V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Global Food Security and Hunger - Aquaculture

☑ Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
135	Aquatic and Terrestrial Wildlife	100%		100%	
	Total	100%		100%	

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2014	Extension		Research	
	1862	1890	1862	1890
Plan	3.0	0.0	4.8	0.0
Actual Paid	4.0	0.0	3.0	0.0
Actual Volunteer	10.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	**1890 Extension**	**Hatch**	**Evans-Allen**
29153	0	174238	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
467874	0	788911	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
82821	0	709504	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

- Investigate the genetic mechanisms for disease resistance and improved quality in economically

important shellfish

- Create a dynamic and cooperative partnership with faculty, staff, businesses, regulatory/advisory councils and the government to research best management practices and discover effective solutions and management practices to address threats to NJ aquaculture as well as investigate opportunities to increase the quality and quantity of the aquaculture harvest.
- Collect and analyze data on how communities and businesses are affected by the aquaculture industry management practices.
- Examine the presence of unhealthy levels of contaminants in aquaculture products.
- Determine best techniques for shellfish hatcheries on and off shore.

2. Brief description of the target audience

- Aquaculture related businesses and employees
- State Department of Environmental Protection
- State Department of Agriculture
- Industry partners who learn ways to improve or protect their harvests
- Communities who depend on aquaculture-related revenue
- NJAES faculty and staff involved in water research/outreach
- Consumers of aquaculture products, including recreational fishing

3. How was eXtension used?

eXtension was not used in this program

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	204	0	0	0

2. Number of Patent Applications Submitted (Standard Research Output)

Patent Applications Submitted

Year: 2014

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	6	16	22

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- A variety of strategies will be implemented to reach target audiences. This will include and not be limited to workshops, field visits, classes, newsletters, media releases, electronic communications,publications. In addition a trained volunteer teaching base will be developed. Quantitative reports of participation will be collected.

Year	Actual
2014	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Short Term - Knowledge of seasonal variations for shellfish diseases. Create census data on communities involved in aquaculture. Determine the level of pollutants in economically important fish species. Develop markers and maps of important genetic traits. Knowledge of shellfish hatchery techniques that decrease time for growth to market size.
2	Medium Term - Identify spatial and temporal relationships between patterns of shellfish diseases in NJ and environmental correlates. To develop disease-resistant strains of shellfish. Develop superior disease-resistant and larger genetic lines of shellfish.Measure the impact of communities on the aquaculture industry. Knowledge of the feasibility of off-shore shellfish farming.
3	Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.
4	Aquatic Robotics: Summer Enrichment Program at Club 21 Summer Camp in Millville - Medium Term - Identify spatial and temporal relationships between patterns of shellfish diseases in NJ and environmental correlates. To develop disease-resistant strains of shellfish. Develop superior disease-resistant and larger genetic lines of shellfish.Measure the impact of communities on the aquaculture industry. Knowledge of the feasibility of off-shore shellfish farming.
5	Sustainable Fisheries Research- Medium Term - Identify spatial and temporal relationships between patterns of shellfish diseases in NJ and environmental correlates. To develop disease-resistant strains of shellfish. Develop superior disease-resistant and larger genetic lines of shellfish.Measure the impact of communities on the aquaculture industry. Knowledge of the feasibility of off-shore shellfish farming.
6	Understanding Ecological Aspects of Shellfish Pathogens to Improve Management - Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.
7	Characterizing the Physical Environment of the Coastal Ocean and its Relationship to Ecosystem Indicators - Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.
8	Shellfish Genetics and Breeding for Aquaculture - Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.
9	Fish, Fishing, and Risk to Eco-receptors and Humans in Coastal New Jersey - Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that

	can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.
10	Marine Natural Product Discovery in Extreme Environments - Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.

Outcome #1

1. **Outcome Measures**

Short Term - Knowledge of seasonal variations for shellfish diseases. Create census data on communities involved in aquaculture. Determine the level of pollutants in economically important fish species. Develop markers and maps of important genetic traits. Knowledge of shellfish hatchery techniques that decrease time for growth to market size.

