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: 2015	Extension		Research	
	1862	1890	1862	1890
Plan	3.0	0.0	4.8	0.0
Actual Paid	3.2	0.0	3.2	0.0
Actual Volunteer	114.0	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**
24286	0	135297	0
1862 Matching	**1890 Matching**	**1862 Matching**	**1890 Matching**
418659	0	628707	0
1862 All Other	**1890 All Other**	**1862 All Other**	**1890 All Other**
56657	0	360081	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

2015	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	96	3009	225	0

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

Patent Applications Submitted

Year: 2015
Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2015	Extension	Research	Total
Actual	9	18	27

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
2015	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	Sustainable Fisheries: From Case-Studies to Global Meta-analysis- 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.
5	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.

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.

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
{No Data Entered}

What has been done
{No Data Entered}

Results
{No Data Entered}

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
Global Fisheries Sustainability - Fishing activities of recreational and commercial fishermen are restricted by perceived low abundance of some fish species and by uncertainty in population status of fish species relative to management goals.

What has been done
An Extension Specialist worked with recreational and commercial fishing groups to explain the workings of stock assessment models used to assess status of fish populations. In addition, the Specialist did collaborative research with (primarily recreational for hire, i.e., charter boat) fishermen to understand the abundance and size and age distribution of black sea bass. As a member of the mid-Atlantic Fishery Management Council's Scientific and Statistical Committee the Specialist provided advisement to the federal fishery managers about the status of fishery resources.

Results
Fisheries are managed within federally prescribed bounds. The Specialist contributed to the evaluation and advance a novel data poor stock assessment method which resulted in an increase in the quota for black sea bass.

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Aquaculture is one of the fastest growing sectors of agriculture with exponential growth struggling to meet a growing demand largely filled by imports. Shellfish aquaculture routinely confronts problems of disease and mortality. These diseases often operate in open systems where both aquaculture and fisheries occur and are significantly influenced by many ecology factors. Clearly, understanding disease dynamics and how disease can be controlled to minimize losses is vital. Successful strategies will lead to increases in aquaculture and fisheries production as well as improvements in the protection of human health. A major impact was the establishment of a molluscan shellfish health advisory panel for the East Coast of the US to help develop a standard, science-based management system for shellfish transfers. The panel has already been called upon to resolve issues in the northeast and midAtlantic. Each objective contributes valuable information to the management of shellfish resources. Two direct contributions were the dissemination of information on the management of the Delaware Bay oyster fishery, and initiating the development of a shellfish health management plan for the East Coast molluscan shellfish industry. Understanding ecological aspects of shellfish pathogens to improve management - 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

Multiple studies were conducted on various aspects of shellfish pathogens. Data from the Delaware Bay oyster disease monitoring program were reported monthly to the industry and incorporated into the annual fall oyster stock assessment to help determine management strategies including setting the annual harvest quota. Host density and community composition were examined as critical factors affecting parasite transmission dynamics in several studies. A Dupont-supported graduate student completed a master's thesis that documented how scavengers accelerate transmission. The NSF EEID program project investigated how parasite consumption as a major pathway for disease transmission is affected by competition for suspended particles. An important experiment on the viability of transmissible stages of Perkinsus marinus was conducted.

