PROGRAM INTRODUCTION

Since 1976, the Delaware Sea Grant College Program (DESG) has worked to promote the wise use, conservation, and management of marine and coastal resources through high-quality research, education, and outreach activities that benefit the public and our environment. Our motto is *"Science Serving the Delaware Coast,"* and to achieve that goal we operate as a fully integrated Sea Grant program where top-quality research supports a broad range of education and outreach efforts that in turn help to identify new research needs.

In Delaware and within our national networks our Sea Grant program is recognized as a leading neutral, science-based organization, backed by the strength and reputation of the University of Delaware. Our team provides research and outreach leadership and support to address environmental and policy challenges across our state and region. We identify and leverage federal and private funding, forge partnerships, and facilitate public engagement to identify pressing societal issues and work toward solutions.

The entire state of Delaware is considered coastal; no part of it is more than eight miles from tidal waters. With only three counties and a land area of 1,982 square miles, it is the second smallest state in the nation, yet Delaware is the sixth most densely populated state (as estimated by the U.S. Census Bureau in July 2013), with population estimates quickly approaching one million people. The combination of state population density and proximity to East Coast urban centers means that there is tremendous pressure to balance resource use among multiple sectors.

DESG understands the importance of the coast to businesses, industries, communities, homeowners and beach-goers; DESG-sponsored research shows that coast-related activities in southern Delaware alone contribute more than $6.8 billion to the state economy.

We also know the challenges involved in maintaining a healthy environment and ensuring that society continues to benefit from our natural resources. Thanks to strong stakeholder engagement across these sectors, DESG is able to deliver science-based information about coastal resources and processes that informs state and local decision-makers, assists resource managers, helps local businesses, protects the safety of citizens, and enhances marine literacy across all ages.

The 2009–2013 DESG Strategic Plan identified four focus areas and a cross-cutting focus: Healthy Coastal Ecosystems; Sustainable Coastal Development; Safe and Sustainable Seafood Supply; Hazard Resilience in Coastal Communities; and Ocean and Environmental Literacy. In our program summary reports for each focus area, we provide examples that demonstrate our contributions to science and society through a combination of research, extension, education, and communication.

Formal input on DESG's focus areas is provided by our state Sea Grant Advisory Council; key stakeholders from public sector agencies, business and industry groups, nonprofit organizations, educational groups and community leaders; and through surveys of stakeholder groups to assess needs and solicit ideas for programming. Built on partnerships and priorities from our stakeholders, the DESG Strategic Plan describes measurable objectives and specific performance measures that address the challenges identified by major stakeholders.

Our successes are reflected in our ability to catalyze partnerships, which enable us to stretch every dollar and maximize our research and outreach resources. We build relationships that address stakeholder needs and make a difference in the lives of Delawareans and the nation.

SAFE AND SUSTAINABLE SEAFOOD SUPPLY (SSSS)

Delaware's coastal waters are rich in fish and shellfish harvested for their recreational and commercial value, although the commercial fishing sector in Delaware is relatively small in comparison to other neighboring states.

GOAL: ❶ Research and outreach that catalyze new product innovations to keep the domestic seafood industry financially competitive and environmentally responsible. ❷ Development of protocols and training for innovative food safety procedures that reduce risk and enhance consumer knowledge about seafood.

Meeting Our Strategic Outcomes: The 2009–2013 Delaware Sea Grant Strategic Plan set forth ten outcomes for Safe and Sustainable Seafood Supply. The outcome stories noted below highlight the most significant science and societal progress towards addressing our strategic plan.

SEA GRANT TECHNICAL ASSISTANCE VITAL FOR DELAWARE AQUACULTURE EFFORTS.

Sea Grant contributions assist in aquaculture industry start-up. Maintaining healthy populations of bivalve shellfish for their ecological, recreational and commercial value to Delaware's Inland Bays is a top priority of the Delaware Center for the Inland Bays (CIB), a National Estuary Program (NEP) member organization. Fifteen years of applied research, demonstration, and technology transfer work guided by DESG leadership and technical support, in cooperation with the CIB and Delaware State University, documented the value and benefit of shellfish aquaculture as a means to improve the quality of the Inland Bays estuary and to enhance local seafood production and economic development. During 2012, DESG participated in a CIB initiated shellfish aquaculture public and private sector stakeholder work group to conduct spatial planning for bottom lease siting and to draft statutory code and regulatory language to reinstate a bottom leasing system for commercial shellfish aquaculture for the Inland Bays. DESG educated coastal community audiences about shellfish aquaculture through workshops, media interviews, public presentations, a white paper *Shellfish Aquaculture in Delaware's Inland Bays: Status, Opportunities and Constraints* and two websites. Commercial shellfish aquaculture legislation (HB 160) was signed into law on August 28, 2013. Technical guidance and leadership provided by DESG to demonstrate the ecological benefits of shellfish aquaculture helped facilitate a new legislative policy that will significantly increase Inland Bays shellfish (oyster) populations and associated ecological services and economic benefits, thus accomplishing a CIB priority for improving the health and stewardship of the Inland Bays estuary.

SEA GRANT RESEARCH AND OUTREACH ACTIVITIES SUPPORT SEAFOOD BUSINESS AND INDUSTRY.