Not Reporting on this Outcome Measure

Outcome #2

1. **Outcome Measures**

Medium Term - Identify spatial and temporal relationships between patterns of shellfish diseases in NJ and environmental correlates. To develop disease-resistant strains of shellfish. Develop superior disease-resistant and larger genetic lines of shellfish.Measure the impact of communities on the aquaculture industry. Knowledge of the feasibility of off-shore shellfish farming.

2. **Associated Institution Types**

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

SEA-SI Sea Science Investigations

Cumberland County, the poorest county in New Jersey, was declared a disaster area following Superstorm Sandy. Then a nor'easter followed. Yet, Cumberland County, absent boardwalks and funnel cake on the western Jersey shore, was not named one of the nine counties eligible to receive the bulk of $1.8 billion in federal hurricane/ disaster aid.

What has been done
SEA-SI: Sea Science Investigations is a hands-on summer enrichment program offered by 4-H at Beaver Dam Boat rentals. Participants become active stewards of the Oranokin Creek, and learn about water quality, marine life, boating, crabbing; take part in hands-on science activities; specimen collection and identification and explore topics such as aquaculture, marine robotics and environmental stewardship practices of local businesses. Curriculum utilized included Project PORTS, Waterbotics, NOAA's How Do We Explore and Private Eye. Offered for three days in August, the program is three hours each day. SEA-SI is designed to include no more than 12 students. Demonstrations and activities relating to underwater ROVs, aquaculture systems, geocaching, water quality and habitat assessment were offered. Critical thinking and creative writing exercises were also included.

Results
A pre-posttest survey and end of session focus group discussion were utilized as evaluation tools in the program. Evaluation revealed the following: 67% rated presenter as excellent 33% rated presenter as very good When asked about prior knowledge of hand lining: 56% indicated no prior knowledge 33% indicated "some? knowledge 11% indicated "lots" of knowledge There was a 123% calculated change, with 67% indicating they now knew "lots" following the program 33% indicating they had learned "some" following the program Respondents indicated an 88% change in their knowledge regarding how oysters clean water Likewise 88% indicated change in their knowledge of aquaculture practices. 22% indicated they knew "a lot", 33 % "a little" and 44% indicated they knew "nothing" about operating an underwater ROV prior to the program. At the close of the program there was a 50% change in knowledge, with 44% responding they had learned "a lot", 34 % indicating they had learned some and 22% indicating they had learned "a little" Focus groups provided further qualitative responses on the learning. Participants remarked "I cannot wait until I come next year!" "The BEST thing I did was the underwater robot." "I will volunteer to help with the oyster shell bags again". "I loved the ROVS".

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #3

1. Outcome Measures

Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Sustainable Fisheries: From Case-Studies to Global Meta-analysis

Commercial and recreational fisheries play a critical economic and social role in the United States. Nationally, commercial landings are worth over $4 billion per year (dockside value) and the economic impact of recreational fishing is more than $38 billion. Despite the clear importance of fisheries, our ability to manage fisheries is falling behind. In 2007, of the 528 fish and invertebrate stocks recognized by the National Marine Fisheries Service (NMFS), only 179 or slightly over one third were fully assessed. Globally, the availability of stock assessments and the status of fisheries generally presents even more cause for concern. It is estimated that approximately two-thirds of fish stocks are currently below the biomass that would support maximum sustainable yield. Biomass of exploited marine fishes declined 38% between 1970 and 2007, although it appears to have leveled-off in recent years. Fishery status in fresh waters is less well known, but in many cases appears to be worse than in marine waters.

What has been done
NJAES researchers are building upon case studies from individual fisheries in the U.S. and other countries to examine the impacts of fishing and other changes on aquatic environments. In addition, the comparative approach helps identify those management strategies that are working and lead to their broader adoption in other locations. These comparisons involve (1) development of a new global database with information about many fish populations around the world based on information that has already been collected by U.S. and foreign fishery management agencies and (2) novel research on fish populations in the U.S., Mexico, and Mongolia which differ in their natural environments and fisheries, but share many of the same challenges, such as vulnerability to climate change and overfishing.