Results

NJAES researchers have provided significant insights into long-term changes in Delaware Bay oyster populations that occur as the oyster population responds to management practices, climate change and environmental variation. A major advance was the insight gained by capturing the impacts of Hurricane Irene and TS Lee that caused extensive freshwater kill across a significant portion of the population in the upper bay. Survival increased with salinity and measured the rate of pathogen inactivation over time. These results were incorporated into ongoing efforts modeling the transmission and spread of marine diseases. The research group found that the incidence of Dermo climbed with increasing per capita dose of Perkinsus marinus, but due to increased competition for suspended particles, fell with oyster density. The net result of such a competitive interaction via pathogen consumption (i.e., overfiltration) is to inhibit the spread of disease. This provides a new perspective for evaluating the observed persistence of Dermo disease in mid-Atlantic estuaries following the decline of oysters due to MSX. Can dense oyster populations overfilter Perkinsus marinus and minimize the impact of disease? The answer has important consequences for the management of oyster fisheries and oyster restoration anywhere Dermo is present. Findings were incorporated into simulations using the hydrodynamic model ROMS coupled to a benthic model to confirm the overfiltration effect over a dense oyster reef. Parasite dilution also occurs by foraging activities of other organisms present on oyster reefs. A series of mesocosm experiments demonstrated that the presence of the commensal, filter-feeding tunicate Molgula manhattensis similarly resulted in lower prevalence and intensity of Dermo disease in oysters. These results were integrated in a compartmental disease dynamic model including oysters and M. manhattensis as focal and non-focal hosts for P. marinus. Another graduate student investigated the impacts of water filtration by shellfish that have been targeted for restoration and enhancement efforts. Ecological interactions between oysters, non-host filter-feeding communities and suspended pathogens in the water column are critical to understanding patterns of disease. Shellfisheries are severely depressed from historical levels with a major factor being losses from diseases that kill shellfish. They represent a billion dollar industry in NJ's economy and are vital to a healthy coastal environment.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #4

1. Outcome Measures

Sustainable Fisheries: From Case-Studies to Global Meta-analysis- 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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)
While we do not control many of the important environmental drivers of ecosystem change, fishery management has the capacity to dampen or amplify the impacts of environmental change on exploited fish populations. Understanding the relative impacts of fishing and environmental change and identifying the most effective strategies for managing fish populations in a changing climate will lead to improvements in how we manage our fisheries.

What has been done
NJAES research will build 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 will help 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.The research team developed and maintained a global database of stocks assessments which will serve as a resource for the

broader fisheries science community and support meta-analyses of fishery status and management approaches.
They have also used comparisons among fisheries around the world to understand the impacts of fishing and environmental change on fish populations and aquatic ecosystems and to identify the most successful fishery management approaches.

Results
NJAES researchers have an improved understanding of how the 2010 Macondo oil spill in the Gulf of Mexico impacted marsh food webs. This research demonstrated a wide range of oil sensitivity across marsh plants and animals and highlighted particularly sensitive species which are also critical network nodes within the food web. The research group has an improved understanding of the population dynamics of harvested marine fishes. In particular, the meta-analysis of natural and fishing-induced variability in fish population size demonstrated that many fish stocks should be expected to occasionally dip below abundance reference points even when the harvest rates have been set at sustainable levels. Thus, abundances below target levels are not necessarily a sign of overfishing.

4. Associated Knowledge Areas

KA Code	Knowledge Area
135	Aquatic and Terrestrial Wildlife

Outcome #5

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
2015	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

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. Through this project I will work with the management communities to determine the best way to bring new information provided by ocean-observing systems into their decision-making.

What has been done

NJAES researcher deployed three glider missions along the New Jersey coast. The first deployment began on July 17, 2015. This glider completed a run from Sandy Hook to Cape May, totaling over 458 km, in just over 20 days. The glider was then deployed again August 2015. Like the first, the second deployment covered the entire coastal area off New Jersey in support of state water quality monitoring. A third deployment in September completed the sampling effort for this year.

Results

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. 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. This work applies a series of Autonomous Underwater Vehicle (AUV) deployments from Sandy Hook to Cape May NJ to address this need by mapping the subsurface DO concentration in near real-time within the near coastal ocean. The three glider missions together collected important water quality measurements along 1,424 km within the coastal waters off New Jersey. These data were reported to NJDEP in realtime 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 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. The research team also worked within a network of stakeholders including fisheries scientists, oceanographers, managers, social scientists, and the commercial fishing industry to build the next generation of observatory informed single species habitat models. The initial target species was butterfish in support of a planned stock assessment for this species in late 2013/early 2014. 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. This year the same method

informed the assessments of two additional species in 2015 stick assessments, bluefish and scup.

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 relevan 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.