coatings were cleaned twice monthly by professional hull cleaners who reported coating condition, fouling level, aggressiveness of cleaning tools and effort. All the coatings performed well and were in good to very good condition after 13 months. Nontoxic coatings were cleaned 26 times per year (twice as often as is typical for cleaning copper paint on San Diego Bay boats). Frequent cleaning allowed hull cleaners to use gentler tools and less effort, reducing damage to the coatings. These findings were extended to 3,500 boat owners, boating and coating businesses, agency staff, policy makers and scientists.

The nontoxic coatings cost more than copper paint to apply and keep clean, but the cost is offset by the nontoxic coatings' longer service life. Boat owners who participated in the study were asked in 2006 about long-term performance of the non-toxic coatings. One owner who had an epoxy coating on his boat for eight years reported the coating was still in good condition. Nontoxic coatings remained on the other three boats after 4.5 years and the owners were satisfied. In contrast, copper paints must be replaced after 2 to 3 years in San Diego (yearly in some parts of the U.S.). Long-lasting, nontoxic epoxy and ceramic-epoxy coatings will enable San Diego Bay boat owners to avoid cost increases from complying with new regulations, and reduce discharges of toxic heavy metals into this sensitive ecosystem. Coastal boat owners in other areas can help improve water quality without incurring extra costs by using nontoxic coatings. Further details can be found in a technical report, "Staying Afloat with Nontoxic Antifouling Strategies for Boats" at <http://seagrant.ucdavis.edu>

The Clam Lease Assessment, Management, and Modeling Using Remote Sensing (CLAMMRS)

This project was conceived, initiated, and is currently administered by the University of Florida's Institute of Food and Agricultural Sciences through an initial grant from USDA's Initiative for Future Agriculture and Food Systems in 2000, with subsequent funding from USDA's Risk Management Agency. The project is a collaborative effort between several federal- and state-funded programs and involves research and extension faculty from the Department of Fisheries and Aquatic Sciences and Cooperative Extension Service in collaboration with the Florida Department of Agriculture and Consumer Services, and the commercial hard clam industry.

Hard clam (*Mercenaria mercenaria*) aquaculture is a relatively new industry in Florida. During the 1990s, successful job retraining programs placed hundreds of former commercial fishermen, impacted by regulatory gill-net closures, into small-scale shellfish aquaculture businesses. In 1991, production of hard clams in Florida was valued at \$1 million with less than 6

million clams produced by 41 growers. Just a decade later, 336 growers in nine coastal counties produced 142 million clams with dock side sales valued at \$18 million. The total economic impact of this fast-growing, marine resource industry was estimated to be \$34 million in 2001. Pilot demonstrations, workshops and production manuals developed by extension personnel working hand-in-hand with displaced fishermen channeled them into this new and highly productive industry.

Building on this initial success, the CLAMMRS project was designed to: “provide a better understanding of clams and their environment to increase production, farm efficiency, and profitability, and thereby enhance sustainable development of open-water clam farming in Florida”. Through adoption of remote sensing technologies by the CLAMMRS project, timely water quality and weather information is made available to the clam-farming industry for management decision-making. With this information, growers have begun to refine and improve management practices, compare crop losses with water quality events, and identify trends in environmental conditions critical to clam health and production. For example, growers have been able to make immediate decisions on whether to plant or transfer seed based upon current salinity and water temperature readings.

Additionally, Sea Grant aquaculture specialists in Florida and three other states (South Carolina, Virginia, and Massachusetts) were involved with the USDA Risk Management Agency in developing a cultivated-clam crop insurance program, the first such program for a commercially cultured marine species in the United States. Involvement in this program will have significant implications on the long-term viability of the hard clam aquaculture industry. For more information on the CLAMMRS project and other information on Florida hard clam initiatives, please visit the following web site: <http://shellfish.ifas.ufl.edu/clammrs.htm> .

The Molluscan Broodstock Program

The Molluscan Broodstock Program (MBP), administered by Oregon State University and funded through grants from USDA’s Cooperative State Research, Education, and Extension Service Special Research Grants Program, the Western Regional Aquaculture Center in collaboration with the USDA-ARS Shellfish Genetics program, and the State Sea Grant programs in Oregon and Alaska, is a classic collaborative partnership between Federal agencies, state Sea Grant and Cooperative Extension programs, and the aquaculture industry.

Research conducted through directed and competitive funding from USDA and state Sea Grant programs has focused on developing a selective breeding program for the Pacific oyster *Crassostrea gigas* for over a decade in response to an identified priority industry need. The research has received additional support from partnerships with commercial oyster producers in California, Oregon, Washington, and Alaska in hosting test sites and in conducting commercial demonstrations with MBP oysters.