Results
NJAES research improved our understanding of how the 2010 Macondo oil spill in the Gulf of Mexico impacted marsh fish communities. There is surprisingly little detectable long-term impact on marsh fishes in Louisiana compared to other severe oil spills such as the Exxon Valdez. A

meta-analysis of a global database of fish stock assessments demonstrated that depensation (negative population growth rate at low abundance) appears to be quite rare or only occurs at extremely low abundance. However, fish populations are naturally quite variable in their reproductive output, which leads to frequent stochastic depletion even for lightly harvested populations. Thus, we should expect to see even sustainably managed populations occasionally dip below target population sizes.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #4

1. Outcome Measures

Aquatic Robotics: Summer Enrichment Program at Club 21 Summer Camp in Millville - Medium Term - Identify spatial and temporal relationships between patterns of shellfish diseases in NJ and environmental correlates. To develop disease-resistant strains of shellfish. Develop superior disease-resistant and larger genetic lines of shellfish.Measure the impact of communities on the aquaculture industry. Knowledge of the feasibility of off-shore shellfish farming.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Aquatic Robotics: Summer Enrichment Program at Club 21 Summer Camp in Millville

Cumberland County ranks at the poorest county in the Garden State and has minority enrollment of 65% (majority Hispanic) which exceeds the New Jersey state average of 49%. New Jersey ASK School test results reveal that students from the Cumberland County Elementary schools are not unilaterally proficient in the areas of science and mathematics. Students in 4th - 6th grades must prepare to meet the challenge of Next Generation Science Standards which include collaborative learning and brainstorming benchmarks implemented through the Engineering Design Process.

What has been done

A total of 39 youth in 4th - 6th grades participated in week long Aquatic Robotics Summer Enrichment programs offered by 4-H faculty at Lakeside Middle School in Millville. The program focused on LEGO robotics in a marine environment, adapting the Waterbotics curriculum to the abilities and interests of slightly younger youth. Imbedded within the program were science and engineering topics including Iterative Design, Simple Machines, Buoyancy, Stability, Action and Reaction, Momentum, Gears/Torque. Cooperative learning and public speaking were incorporated into the program, as were team building and leadership development exercises.

Results

A pre-posttest survey and end of session focus group discussion were utilized as evaluation tools in the program. In addition the Waterbotics curriculum survey was implemented. In the initial session, 16 males and 2 females participated in the program, with all students completing the pre-post survey. In the second session, 16 males and 5 females participated with 19 completing the pre and post evaluation. Evaluation revealed the following: 100% of them knew nothing of the engineering design process or different types of buoyancy (positive, negative and neutral) prior to the program. After the program, 89% indicated they learned some or lots about the engineering design process 11 % learned "a little" about iterative design and the engineering design process. Prior to the program 100 % indicated they knew nothing about buoyancy. Following the session 63% indicated they learned a lot about the principle of buoyancy 26% indicated they had learned some about the principle of buoyancy 11%indicated they had learned a little about the principle of buoyancy - Many youth reported a prior knowledge base in elements of an effective team, while 26% reported they knew nothing, 26% reported knowing "a little", 16% knew "some" and 32 % reported that they knew "a lot", however, 100% of respondents indicated significant gains in knowledge and skills in this domain, with 100% responding they had learned some or a lot about elements of effective teams. The Waterbotics Curriculum survey revealed that 83% of participants stated that the project had changed their minds about how interesting science and technology are. Likewise, 83% stated ?This project made me want to take more classes in science if they are available." - 42 % responded that "This project made me want to do more after school science or engineering projects if they are available." And "This project made me consider engineering as a career path." Focus groups provided further qualitative responses on the learning. Participants offered that "Science is creative, like art". "Leadership is not the same as a title". While some students remarked that brainstorming collectively was challenging, others offered "Brainstorming is easy! We could have MORE people in our group and everyone's ideas would be included". All students could define the engineering design process, identify career prospects related to STEM and reported gains in learning both in science and engineering.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #5