Sea Grant led HACCP training helps lower the incidence of foodborne illness nationwide. The safety of seafood produced and imported to the U.S. is a national priority. To help ensure the safety of seafood products, the Food and Drug Administration (FDA) requires compliance with federal HACCP regulations. DESG, along with other Sea Grant colleagues, has conducted

national and international training for over 200 seafood professionals, including regulators and industry personnel, to meet the requirements of the FDA Seafood HACCP Regulation. Without DESG efforts in leading HACCP, there would be critical lapses in training and issues with the industry processing seafood safely. The Centers for Disease Control (CDC) data show that HACCP training has lowered the incidence of foodborne illnesses in the U.S. In addition, as a member of the Seafood HACCP Alliance (SHA) (a national steering committee) DESG has assisted in training future instructors throughout the U.S. and internationally and played a major role in improving the SHA training materials.

Sea Grant research and development results in a practical alternative recipe for eel and conch bait. Delaware Bay experienced significant declines in horseshoe crab populations in the 1990s. Population declines were attributed largely to harvests of horseshoe crabs for eel and conch bait, estimated at 350,000 (8–15 percent of the total population) annually. Reducing the harvest of female horseshoe crabs was necessary to ensure the long-term viability of the populations. In 2001 landings were capped, and in 2006 harvest of female horseshoe crabs was banned by both New Jersey and Delaware. DESG funded research and partnered with DuPont, Delaware State University and the Delaware Biotechnology Institute to investigate the chemical cue that makes female horseshoe crabs so irresistible to eel and conch; DESG worked with the fishing community to make sure the solution was practical. DESG researchers analyzed the potential compounds that attract eels and conch through a series of chemical analyses, laboratory experiments, and field trials. The research supported by DESG resulted in bait being developed using a small amount of a male horseshoe crab that met the cost and use requirements of the fishing community. In the fall of 2012, LaMonica Fine Foods (Millville, NJ) scaled up production of the bait using a proprietary fish attractant for a commercial product. In addition to the publication of the bait recipe, LaMonica's commercial version was made available to the public in 2013.

Sea Grant sponsored contest winner sees increase in sales. Coast Day is Delaware Sea Grant's annual open house and largest outreach event for the general public. One main reason people come to Coast Day is to enjoy the seafood contests, cooking demonstrations and to consume various seafood delicacies. The most popular contest is the Crab Cake Cook-Off and previous winners of this event have used the recognition of winning to help promote their businesses. The 2013 contest winner, for example, promoted his winning entry at his restaurant and increased crab cake sales immediately. Within one week of winning the Cook-off he witnessed an increase in sales. There was an initial $8,200 increase the first month compared to the same month in 2012. He also began shipping crab cakes to distant locations and he began a crab cake take-out service for his customers. Total seafood sales at his restaurant increased $109,000 for the 2014 season compared to 2013, due chiefly to the promotion of award-winning crab cakes.

SEAFOOD HEALTH AND SAFETY MESSAGES REACH TARGET AUDIENCES.

Sea Grant leads stakeholders to reach consensus messages about health benefits of seafood. DESG hosted a seafood conference *(Framing the Message About Seafood)* in 2011 with a goal to reach a consensus among participants on the health benefits of seafood.

Participants included representatives from academia, healthcare professionals, federal and state government and non-government organizations. By the end of the conference, they agreed on a conceptual framework that focused on the amount of seafood individuals eat, whether they are in special risk groups and the source of products that they consume. An existing website (seafoodhealthfacts.org) was used to launch a web-based tool to deliver information to consumers using the framework. The website provides healthcare professionals and the general public with straightforward, science-based information about the pros and cons of including seafood in a balanced diet. DESG manages the site and actively encourages other groups and organizations to include a link to it as a reliable and impartial "go to" resource for seafood information. The website is linked to, or receives, search engine referrals from more than 840 sources, most notably NOAA FishWatch, the Seafood Network Information Center, NOAA Office of Aquaculture, the National Fisheries Institute, SeafoodSource.com and Monterey Bay Aquarium SeaWatch. From the time the new web tool was launched in 2012, page views began to increase significantly. Page views and unique page views increased about 70 percent between February 2013 and January 2014. Visitors represent all 50 states, and the District of Columbia and international visitors represent a total of 137 countries. DESG efforts have resulted in consumers, dieticians, journalists, and others using the website extensively for personal information and to inform their clients about the health benefits of seafood.

Sea Grant targets various public audiences with seafood-related training and educational opportunities. Seafood is a primary source of high-quality protein and provides a variety of nutrients needed for overall health; therefore, it is paramount that consumers and food professionals understand both its benefits and risks. DESG developed and implements a variety of seafood training activities reaching multiple stakeholder groups annually. Examples include a partnership with the Delaware Department of Education (DOE) to offer annual training programs to school food service workers. DESG conducted two training programs and subsequently, DOE assumed responsibility for continuing to provide instruction concerning seafood safety, handling and preparation for Delaware's school food service workers. Another illustration was a nationwide survey conducted by DESG to assess knowledge and attitudes of the medical community regarding seafood safety issues and the benefits and risks of seafood consumption. The results indicated a need and interest to include more about food and seafood safety in future health care providers' training. DESG is in the process of securing funds to work with University faculty to develop a training module or case-based simulations to address this need.

