

V(A). Planned Program (Summary)

Program # 2

1. Name of the Planned Program

Soil, Water and Natural Resources

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
101	Appraisal of Soil Resources	2%		5%	
102	Soil, Plant, Water, Nutrient Relationships	35%		12%	
111	Conservation and Efficient Use of Water	10%		12%	
112	Watershed Protection and Management	10%		10%	
123	Management and Sustainability of Forest Resources	10%		5%	
131	Alternative Uses of Land	2%		6%	
132	Weather and Climate	2%		10%	
133	Pollution Prevention and Mitigation	5%		12%	
134	Outdoor Recreation	2%		1%	
135	Aquatic and Terrestrial Wildlife	2%		12%	
216	Integrated Pest Management Systems	10%		15%	
806	Youth Development	10%		0%	
	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	10.2	0.0	11.0	0.0
Actual Paid	18.0	0.0	11.7	0.0
Actual Volunteer	2.5	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
851134	0	1110924	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
851134	0	1124209	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	4037075	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Research programs and Extension activities to:

- Develop new land use models for Michigan communities.
- Offer education to planners, elected officials and citizens on how these new models will reduce sprawl and ensure that the desirable outcomes will become reality.
 - Create new remediation strategies to clean up polluted soil and water. These strategies will be environmentally friendly, economically feasible and easy to implement with proper training.
 - Discover new knowledge about the composition, organization and fluctuations of microbial populations in the soils.
 - Develop a user-friendly computer program for nutrient management for Michigan crop and livestock producers to improve the management of fertilizer and manure nutrients on cropland to protect water resources and boost crop productivity.
 - Develop management techniques for potato and vegetable growers that includes cover crops.
 - Develop new nitrogen application recommendations for turf managers.
 - Develop a management system for Michigan inland lakes that does not involve sampling the lakes.
 - Develop Total Maximum Daily Load (TMDL) assessment tools for evaluation of Michigan watersheds.
 - Determine how wildlife responds to ecosystem management decisions in forest and agricultural systems
- Develop fish population/community computer models for species important to Michigan. These models will be used to evaluate different fishery management strategies.
- Develop web-based tools and models for natural resources managers so knowledge can be shared quickly and easily.
- Develop computer models to assess how habitat management affects species important to Michigan, including white-tailed deer, salmon, trout and perch.
- Promote and support value-added processing of forest products, including wood products, biofuels, maple syrup and other nontimber products.
- Identify, prevent and control exotic invasive pests and diseases of forests.
- Conduct educational programs to help farmers improve nutrient management and other practices to maintain and improve quality of groundwater and surface water.
- Conduct educational programs with riparians and lake users to enhance their understanding of watershed management and inland lakes water quality issues.
- Work with state agencies and local communities to encourage protection of community groundwater supplies through wellhead protection programs.

- Educate and train health officials, consultants, engineers and riparians to improve onsite and decentralized wastewater treatment and design.

2. Brief description of the target audience

Michigan farmers, natural resource managers, private citizens, agriculture and natural resources industry representatives, state agencies, riparians and foresters.

3. How was eXtension used?

All MSUE field educators and specialists are encourage to be involved in eXtension through both the Ask an Expert and Communities of Practice (CoP). A total 7.73 fte's were involved in this area of soil, water and natural resources with 3.62 fte's funded through 3bc funds.

An example:

Question: IN WHAT ORDER DO YOU ADD SEED MANURE AND WEED KILLER IN THE SPRING

Response: Hello,

I am sending links to two articles that will help answer your question. It may be that you can avoid using any herbicide through management practies, and you may want to soil test to see if you even need to add nitrogen to the soil.

If you do need to use herbicide, you want to do it when the weeds are still fairly small (which they still may be in Houghton).

<http://extension.psu.edu/animals/equine/pasture-weed-management/basic-pasture-management-for-the-equ...>

http://msue.anr.msu.edu/news/5_guidelines_for_managing_spring_horse_pastures_in_2014

V(E). Planned Program (Outputs)

1. Standard output measures

2014	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	8024	24072	48169	96338

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

Patent Applications Submitted

Year: 2014

Actual: 3

Patents listed

MICL01821: Microbial Ecology and Genomics of Soil Bacteria #14/015,787 (8/13/13); MICL02373: Development of Biodegradable and Compostable Nanocomposites#14/233,314(4/29/14); MICL01574 :Movement and Degradation of Organic Contaminants and Pesticides in Soils and Sediments #8633133 (1/21/14)

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2014	Extension	Research	Total
Actual	2	48	0

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number of research programs on soil, water and natural resources.

Year	Actual
2014	43

Output #2

Output Measure

- Number of adult participants trained in soil, plant, water and nutrient relationships.

Year	Actual
2014	453

Output #3

Output Measure

- Number of adult participants trained in how human activities impact on ecosystems.

Year	Actual
2014	7571

Output #4

Output Measure

- Number of youth participants trained in how human activities impact on ecosystems.