1. Outcome Measures

Sustainable Fisheries Research- Medium Term - Identify spatial and temporal relationships between patterns of shellfish diseases in NJ and environmental correlates. To develop disease-resistant strains of shellfish. Develop superior disease-resistant and larger genetic lines of shellfish.Measure the impact of communities on the aquaculture industry. Knowledge of the feasibility of off-shore shellfish farming.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Sustainable Fisheries Research

Commercial and recreational fishermen in NJ struggle with the need to balance fishing activities and conservation. Natural resource managers at the state and federal level provide a management framework designed to keep these needs in balance, but they also struggle to understand the implications of climate change and changes to fish habitat for sustainable fishery management.

What has been done
An Extension Specialist research on NJ fisheries involves fishermen and natural resource managers in a collaborative research process where they work alongside scientists to solve problems of mutual interest. Two examples of such collaborative research are: 1) Ecosystem modeling of fishery management decisions in Barnegat Bay. In a study funded by the NJDEP, we developed an Ecopath with Ecosim model of the Barnegat Bay estuary. This model was based on historical data of fish and invertebrate biomass in the Bay, their diets and key life history characteristics, and estimates of primary productivity. Data collection involved interviews with scientists and stakeholders (residents and fishermen) familiar with Barnegat Bay and its ecological components and processes. This model was used to evaluate the likely direct and indirect impacts of changes to management of important Bay fisheries, including those targeting hard clam and blue crab. 2) Electronic tagging study to understand passage of American shad

and river herring through a fish ladder on the Raritan River. In a study funded by the NJ DEP, we have been working with volunteers including students from Rutgers and residents of Middlesex and Monmouth Counties to capture and tag fish as they migrate up the Raritan River on their annual spawning migration. Captured fish are tagged with electronic tags which are used to record their passage through a fish ladder on the Island Farm Weir (IFW) in Bound Brook, NJ. This research has determined that, despite the presence of the fish ladder, the IFW remains a significant barrier for upstream migration of fish. More than 25 volunteers assisted with this research and learned about the ecology of the Raritan River.

Results
From conversations with volunteer fishermen and Barnegat Bay stakeholders, it is clear that for nearly all of them, their understanding of fish biology and ecosystem processes has increased. For most volunteers working on the Raritan River study, their understanding of barriers to fish migration and the challenges of restoring rivers has increased.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #6

1. Outcome Measures

Understanding Ecological Aspects of Shellfish Pathogens to Improve Management - Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Understanding Ecological Aspects of Shellfish Pathogens to Improve Management

Oyster and hard clam fisheries are severely depressed from historical levels with a major factor being losses from diseases that kill shellfish. Aquaculture is developing rapidly, but routinely confronts the same problems of disease and mortality. These diseases are often operating in open systems where aquaculture and fisheries occur. As such, they are significantly influenced by many ecology factors. Because aquaculture is one of the fastest growing sectors of agriculture, understanding disease dynamics and how it can be controlled to minimize losses is critical and have major impacts on the industry. The ability to detect pathogens, predict their presence, and control their impact is of paramount importance to the management of shellfish populations (wild or farmed) in New Jersey and elsewhere. It follows that by enhancing our understanding of host-pathogen-environment interactions we can identify potential control points and develop new or improve existing strategies to lessen the negative impacts of these pathogens. Successful strategies will lead to increases in aquaculture and fisheries production as well as improvements in the protection of human health.

What has been done
NJAES researchers at our Haskins Shellfish Laboratory conduct laboratory and field studies study shellfish parasite life history and ecology, including spatial and temporal relationships between shellfish pathogens and environmental correlates, examine the ecological processes involved in maintaining self-sustaining oyster populations with minimal impacts from disease, develop disease-resistant shellfish populations, develop detection assays for shellfish pathogens, and assist the shellfish industry and regulatory agencies.