Sea Grant informs fish consumption advisories through enhanced data collection. DESG provided funding for the development and application of a new molecular technique for distinguishing subpopulations of white perch in the Delaware Bay. *Morone americana* is a commercially and recreationally important species with known subpopulations whose contamination levels vary according to their life histories. DESG also facilitated collaboration between the research and state fishery managers that resulted in the sharing of fish tissue samples. Researchers can now provide fisheries managers with specific population distribution to tie to contamination studies. Because white perch also is a species used to monitor fish contaminant levels in the Delaware Estuary south of Trenton, New Jersey, the research is critical to fish consumption guidelines for the Delaware Bay more generally. In the future, fish consumption guidelines may be more specific and allow for more efficient consumption guidelines.

PIER PRP Program Focus Area Report

Delaware Sea Grant College Program

Safe and Sustainable Seafood Supply

Program Focus Area: SAFE AND SUSTAINABLE SEAFOOD SUPPLY

Program Goals

1. Research and outreach to catalyze new product innovations that keep the domestic seafood industry financially competitive and environmentally responsible.
2. Development of protocols and training for innovative food safety procedures that reduce risk and enhance consumer knowledge about seafood.

JUMP TO REPORT SECTION

Full Text of Impacts
Program Performance Measures
Objectives

Impacts and Accomplishments toward Program Goals

1. **Program Goal: Research and outreach to catalyze new product innovations that keep the domestic seafood industry financially competitive and environmentally responsible.**
   Impact(s)
   - 20039 - Coast Day 2014 Crab Cake Cook-off Judge (2013 Winner) Reports Financial Success
   - 19436 - Sea Grant Technical Assistance Contributes to Passage of New Shellfish Aquaculture Legislation (Updated from 2012)
   - 19435 - Sea Grant Partnership Provides Vital Training for Future Instructors for Seafood Hazard Analysis Critical Control Point (HACCP)
   - 17163 - 2012-2013 Fishery Bait No Longer Reliant on Female Horseshoe Crabs
   - 15324 - Collaborative shellfish aquaculture research and demonstration work produces measurable environmental benefits for Delaware's Inland Bays
   - 14131 - Delaware Inland Bays Oyster Gardening/Restoration Program

   Accomplishment(s)
   - 20114 - Win-win: Fellowship Produces Important Research and Provides Professional Development
   - 20113 - White Perch Delaware Bay: New Molecular Tools to Distinguish Populations
   - 20108 - Does Water Quality Affect Consumersâ€™ Willingness to Pay for Locally Harvested Oysters?
   - 20105 - Examination of an Experimental Pathogen Surrogate to Improve Shellfish Safety
   - 20084 - 'Focus on Coastâ€™ Seminars Educate Public and Decision-makers on Delaware Marine Fisheries

2. **Program Goal: Development of protocols and training for innovative food safety procedures that reduce risk and enhance consumer knowledge about seafood.**
   Impact(s)
   - 20040 - Seafood HACCP Training and Implementation Helps Reduce Incidence of Foodborne Illness Due to Fish as Reported by Center for Disease Control
   - 17146 - 2012-2013 New Web tool developed as a Result of a Sea Grant Sponsored Workshop Assists Consumers Make informed Seafood Choices
   - 15326 - Stakeholders at Sea Grant sponsored conference develop a consensus message about the health benefits of consuming seafood

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Full Text of Impacts and Accomplishments

20114 - Win-win: Fellowship Produces Important Research and Provides Professional Development

Relevance
Fisheries management requires skilled, knowledgeable professionals to work with researchers on complex simulation models upon which harvest quotas rely. Capacity building in this field is complex, requiring not only the technical (mathematical, modeling, and fisheries biology) expertise, but an understanding of the real world, societal influences on the development of fisheries management.

Response
The National Marine Fisheries Service (NMFS) supports an annual Fellowship competition that requires

Fellows to work with a mentor within the Service. Research projects are carefully developed to not only provide the Fellow with a rich research experience, but to answer pressing and important problems through directly applicable research. Along the way the Fellows learn about how NMFS manages the nation's fisheries, experiences what professional life as a NMFS resource manager involves, and typically engages with members of the fishing community on these important issues.

Results
Delaware Sea Grant's 2014 NMFS Fellow conducted economics research on the halibut fishery, and the effects of the characteristics of the Individual Fishing Quota (IFQ) shareholder on their use of a hired skipper. Study results are of interest to fisheries managers because the work identified potential attributes that managers can regulate. Non-Alaskan shareholders are more likely to hire skippers, as are those with more diverse holdings. The research has been presented to the Alaska fisheries community, as well as at national fisheries management meetings and a scientific paper is being readied for submission to a peer-reviewed journal.
RECAP: Through active participation in the fisheries management community graduate students can provide important scientific contributions to the effort while learning about professional fisheries management. Back to Goals

20113 - White Perch Delaware Bay: New Molecular Tools to Distinguish Populations
Relevance
White perch (Morone americana) are a commercially and recreationally important fish species in the Delaware River and Bay and are used to monitor contaminant levels in six zones of the Delaware River downstream from Trenton, NJ and to set consumption advisories. It is unknown whether management boundaries for white perch correspond with population boundaries. In a previous pilot study, Sea Grant researchers demonstrated genetic differentiation among several Delaware Bay tributaries, indicating that at least some tributaries are reproductively isolated.

