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: 2013	Extension		Research	
	1862	1890	1862	1890
Plan	3.0	0.0	4.8	0.0
Actual Paid Professional	5.9	0.0	3.3	0.0
Actual Volunteer	798.0	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**
35808	0	162351	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
506426	0	937896	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
120331	0	546033	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

2013	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	18027	6670	1500	6550

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

Patent Applications Submitted

Year: 2013

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2013	Extension	Research	Total
Actual	2	20	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
2013	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	Medium Term - Collaborative Fisheries Research - 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	Long Term - Shellfish Genetics and Breeding for Aquaculture - 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
2013	0

3c. Qualitative Outcome or Impact Statement

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

Coastal ecosystems span from 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. While only 10% of the oceans are coastal, they contain an abundance of natural resources and by 2050 it is estimated that 75% of Earth's human population will live within its watershed. In New Jersey, its beautiful coastlines are an integral part of the state's vibrant landscape, providing myriad recreational opportunities for residents and visitors from around the world. Beaches and other shorelines create jobs, support local business and invite new residents to make New Jersey

their home. New Jersey's coastlines and waterways attract an estimated $36 billion in tourism each year. In 2004 alone, tourism provided 38,431 jobs locally, $1 billion in payroll, $.6 billion to restaurants, $.5 billion in real estate sales and $.2 billion in recreational spending.

What has been done
NJAES researcher and Extension Specialist continued his research thrust by coordinating an extensive array of existing observational, data management, and modeling assets to generate and disseminate real-time data, now casts and forecasts of the ocean extending from Cape Cod to Cape Hatteras. An important component of the research was the outreach to stakeholders throughout the state with vested interests in the coastal ocean and to build an outreach program around the research to ensure that useful information is communicated to the appropriate stakeholders throughout New Jersey and beyond.

Results
The research focus was to identify important physical parameters sampled by the ocean observatory that predict the abundance and distribution of important fish species within the Mid-Atlantic Bight. Work within a multi-disciplinary team developed community and species-specific habitat models with application to fisheries management in the region. Work with partners from the commercial fishing industry to the development and evaluation of an environmentally based habitat model of butterfish with the specific purpose to inform an assessment in 2013. Butterfish is an important by-catch species in the longfin squid fishery. Through a series of workshops we gathered input from the industry, management and assessment communities and improved our existing model of butterfish habitat with their significant input. The success of the dissolved oxygen glider program has led to the development of a program in which Rutgers has partnered with NJDEP and EPA to push glider technology toward operational water quality monitoring. Work continues to identify relevant spatial and temporal scales observed by the glider missions that could change the way in which the coastal ocean is assessed and classified. We have also worked with fisheries scientists to identify the importance of different ocean observing data products in explaining variability in the physical ocean as it relates to coupled physical/biological processes and thus identify specific parameters useful as habitat indicators. The success of these initial models has led to the development of a team of stakeholders that include scientists, managers, and commercial fisherman to address the butterfish by-catch impact on the longfin squid fishery in the Mid-Atlantic Bight.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

<u>Outcome #3</u>

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
2013	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.

What has been done
NJAES Researchers continue screening new extracts, fractions and compounds from the extensive collection of marine organisms, to create a library of apoptosis inducing compounds that have a potential to be developed as anti-cancer drugs, 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 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
During 2013, a paper was submitted in the high impact journal Marine Drugs, Mode of Action of Diterpene and Characterization of Related Metabolites from the Soft Coral, Xenia elongata. This work is a continuation of the US patent issued on our work composition and methods for treating cancer". Several diterpene analogues were synthesized and tested for apoptosis induction. Besides the work on various ecological and genetic studies of the deep-sea hydrothermal vent organisms, a tremendous amount of work has been done on the structural elucidation of natural compounds which include 1D and 2D NMR as well as interpretations and analyses of mass spectral data. Various outcomes and impacts of this project are featured on the following Rutgers/NJAES website: http://deepseacenter.rutgers.edu/. The issuance of the US patent for our work and our ongoing search for new natural generated interest on the part of major pharmaceutical companies in NJ regarding potential development and commercialization of the results for the treatment of wide variety of cancers such as breast and cervical cancers. Other challenging impacts are the development of new ceramide compounds and derivatives as new

inhibitors of cancer cell growth. The mechanism of action of these interesting metabolites will involve collaboration with several pharmaceutical science groups in NJ (e.g., Reaction Biology).

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #4

1. Outcome Measures

Medium Term - Collaborative Fisheries Research - 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
2013	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Collaborative 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
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. Tagging study on black sea bass, involved tagging 1,500 individual black sea bass off the coast of NJ with the help of more than 60 volunteers. A larger but more diffuse group of fishermen assist the project by reporting recaptures of tagged black sea bass that they catch, but we have

spread the word through posters at bait shops, boat ramps, and fish processing plants from Rhode Island to Virginia. Electronic tagging study is to understand the 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.

Results
Recreational and commercial fishermen in New Jersey and throughout the mid-Atlantic region and volunteer fishermen appear to be very satisfied with the program as our tagging trips are made up of approximately 80% repeat volunteers. Many of the fishermen reporting tagged fish also appear to be satisfied as approximately 20% of our tag returns are from fishermen who have already reported tags previously. Volunteer fishermen have reported increased knowledge of black sea bass reproductive biology which improves management of this important species. This work has also led to increases in knowledge about the biology including the important observations that sex change (from female to male) does not occur during the summer spawning session. This means that sex change cannot replace male fish that are caught during the spawning season, this increases the chance that size limits in the fishery can lead to skewed sex ratios in the population.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #5

1. Outcome Measures

Long Term - Shellfish Genetics and Breeding for Aquaculture - 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
2013	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. The eastern oyster (Crassostrea virginica) industry along much of the Atlantic coast has been devastated by three diseases: Dermo (caused by Perkinsus marinus), MSX (Haplosporidium nelsoni) and ROD (caused by Roseovarius crassostreae).

What has been done
In 2013, NJAES Researchers conducted the following research under support from USDA/NRAC and USDA ARS: 1) continued selective breeding of disease-resistant eastern oysters and performed field evaluations; 2) provided the latest disease-resistant tetraploid eastern oysters to the industry for triploid production; 3) identified disease-resistance genes in the Pacific and eastern oysters; 4) participated in the international oyster genome project, which completed the sequencing of the Pacific oyster genome. In selective breeding, NJAES produced a new generation of Rutgers NEH disease-resistant lines. The new lines were deployed for field evaluation, 6 eastern oyster lines developed by various institutions including Rutgers University, Virginia Institute of Marine Science, University of Rhode Island and University of Maine were also evaluated.

Results
Results show that the Rutgers NEH line outperformed all other lines at Cape Shore in Delaware Bay, New Jersey. We provided Rutgers NEH disease-resistant stock to hatcheries for commercial production. We also provide tetraploid NEH stocks to the industry for the production of triploid oysters. For identifying disease-resistance genes, we sequenced the transcriptome of the eastern oyster and identified 657 genes related to immune response. Many key genes related to innate immunity are expanded in the eastern oyster revealing a complex defense system in the eastern oyster probably in adaptation to filter-feeding in a pathogen-rich environment. This gene set provides a valuable database for future studies on disease resistance in the eastern oyster. Rutgers importance to the industry was highlighted when the Haskin Shellfish Research Laboratory Shellfish geneticist was named a 2013 Inventor of the Year by the New Jersey Inventors Hall of Fame for helping decode the genome of the native eastern oyster to identify the genes responsible for disease resistance.

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

{No Data Entered}

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.