Results
NJAES researchers continued to collect spatial and temporal data for shellfish pathogens in Delaware Bay and related these data to several environmental correlates. This work was presented at several meetings and workshops and is published in the technical reports. The primary use for this information was to help manage the Delaware Bay Oyster Fishery. Models were developed to explore transmission dynamics of Perkinsus marinus (the pathogen that causes Dermo in shellfish), using data results from experiments conducted during the past two years. Experiments were completed to investigate survival of Perkinsus marinus in seawater, a parameter that is poorly understood and critical to modeling disease transmission. These studies indicated initial high survival for about three days, then a rapid decay that began to plateau within a week. The annual stock assessment of the Delaware Bay Oyster Population was completed, including disease analyses, and presented to both the industry and regulatory agency to help develop harvest quotas. Funding was obtained to hold workshops to identify and resolve regulatory issues among East Coast states regarding movements of shellfish for aquaculture, restoration and other activities so that risks of spreading disease are minimized.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #7

1. Outcome Measures

Characterizing the Physical Environment of the Coastal Ocean and its Relationship to Ecosystem Indicators - Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Characterizing the Physical Environment of the Coastal Ocean and its Relationship to Ecosystem Indicators

Coastal ecosystems span watersheds to the deep sea and are extremely complex. This complexity hinders planning for ocean resource management, sustainable development, energy policy, homeland security and emergency response. This lack of understanding is fueling governments around the world to build regional integrated coastal ocean observing networks. The networks are enabled by rapid advances in technology, from satellites in space to robots below the ocean surface. These systems are built to support both basic research and the practical needs of society, from offshore resource management to the economy. The coastal ocean is a highly variable system with processes that have significant implications on the hydrographic and oxygen characteristics of the water column. The spatial and temporal variability of these fields can cause dramatic changes to water quality and in turn the health of the ecosystem. One important water quality measure is the amount of oxygen in the water. Very low oxygen conditions can starve species like fish of oxygen, resulting in large die-offs. While low Dissolved Oxygen (DO) concentrations are not uncommon in the coastal ocean, what is less understood is how the location and size of these low DO regions vary and what impact that variability has on ecosystem health. Therefore, alternative sampling strategies are needed to continuously map these low DO areas in a way that quantifies this variability.

What has been done

NJAES researchers are using continuous ocean observations enabled by rapid advances in technology (Autonomous Underwater Vehicles or AUVs) to describe the physical environment. Of particular interest is defining the physical variables at the necessary temporal and spatial scales to describe the critical interactions with the ecosystem, from phytoplankton and bacteria to fishes. This can be accomplished by coordinating an extensive array of existing observational, data management, and modeling assets to generate and disseminate real-time data, nowcasts and forecasts of the ocean extending from Cape Cod to Cape Hatteras. Interactions with the Mid-Atlantic Regional Association Coastal Ocean Observation System (MARACOOS) will ensure that data is collected at the appropriate time and space scales. An important component of the research will be the outreach to stakeholders throughout the state with vested interests in the coastal ocean.

Results

During this reporting period we deployed three glider (AUV) missions along the New Jersey coast to map the subsurface DO concentration in near real-time within the near coastal ocean. The first deployment began on July 17, 2014. The three missions together collected important water quality measurements along 1,417 km within the coastal waters off New Jersey. These data were reported to NJDEP in real-time throughout each deployment. Sensor calibration was conducted under the guidance of an existing Environmental Protection Agency Quality Assurance Project Plan. One of the critical parameters reported to the NJ Department of Environmental Protections (NJDEP) was dissolved oxygen (DO). DO is a measure of the amount of oxygen in the water. This is used by NJDEP as an indicator of water quality. Very low oxygen conditions can starve species like fish of oxygen resulting in large die-offs. The glider is being used to monitor conditions so that NJDEP can get a better background on how effective DO is as a metric of water quality and also track the occurrence of dangerous low events. Over the past few year, a model of Butterfish thermal niche was developed and coupled to a hindcast of daily bottom water temperature derived from a de-biased regional numerical ocean model (ROMS) in order to project thermal habitat suitability in the Northwest Atlantic on a daily basis over the last 40 years. This model of habitat suitability was used to estimate the proportion of thermal habitat suitability available on the Northeast US continental shelf that was sampled on fishery-independent surveys conducted during the spring and fall. The method explicitly accounted for the relative motions of thermal habitat in the context of sampling on the survey. The habitat based estimate of availability developed using the approach was integrated into the catchability estimate used to scale population size in the butterfish stock assessment model accepted at the 59th NEFSC stock assessment review. The contribution of the availability estimate (along with an estimate of detectability) allowed for the development of fishery reference points, a change in stock status from unknown to known, and the establishment of a directed fishery with an allocation of 20,000 metric tons of quota.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #8