Response
Through a modest program development award Delaware Sea Grant is supporting research to develop molecular tools for population differentiation of the white perch in Delaware Bay. Levels of harmful contaminants may vary depending on the life histories of the subpopulations that are known to exist. Fish that spend more time in contaminated systems very likely contain higher levels in their flesh. A new molecular tool could be useful to fisheries managers to discriminate between more or less contaminated subpopulations.

Results
As work continues on this project researchers are refining techniques to describe white perch population structure using the molecular data.
RECAP: A new tool for refinement of white perch consumption advisories based on subpopulation data may be available to fisheries managers in the near future. Back to Goals

20108 - Does Water Quality Affect Consumers' Willingness to Pay for Locally Harvested Oysters?
Relevance
Oyster aquaculture in the Delaware Inland Bays has been approved, yet little is known about resident and visitor willingness to pay for local shellfish. In addition to their commercial value, oysters are recognized as important filter feeders, capable of significantly improving local water quality. Capturing that positive feedback (more oysters, better water quality, higher WTP) may be important as resource managers are actively considering aquaculture development options. This ecosystem value may substantially increase the recognized economic value of the industry if it can be captured and described.

Response
Delaware Sea Grant researchers have drafted an economic survey and deployed it on participants in an aquaculture workshop convened by the Delaware Center for the Inland Bays. The instrument is currently undergoing minor revisions, and will be deployed to more general audiences in the second year of the project.

Results
Workshop audience members consistently indicated an unwillingness to pay for oysters from nutrient rich waters. They were, however, interested in purchasing local oysters.
RECAP: Initial data indicate that consumers care about the water quality in their coastal ecosystems, and may consider it, when determining whether to pay a premium for locally harvested oysters.
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20105 - Examination of an Experimental Pathogen Surrogate to Improve Shellfish Safety
Relevance
The Centers for Disease Control reports that norovirus (NV) is responsible for 19-21 million illnesses each year in the US and is the most prevalent cause of food bourne illness. NV associated with raw or under-cooked oysters has been associated with several outbreaks. Because NV is not readily cultivated, viral surrogates such as murine norovirus (MNV) are widely used by researchers to predict human NV behaviors. MNV has many limitations and so alternative surrogates are being sought to allow for more diverse and thorough research into the pathogen. Tulane virus (TV) shows promise as an appropriate surrogate worthy of additional investigation.

Response
With a modest program development investment a Delaware Sea Grant researcher is conducting a host of laboratory experiments to determine similarities and differences in the cultivation and response of MNV and TV.

Results
Work is ongoing and promises to provide important information regarding the feasibility of this surrogate for future NV work. A readily cultivable viral surrogate for NV will provide researchers with a critical tool for evaluating the impacts of cooking methods, time and temperatures on inactivation of human NV on oysters.
RECAP: Tulane virus (TV) is being examined to determine as a new viral surrogate for human norovirus contamination on cooked oysters. Our work could help improve seafood handling and enhance consumer knowledge about safe and sustainable seafood. Back to Goals

20084 - 'Focus on Coast' Seminars Educate Public and Decision-makers on Delaware Marine Fisheries
Relevance
Delaware's coastal waters are rich in fish and shellfish harvested for their recreational and commercial fishing value. Commercial fishing, charter boats, bait and tackle stores and related services and businesses employ thousands of Delawareans and contribute millions of dollars to Delaware's coastal economy. While these businesses depend on a healthy coastal ecosystems and sustainable fishery stocks, improved understanding the key marine fishing business sectors within our coastal economy by local community leaders and decision makers is also vital to ensuring a robust coastal economy and high quality of life for residents.

Response
In cooperation with the DNREC Division of Fish and Wildlife, Delaware Sea Grant organized a "Focus on the Delaware Coast: Sustaining Delaware's Marine Fisheries" seminar in February 2014 to identify and discuss constraints, issues, and opportunities to strengthen Delaware's commercial and recreational fishing industries.

Results
The seminar was targeted to coastal community leaders, commercial and recreational fishermen, and charter boat captains and businesses that support Delaware's marine fisheries.
Each group had an opportunity to represent their particular interests and to develop a better understanding about the concerns and goals of other resource stakeholders and the state of the industry overall through discussions during the seminar.
RECAP: Delaware Sea Grant in collaboration with the DNREC Division of Fish and Wildlife developed a public forum to address challenges and opportunities with regard to the sustainability of Delaware's commercial fisheries. The "Sustaining Delaware Marine Fisheries" seminar is part of the long-running "Focus on the Coast" series that spotlights coastal resource issues in Delaware. The seminars provide relevant science-based information to support local decision-making. Back to Goals

20040 - Seafood HACCP Training and Implementation Helps Reduce Incidence of Foodborne Illness Due to Fish as Reported by Center for Disease Control
Relevance
Federal regulations require that all facilities processing or distributing seafood have employees certified in Hazard Analysis Critical Control Point (HACCP).