Year	Actual
2014	48169

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of research programs to discover new knowledge about the composition, organization and fluctuations of microbial populations in the soils.
2	Number of adult participants with increased knowledge of how human activities impact ecosystem.
3	Number of research programs to determine how wildlife responds to ecosystem management decisions in natural resource and agricultural systems.
4	Number of adult participants with increased knowledge of soil, plant, water and nutrient relationships.
5	Number of research programs that deal with fish population dynamics and the management of Great Lakes fisheries.
6	Number of research programs that deal with the security, stewardship and management of Michigan's water resources.
7	Number of research programs that analyze key soil characteristics to better assess their agricultural and environmental contribution, including crop yield.
8	Number of research programs that explore the occurrence, transport and fate/effect of organic contaminants, chemicals, pesticides, pharmaceuticals and particulates in soils.
9	Number of research programs to develop new land use models for Michigan communities.

Outcome #1

1. Outcome Measures

Number of research programs to discover new knowledge about the composition, organization and fluctuations of microbial populations in the soils.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	3

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Soils constitute a huge reservoir of microbes, whose activities have a profound impact on crop productivity, soil fertility and biogeochemistry. However, knowledge of the composition, organization and fluctuations of indigenous microbial populations in soil ecosystems is scarce, even though metabolism of such microbes drives many ecosystem level processes.

What has been done

Research to: understand temporal and spatial control of gene expression during development of soil bacteria; determine how well the most promising candidate strains of cereal-adapted rhizobia perform as superior biofertilizer inoculants for rice and wheat when scaled up to full-size farmer plots; investigate novel cultivation strategies and cultivation-independent techniques to advance our understanding of microbes and microbial communities in soils; and develop new technologies to control soil-borne diseases.

Results

Our research supports the use of alternative fertilizer management techniques in flooded agroecosystems by the mitigation of Nitrogen losses through denitrification and decreased overall Nitrogen flux rates.

A major accomplishment during this reporting period was the completion of the research to analyze various formulas used in ecology research to compute biovolume body mass, rank their accuracy under several testing conditions, and publish the results with recommendation of those formulas that perform with greatest accuracy and adaptability to various digital imaging conditions. That work has high impact to ecology researchers because the information gained (biovolume body mass) represents a very significant metric for various ecological assessments.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships

Outcome #2

1. Outcome Measures

Number of adult participants with increased knowledge of how human activities impact ecosystem.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	6435

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

One example in this area is regarding Michigan's 11,000 inland lakes. The state of Michigan simply doesn't have the resources in these economic times to manage these precious water resources. MSUE partnered with state to work on this need.

What has been done

MICHIGAN INLAND LAKES CONVENTION.

MSUE was involved in marshaling the passion and energy of volunteers across the state as well as organizations that work to help manage inland lakes by helping to organize the first Michigan Inland Lakes Convention. Target audience included lake enthusiasts, professionals, government officials, and educators. The convention helped participants learn how to become better stewards and protect Michigan's inland lakes. More than 25 sessions were offered, including a natural shoreline workshop as well as a septic workshop. The Convention was a partnership between MSUE, MDEQ, MDNR, Michigan Lake and Stream Associations, Michigan Natural Shoreline Partnership, MSU Institute of Water Research, and the Michigan Chapter of the North American Lake Management Society.

Results

373 people attended the Convention.

More than 66% represented nonprofit agencies or were riparian landowners.

More than 75% reported increased leadership, confidence and stewardship.

More than 90% reported they gained information that will assist them as professionals or volunteers.

Due to the overwhelming success of the event, the Partnership has agreed to make it a biennial event; the next Convention will take place in 2016.

http://msue.anr.msu.edu/news/lakes_convention_attracts_hundreds_of_lakeshore_owners_and_professionals

What difference did it make - public value?

Due to the overwhelming success of the event, the Partnership has agreed to make it a biennial event; the next Convention will take place in 2016.

http://msue.anr.msu.edu/news/lakes_convention_attracts_hundreds_of_lakeshore_owners_and_professionals

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
131	Alternative Uses of Land
132	Weather and Climate

Outcome #3

1. Outcome Measures

Number of research programs to determine how wildlife responds to ecosystem management decisions in natural resource and agricultural systems.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

A better understanding of wildlife-habitat relationships as influenced by natural and human wildlife habitat disturbances is needed in order to make more effective natural resources management decisions to sustain biodiversity and conserve wildlife populations, communities and habitat.

What has been done

Research to: understand the mechanisms of wildlife dynamics on landscape mosaics; develop a better understanding of wildlife-habitat relationships as influenced by natural and managed wildlife habitat disturbances; and uncover systematically informative morphological and molecular characteristics related to arthropods in order to revise classifications and test evolutionary hypotheses.