1. Outcome Measures

Shellfish Genetics and Breeding for Aquaculture - Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Shellfish Genetics and Breeding for Aquaculture

Shellfish are important marine resources. They support major aquaculture and fishery industries in the US and around the world. The sustainable development of the shellfish aquaculture is increasingly dependent on technological advances. Currently there are a number of problems and challenges facing the shellfish aquaculture industry, where genetic research and development can contribute greatly.

What has been done
NJAES researchers are engaged in an integrated research program in shellfish genetics and breeding using both traditional and modern approaches to serve the shellfish aquaculture industry. The overall objective of the research is to produce superior shellfish varieties that are disease resistant, fast growing, of high meat quality, and sterile, by using a combination of traditional and modern approaches. The program covers three areas of research: 1) selective breeding for faster growing and disease-resistant oysters; 2) developing sterile and faster growing varieties by ploidy manipulation; and 3) genetic studies toward the mapping of genes affecting commercially important traits and marker-assisted selection (MAS). Specifically, we propose to: 1) continuously improve shellfish strains; 2) to develop and improve new tetraploid lines; and 3) to map oyster genes affecting disease-resistance.

Results

Rutgers University has maintained an oyster breeding program since 1960. Strains developed at Rutgers had shown strong resistance to MSX, but they did not grow well and did not show much resistance to Dermo. We continued our oyster selection program with added attention to improved Dermo resistance and fast growth. We carried the selection program forward for four more generations from 2004 and 2013. As a result, Rutgers strains have shown significant improvement in both disease resistance and growth. In a recent comparison, Rutgers strains outperformed all other strains in NJ and some other culture sites in New England area. Second, we developed and improved superior triploid eastern oysters from Rutgers disease-resistant strains, and released them for aquaculture production. Triploid oysters are ideal for aquaculture because of their sterility, superior growth and improved summer meat quality. Triploid oysters have become an important part of the oyster aquaculture industry. Triploid oysters are produced by mating normal diploids and tetraploids that have four sets of chromosomes. We produced and selectively bred tetraploid eastern oysters for seven generations. Triploid oysters produced from Rutgers tetraploids combine the superior growth of triploids and disease resistance that was developed over 50+ years of selective breeding. They grew faster, survived better and yielded 82 - 192% more meat than normal diploids. Diploids and triploids from Rutgers strains have become popular stocks for aquaculture in NJ and the New England area. We are one of the leading groups of the international oyster genome project that sequenced the genome of the Pacific oyster for the first time. Research on oyster genomics has provided not only new tools for oyster breeding, but also novel insights to basic biology of molluscs, as exemplified by the publication of the oyster genome in Nature. In addition to research on oysters, we also conducted basic and applied research on other economically important shellfish species such as clams, scallops, pearl oysters and abalone in collaboration with international partners. These studies broadened our knowledge on a wide range of shellfish species and may have broad impact on shellfish aquaculture.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #9

1. Outcome Measures

Fish, Fishing, and Risk to Eco-receptors and Humans in Coastal New Jersey - Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Fish, Fishing, and Risk to Eco-receptors and Humans in Coastal New Jersey

Most states are facing an environmental situation in which contaminants are increasing, human populations are increasing, habitat for wildlife is decreasing, and human and ecological health risk is increasing.