Response
DESG continues to conduct training and develop HACCP training materials for the seafood industry processors and regulators.

Results
The CDC has reported that the FDA Seafood HACCP regulation has played a major role in reducing the average number of fish-attributed outbreaks from an average of ~65 per year from 1998 to 2004 to ~32 per year from 2005 to 2012.
RECAP: The Center for Disease Control (CDC) has recognized the important role played by Delaware Sea Grant (DESG) HACCP trainer to help in significantly reducing foodborne illness outbreaks caused by seafood. Back to Goals

20039 - Coast Day 2014 Crab Cake Cook-off Judge (2013 Winner) Reports Financial Success
Relevance
Coast Day is the annual open house at DESG and University of Delaware, College of Earth, Ocean and Environment (CEOE) and seafood favorites are showcased by local chefs at the Crab Cake Cook-off and the Seafood Chowder Challenge. DESG activities included organizing all of the seafood related events such as the Crab Cake Cook-off, the Cook-off Trivia Contest, the Chowder Challenge, Seafood Seminars, all food and seafood vending operations, and the Annual Oyster Shucking Contest.

Response
A chef from Frontier Land in Ocean City, MD entered and won the 2013 Coast Day Crab Cake Cook-off. As part of his prize he was invited back to be a Judge for the 2014 Coast Day Crab Cake Cook-off.

Results
When DESG contacted him to confirm his attendance for the 2014 event he reported "Our crab cake sales are up 195%. We now have folks buying a dozen at a time and folks are asking us to flash freeze packs in dry ice and ship them all over the country!"
RECAP: Crab cake sale increases of 195% attributed to first place prize and media attention resulting from Delaware Sea Grant (DESG) Crab Cake Cook-off. Back to Goals

19436 - Sea Grant Technical Assistance Contributes to Passage of New Shellfish Aquaculture Legislation (Updated from 2012)
RELEVANCE: The cumulative impact of sustained agricultural and suburban development and eutrophication In Delaware's three Inland Bays (Indian River, Rehoboth and Little Assawoman) has degraded estuarine water quality and habitat, and has reduced diversity and abundance of various species of fishes, invertebrates and submerged aquatic vegetation. Maintaining healthy populations of bivalve shellfish for their ecological, recreational and commercial value to Delaware's Inland Bays is one of the top priorities of the Delaware Center for the Inland Bays (CIB), a National Estuary Program (NEP).
RESPONSE: Delaware Sea Grant, in partnership with the CIB, DE DNREC, and Delaware State University, provided scientific and technical guidance and leadership in support of a 15 year shellfish aquaculture restoration and research/demonstration program effort that: (1) characterized shellfish growth, survival and demonstrated the use and effectiveness of viable aquaculture methods; (2) conducted applied research to demonstrate the ecological benefits of shellfish aquaculture; (3) educated coastal community audiences about the benefits of healthy shellfish populations; and (4) produced juvenile and adult oysters for stock enhancement and restoration through a coastal citizen volunteer (oyster gardening) program.
RESULTS: The impact of these activities and growing public interest led to the formation of a CIB stakeholder work group that reviewed current policies and regulations, and drafted legislation to reinstate commercial bottom leases for shellfish aquaculture in the bays. On June 4, 2013 during the 147th session of the Delaware General Assembly, House Bill 160 was introduced. It passed with unanimous votes in both the House and the Senate and Governor Jack Markell signed the legislation on August 28, 2013.
RECAP: Sustained technical guidance and leadership provided by Delaware Sea Grant to demonstrate the ecological and economic benefits of shellfish aquaculture helped facilitate a new legislative policy that will significantly increase Inland Bay shellfish (oyster) populations and associated ecological services and benefits. Back to Goals

19435 - Sea Grant Partnership Provides Vital Training for Future Instructors for Seafood Hazard Analysis Critical Control Point (HACCP)
RELEVANCE: Federal regulations require that all facilities processing or distributing seafood must operate under a Hazard Analysis Critical Control Point (HACCP) system to insure the safety of seafood products during processing, and the import of any seafood into the United States. The Seafood HACCP Alliance (SHA), whose membership includes many Sea Grant seafood specialists as well as federal and state agency personnel, is committed to assist with HACCP training of seafood industry personnel as well as training and certifying new instructors. The SHA helped in determining that the Association of Food and Drug Officials (AFDO) needed more certified trainers to insure that key personnel in seafood processing facilities continue to be properly trained and certified.
RESPONSE: Delaware Sea Grant, working in partnership with numerous other Sea Grant seafood technology specialists and the AFDO, helped in developing a program and training materials, and participated as a trainer at a "Train-the-Trainer" session at the SHA meeting held in Orlando, FL in September 2013. The HACCP "Train-the-Trainer" sessions are 2-1/2 day classroom courses that provide actual training techniques, materials, and requirements for qualified participants to be recognized by AFDO "as recognized" SHA instructors. The sessions are open to regulatory officials, industry employees, academia and international participants.
RESULTS: Delaware Sea Grant assisted in the delivery of standardized training according to the SHA protocols maintained by AFDO (www.afdo.org). Thirty-five individuals were certified to be new Seafood HACCP instructors and are now able to assist the industry in meeting the requirements of the federal regulations.
RECAP: Delaware Sea Grant and partners help in training new seafood HACCP instructors to assist seafood industry personnel meet federal safety regulations. Back to Goals