Selection of high-performing oyster families is conducted primarily at Oregon State University’s Hatfield Marine Science Center at Newport, Oregon. Wild oyster broodstock from Washington State and from British Columbia, Canada, were used to create the original founding families. Typically, pairs of broodstock oysters are crossed to produce families that are planted at commercial grow-out sites in cooperation with industry partners in Tomales Bay, CA; Yaquina Bay, OR; in Willapa Bay, Totten Inlet, Dabob Bay, Sequim Bay, and Westcott Bays in Washington; and in Prince William Sound, AK. Oyster families with the highest survival rates, meat yields, or with other desirable traits, such as shell shape and color, are then selected and

crossed to produce the next generation of MBP-select families.

Selected families are pedigreed utilizing the latest genetic molecular “finger-printing” techniques, and this information, along with information on the heritability of desirable phenotypic characteristics, are used to develop appropriate breeding schemes for commercial production that will prevent long-term inbreeding depression. Germplasm from these selected families are also maintained at a genetic repository to preserve improved genetic materials for future use. Support from the Alaska Sea Grant and Cooperative Extension Programs is providing training to shellfish farmers in maintenance and data collection at a MBP test site located in Kachemak Bay, Alaska. This collaboration is developing a line of oysters specifically suited to Alaska’s cold seawater conditions.

Since its inception in 1995, the MBP has produced oyster families that have achieved an average increase in yield of 20% whole live weight per generation. The West Coast oyster industry is currently making use of these selected lines and MBP-funded research scientists and state extension personnel are making specific recommendations to industry on the use of this broodstock to enhance commercial production and profitability of the West Coast oyster industry. Additional information on the Molluscan Broodstock Program can be found at the following URL: <http://hmsc.oregonstate.edu/projects/mbp> .

Open-Ocean Aquaculture Demonstration Program

In 2005, the Bush administration introduced the National Offshore Aquaculture Act. Although there are still many technical and legal obstacles to iron out, the primary goal of this legislation is to “Encourage the development of responsible marine aquaculture in the Exclusive Economic Zone by providing the necessary authorities and procedures for offshore marine aquaculture operations, demonstrations, and research through public-private partnerships”.

Prior to the submission of the bill, research and demonstration of new technologies developed to produce aquaculture products in the deep-water marine environment had been underway for many years. Projects are currently in the water and are basically demonstration projects as defined in the Act (e.g., “demonstration” means pilot-scale testing of aquaculture science and technologies, or farm-scale research).

The University of New Hampshire’s (UNH) Atlantic Marine Aquaculture Center initiated its Open Ocean Aquaculture Demonstration Project with funding from NOAA in 1998 and in 1999 stocked its first fish, summer flounder, into a submersible cage off of the coast of New Hampshire. This project was designed to conduct research and demonstrate the feasibility of the concept by a team of University of New Hampshire marine biologists, engineers, and extension staff; and in collaboration with local fishermen, to develop and transfer new technological innovations to the commercial sector. Since the project’s inception, several species of marine finfish have been successfully stocked into the cages including summer flounder, cod, haddock, and halibut.

The UNH project also developed equipment and techniques to grow blue mussels in the open-ocean environment. That technology has been transferred to a commercial fisherman who has 12 longlines capable of producing 150,000 pounds of blue mussels a year in 130 feet of water off the New Hampshire coast. UNH helped the fisherman get the necessary permits and continues to work with him on improving harvesting and processing techniques. Other fishermen and interested parties have visited the site as part of the technology transfer process. For additional information on this ongoing project, please visit the following websites: <http://ooa.unh.edu>, <http://extension.unh.edu/News/Mussels.htm>, <http://www.seagrant.unh.edu/news/ooa.html>

Conclusion

In each of the previous examples there are shared commonalities. The first is that marine extension education is always a partnership with extension educators working in a collaborative fashion with the research community and marine resource users. The second is that the educational effort or demonstration project must target an important industry need, often identified through a needs assessment conducted by extension personnel. The third is that research is targeted at solving industry problems or creating opportunities. Extension personnel are responsible for insuring that the research community is aware of these problems and opportunities, and can respond with targeted research to solve problems and exploit opportunities.

Extension activities consisting of demonstration projects, workshops, research highlights, fact sheets, production manuals, and more importantly, personal, face-to-face contact and site visits are all important teaching tools and help to establish trust. Sea Grant and Cooperative Extension offices located in coastal states throughout the US function as information conduits from universities to coastal dependent businesses and resource users, and back to the academic community. These activities all help inform and guide people as they change and adapt to new technologies and opportunities.