What has been done
NJAES researchers examined toxic chemicals in fish, and the fate and effects of these chemicals in eco-receptors and humans. To understand the potential risk to consumers of fish and shellfish, it is essential to understand fishing rates, consumption rates, the reasons why people fish, and contaminant levels in those fish or other resources. Few scientists examine the whole process from how and why people fish, through understanding of the marine ecosystem, to contaminants in fish and other marine resources (e.g. shellfish, birds), to risk assessment and risk management. Collaborations with the public, with the Jersey Coast Angler's Association, with the Jersey Shore Shark Association, and with NJ DEP (through fish collections on their trawls) resulted in research that is both scientifically sound and directly responsive to the needs of the public to understand the risks from fish consumption. Outputs included publications to the scientific community, meetings and communication tools for the general public, brochures for the general public and meetings and information for regulators and state agencies. Another area of research has involved examining the effects of Superstorm Sandy on the perceptions of coastal residents about ecological resources. This has resulted in several publications and talks, as well as additional funding from the US Centers for Disease Control.

Results
Our research findings for the period can be summarized as the following:
We examined selenium mercury molar ratios in internal tissues of bluefish (because they are an important game fish for NJ), as well as these ratios in a range of New Jersey fish. The ratios are important because excess selenium might partly ameliorate the adverse effects of mercury. The ratios were fairly high for most fish, meaning that selenium levels would be protective. The ratios were low for some fish, which suggests that the effects of mercury would be felt. We examined fish consumption rates of NJ anglers in light of mercury levels, and determined that some fishermen are eating enough fish to be above the safe advisory levels. We computed these for a

number of the most frequently eaten selfcaught fish. Sushi is an important food item to NJ residents, and we found that the mercury in tuna sushi can be sufficiently high to provide a risk to high end consumers. We examined overall fish consumption and the relative risk from different species of fish, and showed that the NJ consumer can select fish that are high in nutrients and fatty acids, while being low in mercury. Using feathers as a bioindicator, we found that mercury levels did not change dramatically over a 25 year period, but that cadmium and lead decreased. The decreases were partly due to regulation (no more lead in gasoline, removal of cadmium from batteries), and the lack of a change in mercury may be due to increases from power plant emissions in the US and China.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #10

1. Outcome Measures

Marine Natural Product Discovery in Extreme Environments - Long Term - Clear and comprehensive understanding of community, environmental, genetic and physical regulators of aquaculture quality and quantity. A safe and secure aquaculture industry that can meet consumer demands for high-quality products and also be environment friendly and economically viable. Creation of superior aquaculture products that will be of high demand outside NJ.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Marine Natural Product Discovery in Extreme Environments

With the lack of effective agents to control a spectrum of deadly cancers and viruses (e.g., HIV) and with drug-resistant microbes reaching epidemic proportions, pharmaceutical firms are actively searching for novel biodiversity to screen for bioactive natural products and are in the active process of attempting to synthesize many of the promising bioactive compounds. Despite our

relatively rudimentary knowledge of biodiversity in marine ecosystems, recent discoveries have identified a number of natural products with commercially-significant activities such as: anti-tumor, anti-microbial, anti-viral, antifungal, anti-parasitic, and anti-inflammatory agents; cardiovascular modulators; and cytotoxins.

What has been done

NJAES research focused on commercial product development, and innovative educational initiatives associated with organisms inhabiting deep-sea hydrothermal vents and cold-water seeps. Specific objectives are outlined as follows: (1) to screen a wide spectrum of invertebrates and microorganisms isolated from deep-sea extreme environments for bioactive compounds of significant use to a wide range of industrial companies with distinct product emphasis (e.g., pharmaceuticals, bioremediation, food, detergents). To this end, we propose to continue screening new extracts, fractions and compounds from our extensive collection of marine organisms, and to create a library of apoptosis inducing compounds that have a potential to be developed as anti-cancer drugs. (2) to continue sampling and basic research efforts at deep-sea hydrothermal vents and cold-water seeps at various sites in the oceans throughout the world: and (3) to undertake a diversity of educational initiatives, centered around the showing of a large-screen IMAX film entitled Volcanoes of the Deep Sea that we co-produced in conjunction with the Stephen Low Company and which is presently being shown at museums and science centers throughout the world. These efforts are an integral part of a concerted effort to educate an extremely large segment of the public to the wonders of the highly unique deep-sea ecosystems in which we are conducting our ongoing research efforts.