17163 - 2012-2013 Fishery Bait No Longer Reliant on Female Horseshoe Crabs
RELEVANCE: Significant declines in horseshoe crab populations in the 1990s led to the establishment of a 30 square mile no-take area at the mouth of the Delaware Bay. In 2001 landings were capped, and in 2006 harvest of female horseshoe crabs was banned by New Jersey and Delaware. Horseshoe crab eggs are a major food source for migratory waterfowl, and horseshoe crab blood is an indispensable product for sterility testing of nearly all medical equipment and tests. Population declines were attributed largely to harvests of horseshoe crabs for eel and conch bait, estimated at 350,000 (8-15% of the total population) annually. Reduction in harvesting of female horseshoe crabs was necessary to ensure the long-term viability of the populations.

RESPONSE: Delaware Sea Grant funded research and partnered with DuPont, Delaware State University and the Delaware Biotechnology Institute to research the chemical cue that makes female horseshoe crabs so irresistible to eel and conch. In consultation with the fishing community, and in

response to their needs, Delaware Sea Grant ensured the research sought a practical solution for the fishing community.

RESULTS: DESG researchers analyzed the potential compounds that attract eels and conch through a series of chemical analyses, laboratory experiments, and field trials. A bait was developed that met the cost and use requirements of the fishing community. The published recipe is for an alginate-based bait using 1/8 of a male horseshoe crab-which field tests demonstrated was just as effective as bait made solely from 1/2 of a female horseshoe crab. Researchers also demonstrated that exotic, invasive Asian shore crabs were as effective in the alginate bait when used 50:50 with horseshoe crab tissue. The research, supported by Delaware Sea Grant, resulted in an inexpensive, effective bait that reduces reliance on the horseshoe crab population; instead of using 1/2 of a female horseshoe crab per pot, fishermen can now use 1/16 of a male horseshoe crab for effective results. In the fall of 2012, LaMonica Fine Foods (Millville, NJ) scaled up production using a proprietary fish attractant for a commercial product. In addition to the publication of the bait recipe, LaMonica's commercial version was made available to the public in 2013.
RECAP: Research and development supported by DESG has resulted in a practical alternative recipe for eel and conch bait that uses 1/16 of the amount of horseshoe crab tissue needed previously.

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17146 - 2012-2013 New Web tool developed as a Result of a Sea Grant Sponsored Workshop Assists Consumers Make informed Seafood Choices
RELEVANCE: While the health benefits of eating seafood outweigh the risks, there is concern that contaminants in some species may pose risks for certain people. But, the problem of reduced seafood consumption, due to price, availability, or undue caution may be the greatest risk for the U.S. population. Seafood educators have been concerned about the mixed messages the media, and others, have been delivering about seafood and health.

RESPONSE: A team of Sea Grant extension specialists, and other partners, used an existing Internet based resource, the Seafood Health Facts Website (http://seafoodhealthfacts.org) and created a web tool that delivers safe and healthy seafood consumption information designed to meet individual consumers' needs. A tiered approach guides consumers, or healthcare providers, to customized advice for themselves or patients on how much seafood to eat, which types to eat in moderation, and other helpful tips.

RESULTS: The stakeholders at the Framing the Message about Seafood conference arrived at a consensus on an approach that could be translated to a web-based resource that was easy to use and provides important information to consumers. The seafoodhealthfacts.org website has seen a tremendous increase in visitors in 2012 and use of the online tool has also increased. Between February 2012 and July 2012 the average monthly visitors were between 1,000 and 3,000 per month. Since July it has continued to grow, reaching 15,000 visits by the end of January 2013. Seventy-three percent of the visits are characterized as "organic" by keyword (e.g. is seafood healthy, seafood health facts, salmon nutrition). Twenty percent of the visits were direct traffic to the site and seven percent were from referrals from other sites including: google.com, seafood.ucdavis.edu, seafoodsource.com, nmfs.noaa.gov, FishWatch.gov, and udel.edu.
RECAP: The most significant result of the Framing the Message About Seafood conference was a consensus among participants on a conceptual framework to present information to consumers based on how much seafood they eat, their status in a special risk group and the source of products that they consume (commercial or recreational). The new web tool was developed for the Seafood Health Facts website, peer reviewed, and launched within six months of the conference.

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15326 - Stakeholders at Sea Grant sponsored conference develop a consensus message about the health benefits of consuming seafood
RELEVANCE While the health benefits of eating seafood outweigh the risks, there is concern that contaminants in some species may pose risks for certain people. But, the problem of reduced seafood consumption due to price, availability, or undue caution may be the greatest risk for the U.S. population. Seafood educators have been concerned about the mixed messages the media, and others, have been delivering about seafood and health.

RESPONSE Delaware Sea Grant, along with many partners, received funding to conduct a "Framing the Message about Seafood" workshop to bring together stakeholders to address the topic of the health benefits of seafood. Industry representatives, government, academia, and advocacy communities discussed the challenges of a risk-based approach to seafood safety and the roles of government and industry.

RESULTS Participants developed a consensus message based on scientific evidence that eating seafood can have very positive health benefits. The message has been posted on a seafood website (seafoodhealth.org) and has been viewed by more than 11,500 individuals. In addition, the Delaware Department of Natural Resources and Environmental Control (DNREC) simplified their seafood messages and listed the seafoodhealthfacts.org website on their website and their 2012 SportFishing Guide. The Website continues to receive considerable referrals and will continue to be a resource for the public to obtain reliable and accurate information on seafood consumption.
RECAP: RECAP This represented the first time a stakeholder group had convened to discuss the information that has been presented to the public on seafood health benefits and risks. A consensus was reached on a science-based approach that could be readily translated to an existing Web-based

resource. Back to Goals

15324 - Collaborative shellfish aquaculture research and demonstration work produces measurable environmental benefits for Delaware's Inland Bays
RELEVANCE Delaware's three coastal bays are degraded ecosystems due to chronic nutrient pollution. Habitat loss and poor water quality has reduced species diversity and abundance. Bivalve suspension (filter) feeding shellfish (especially oysters) and the ecosystem services they provide are of critical importance for maintaining estuarine health. The abundance and distribution of wild Inland Bay oyster populations, decimated by MSX disease during the 1960s, is very low and has not recovered sufficiently for a natural return of oyster stocks.

RESPONSE Delaware Sea Grant in cooperation with the Delaware Center for the Inland Bays (CIB), Delaware Department of Natural Resources and Environmental Control (DNREC) and Delaware State University researchers initiated field research in 1998 (to the present) to investigate and demonstrate the value of using shellfish aquaculture methods for oyster restoration and stock enhancement.

RESULTS Field research has demonstrated the environmental benefits and value of oyster aquaculture. A network of 120 oyster culture sites maintained by 200 coastal resident volunteers provides recruitment, nursery habitat and predator refuge for 49 species of fish and invertebrates and also produces adult oysters for restoration work. The variety and quantity of estuarine species found in oyster aquaculture gear has equivalent ecological value with natural eel grass beds and oyster reefs. Oyster restoration work has been linked to recent observations of significantly increased natural oyster recruitment.
RECAP: Delaware Sea Grant's leadership and technical advisement for shellfish aquaculture research and restoration has increased Inland Bay oyster populations, habitat for fish and other species, natural recruitment and other related ecosystem services (water filtration, and nutrient cycling). Back to Goals

14131 - Delaware Inland Bays Oyster Gardening/Restoration Program
RELEVANCE Delaware's Inland Bays are subject to chronic adverse environmental impacts due to excessive nutrient inputs from agricultural and suburban development. As bivalve filter feeders oysters play a critical ecological role in coastal estuaries as a keystone species to facilitate nutrient cycling and water clarification. Oysters provide habitat and refuge for benthic invertebrates and juvenile fishes. Current Inland Bay oyster populations are minimal as a result of disease related mortality and support negligible natural recruitment.

RESPONSE To restore oyster populations, Delaware Sea Grant and the Delaware Center for the Inland Bays (CIB) initiated an oyster gardening program with coastal resident volunteers in 2003. Volunteers cultivate hatchery produced oysters in floating baskets at their docks to promote natural spawning and recruitment before being transplanted to off-bottom locations around the estuary for further growout. Graduate students from Delaware State University documented environmental impacts related to oyster restoration activities.

RESULTS Program results include (1) 40-50 bushels of oysters are transplanted to the estuary annually; (2) new natural oyster recruitment in previously barren Fenwick Island sites was observed; (3) the value and importance of oysters and culture gear as habitat to recruit and protect 49 species of juvenile fish and invertebrates was demonstrated; and (4) a tenfold expansion from 13 culture sites to more than 130 sites and greater than 150 volunteers including two coastal municipalities (Fenwick Island and South Bethany) highlights community interest in the effort.
RECAP: RECAP Oyster gardening activities demonstrated the ecological and potential economic value of maintaining robust oyster populations in Delaware's Inland Bays. Back to Goals

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Program Performance Measures (2010 - 2013)

Program Performance Measure	Program Plan Target (2010-2013)	Reported	Program Comments
Number of school food service workers/managers educated on health benefits of seafood.	135	87	2010 - On target to achieve by 2013. 2011 - Average 30 workers trained annually on target to achieve goal by the end of 2013. 2012 - Scheduled to achieve target by end of 2013 2013 - 118 school service workers/managers of the target 135, were educated however, in 2013 DE Dept of Educ School of Nutrition Program revised their policies on inservice training for school service workers and reduced the number of invited speakers.