Results

Recent discoveries have identified a number of natural products with commercially-significant activities such as: anti-tumor, anti-microbial, anti-viral, anti-fungal, anti-parasitic, and anti-inflammatory agents; cardiovascular modulators; and cytotoxins. Bioactive marine natural products are often structurally unique with no counterparts in terrestrial organisms. We have available to us highly unique and vast collections of different marine organisms from extreme and unexplored environments and we are using a new and effective method to screen compounds for potential anti-cancer (i.e., apoptosis induction) activity. In May 2014, researchers associated with NJAES Project NJ32107 were honored at a Patent Award Reception hosted by Rutgers' Senior Vice President of Research (Christopher Molloy) for their receipt of a Patent (Patent No: US 8,183,395 B2) for "Compositions and Methods For Treating Cancer"; screening extracts of cultured novel species bacteria from deep-sea hydrothermal vents, as well as screening extracts of invertebrate mussels from hydrothermal vent habitats for bioactive compounds; developed a new assay using a combination of two or three cell-based assays for induction of apoptosis (ApopScreen), necrosis (ApopScreen and LDH) and autophagy (ApopScree and Cytotoxic) to detect novel classes of bioactive compounds from deep-sea hydrothermal vent organisms; isolated and cultured numerous micro-organisms from a variety of extreme deep-sea hydrothermal vent environments; identified the structure of bioactive compounds and specifically those with newly active compounds as necrosis inducers using advanced and sensitive NMR methods capable of measuring a high quality carbon spectrum on 1000+ molecular weight samples as small as 0.1 mg; synthesized new and unusual molecular structures with potential anti-cancer activity for drug development and pharmaceuticals in conjunction with the Department of Chemistry at Rutgers University; developed a synthetic method for hydroxyethylamine chromene and chromane in order to increase their bioactivities; verified the mechanism of action of bioactive compounds, specifically those with necrosis inducer activity using LDH and MTT assays; and developed a new method of screening for the detection of apoptosis, necrosis and autophagy inducer. Various outcomes and impacts of this project are featured on the following

Rutgers/NJAES website: http://deepseacenter.rutgers.edu/. The development of new ceramide compounds and derivatives as new inhibitors of cancer cell growth has been brought to the attention of several pharmaceutical science groups in NJ (e.g., Reaction Biology) and is expected to lead to a number of productive collaborations over the coming years.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Public Policy changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges
- Populations changes (immigration, new cultural groupings, etc.)

Brief Explanation

None to report.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

NJAES research and extension outcomes related to this planned program were evaluated utilizing a variety of evaluation methods appropriate for each initiative to determine effectiveness on both a qualitative and quantitative level. For KASA and practice change we included the measurement of knowledge gained as measured by pre/post Likert-scale assessments. Surveys were used to measure increase in skills acquired, behavior change and practice adoption. For process evaluation we focused on program delivery, participation, relevance and timeliness. Data was collected at appropriate times for each initiative that supports this planned program. IRB approved evaluation instruments were used to collect research and extension data. Data analyses and comparisons relevant to basic and applied research and demonstration were collected and analyzed and reported utilizing a variety of data collection methods appropriate to each research question. The major goal of evaluating is the demonstration of social, economic, behavior and environmental changes in conditions that contribute to improved quality of life as a result of participation in programs and benefits of research solutions. See state defined outcomes for detailed results of each initiative.

Key Items of Evaluation

None to report.