			Thus, DESG temporarily suspended the program. Performance measure not achieved by target date due to factors beyond our control
Number of seafood plant managers that participate in training.	65	264	2010 - On target to achieve by 2013. 2011 - More than 75 plant managers have been trained so far target exceeded in 2011. 2012 - Target was exceeded in 2012 and anticipate that an additional 45 will be trained in 2013 2013 - 69 seafood plant managers participated in training in 2013. Performance measure achieved and exceeded
Number of Seafood processors certified in new HACCP regulations.	15	126	2010 - On target to achieve by 2013. 2011 - 20 seafood plant managers have been trained. Target was achieved in 2011. 2012 - As a result of DE SG participation in SHA Train-the-Trainer Programs 75 Trainers were AFDO certified to be Instructors.Target was achieved in 2012. In addition it is anticipated that 20 seafood processors will be HACCP certified and 20 instructors will become AFDO Certified Trainers in 2013 2013 - 39 seafood processors were certified in new HACCP regulations in 2013. Performance measure achieved and exceeded
Number of shellfish processors using newly developed high pressure processing parameters.	3	0	2010 - On target to achieve by 2013. 2011 - Research is completed and FDA has approved process. Equipment can be cost prohibitive. 2012 - Due to the high cost of equipment, it is doubtful this target will be achieved 2013 - Research is completed and FDA has approved process. High cost of equipment has prohibited further implementation to date
Number workshops sponsored by Delaware Sea Grant to educate seafood consumers on fisheries management and seafood nutrition, safety and quality.	35	45	2010 - On target to achieve by 2013. 2011 - Averaging 13 workshops each year. On target to achieve goal by the end of 2013. 2012 - Target achieved in 2012 2013 - 6 workshops sponsored to educated consumers in 2013. Performance measure achieved and exceeded

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Program Objectives (2010 - 2013)

Program Objective	Achieved (yes/no)	Program Comments
By 2011, Delaware Sea Grant will conduct 8 briefings and seminars to initiate discussions on the benefits and constraints of aquaculture development in Delaware.	Yes	2010 - To be completed in 2011. 2011 - Nine programs were conducted in 2011. Goal exceeded in 2011. 2012 - Goal achieved in 2011 2013 - Goal achieved in 2011
By 2013, Delaware Sea Grant will assist in educating 30 HACCP trainers and 25 seafood inspectors on the changes made to the Hazards Guide.	Yes	2010 - To be completed by 2013. 2011 - Will exceed target by 2013. 2012 - Goal achieved in 2012. Trend expected to continue in 2013 2013 - Delaware Sea Grant will continue to participate in training Seafood Inspectors on HACCP protocols to keep industry current
By 2013, Delaware Sea Grant will assist in training 65 seafood plant managers of safe methods for processing their products. Managers, will then train their staff workers.	Yes	2010 - To be completed by 2013. 2011 - Goal exceeded in 2011. 2012 - Goal achieved in 2011. Trend continued in 2012 2013 - Training materials produced and are now available online for use in seafood processing plants

By 2013, Delaware Sea Grant will conduct 35 workshops to reach consumers about sustainable fisheries and how this knowledge can be used when buying seafood.	Yes	2010 - To be completed by 2013. 2011 - Averaging 13 workshops each year. On target to achieve goal by the end of 2013. 2012 - Goal achieved in 2012
By 2013, Delaware Sea Grant will conduct 35 workshops to reach consumers about the health benefits of seafood.	Yes	2010 - To be completed by 2013. 2011 - On target to achieve goal by the end of 2013. Average 13-15 workshop each year. 2012 - Goal achieved in 2012
By 2013, Delaware Sea Grant will provide Web based aquaculture information to 10,000 unique DARC Web site visitors.	Yes	2010 - To be completed by 2013. 2011 - One-half way (5,800) to target goal. On target to achieve goal by the end of 2013. 2012 - Cumulative total 7,349 towards to target goal. On target to achieve goal by the end of 2013 2013 - 10,737 unique visitors visited DARC website by the end of 2013
By 2013, Delaware Sea Grant will train and certify 15 Delaware seafood processors and 50 seafood processors from the region and the nation.	Yes	2010 - To be completed by 2013. 2011 - On target to achieve goal by the end of 2013. 2012 - Goal achieved and exceeded in 2012 2013 - Delaware Sea Grant will continue training industry personnel on HACCP principles as the need arises
By 2013, processing parameters will be developed through Delaware Sea Grant research and transferred to 3 shellfish processors using high pressure processing.	No	2010 - To be completed by 2013. 2011 - Though FDA-approved, processing equipment is cost-prohibitive for moderately-sized facilities. 2012 - Though FDA-approved, the new process requires equipment that is cost-prohibitive for small-to-moderately sized processing plants 2013 - Though FDA-approved, the new process requires equipment that is cost-prohibitive for small-to-moderately sized processing plants
By 2013, Sea Grant will educate 135 school food service workers/managers about the health benefits of seafood.	No	2010 - To be completed by 2013. 2011 - On target to achieve goal by the end of 2013. Average 30 food service workers/managers each year. 2012 - On target to achieve goal by end of 2013 2013 - 87 school service workers were trained by the end of 2012. In 2013 the Delaware Department of Education School Nutrition Program revised its policies on in-service training for school service workers and reduced the number of invited speakers. Thus, no programs were conducted by DESG in 2013
By 2013, Sea Grant will educate 30 healthcare providers in Delaware about the benefits and risks of seafood consumption.	Yes	2010 - To be completed by 2013. 2011 - Achieved goal in 2011. To date, 55 health care providers have been educated about the benefits and risks of seafood consumption. 2012 - Goal achieved in 2011 and exceeded in 2012 2013 - Delaware Sea Grant continues to address the need of Health Care Provides to become more educated on seafood risk/benefit issues