Results

Research analyzed county-level data from five Midwestern states across 12 years and revealed a phenomenon "the suburb effect": communities with suburban landscapes experience more collisions and more severe ones than other types of landscapes. Deer live in close proximity to humans in suburban communities. Often, these communities infringe upon deer habitat, hunters don't usually hunt in these areas, and traffic tends to be heavy in and surrounding these communities.

In suburban areas, you have the perfect storm of good habitat, a lot of deer and a lot of traffic. This phenomenon was consistent across all 12 years analyzed. Knowing that helps draw the conclusion that it may be worth investing in extensive, long-lasting mitigation efforts, such as building underpasses for wildlife to safely cross roads.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
135	Aquatic and Terrestrial Wildlife

Outcome #4

1. Outcome Measures

Number of adult participants with increased knowledge of soil, plant, water and nutrient relationships.

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	394

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Citizens are looking for ways to make a difference in their communities. In addition, there is a great need to educate citizens regarding soil, plant, water and nutrient relationships.

What has been done

The MSU Extension Master Gardener Program (MGP) provides interested individuals with the chance to take part in a focused, 13-week training experience that provides in-depth education in many aspects of horticulture, including trees and shrubs, flowers, vegetables, fruit, soil, water, pests, indoor plants and lawns.

Individuals who complete the training can get involved in local gardening activities, sharing the joys of gardening with people of all ages, and teaching environmentally friendly gardening practices. Volunteers will have the opportunity to help other gardeners solve garden problems and participate in special projects that improve our communities.

After completing 40 hours of fun, rewarding community service, these participants earn their Extension Master Gardener certification, a widely recognized designation. Master Gardener Volunteers can then earn special recognition and awards and become leaders in their communities.

The MGP connects gardeners across Michigan to MSU resources. MSU is recognized as one of the nation's top plant science teaching and research universities. In addition to the Master Gardener Training Program, university experts present a wide variety of seminars and classes that volunteers may use to enrich their lives and the lives of others.

Results

Evaluation of the Master Gardener College found

- 87% of the participants gained knowledge that influenced a number of new adoption of landscape practices that included:

- using native plants
- plant selection and placement
- enhancing pollinators through habitat enhancements
- spraying fewer pesticides
- raising their mowing height
- mulching leaves into their lawn
- reducing lawn areas
- replacing lawn with alternative plants
- incorporating water-wise practices into their landscape

A subset of questions were asked of attendees who participated in tours of horticulture operations. (N=64) These questions were directed at the individual's knowledge gained that would influence their purchase decision of MI horticulture products.

- 35% gained knowledge that would influence their purchasing decisions
- 30% made purchases of MI horticulture products as a result of participating in MG College.

Extension Master Gardeners have improved their communities through efforts that not only beautify but also increased food security and support community development. Residents trained through the Master Gardener Program become supporters of and advocates of MSU and MSU Extension.

Overall MSU Extension Master Gardener Program had over 3,000 Extension Master Gardeners from 76 counties that provided 376,986 volunteer hours to MSU Extension and their communities at an economic value of \$8.32 M dollars. (This value was determined by using the Independent Sector's national value of volunteer time of \$22.55.) These individuals have also pursued 92,278 hours of continuing education to ensure information shared is current, relevant and grounded in science.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships

Outcome #5

1. Outcome Measures

Number of research programs that deal with fish population dynamics and the management of Great Lakes fisheries.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Urban, industrial and agricultural development have caused remarkable changes in the lakes' flora and fauna and fauna associated habitats over the past 200 years. Today, the lakes have aquatic communities that are structurally and functionally volatile and exhibit rapid changes in species number and abundance. Successful fish management of the Great Lakes is now actively focused on the lakes as ecosystems.

What has been done

Research to: investigate areas of uncertainty for Great Lakes fishery management, particularly sea lamprey control and salmon stocking; determine how fish population dynamics are affected by the physical, chemical and biological environment; investigate how human activities bring about changes in aquatic habitats; develop models capable of predicting response of fish to habitat alteration; investigate the environmental effects on fish genetic diversity.

Results

In 2009, the Michigan Department of Natural Resources(MDNR) discovered that walleye in the Inland Waterway a 45-mile long network of four lakes and multiple rivers spanning private, public and Native American tribal land in Cheboygan County had greatly diminished since they were last surveyed in 1998. Returning the walleye population to a more sustainable level has become a priority because of their importance to commercial, sport and tribal fishing in the area. Now, through the efforts of Michigan State University (MSU) AgBioResearch fisheries scientists, the MDNR and tribal fisheries managers are making more informed decisions to help the fish recover. They were able to learn about the movements of the fish through tagging and learn about the nutrition habits of these fish. They

discovered a shortage of zooplankton in the Inland Waterway, escalated by invasive species such as zebra mussels that compete for the same resources, was limiting the population's growth. With a more complete picture of their fishery in hand, both the MDNR and the tribes are now able to make better decisions about the use of their shared resource.

4. Associated Knowledge Areas

KA Code	Knowledge Area
112	Watershed Protection and Management
134	Outdoor Recreation
135	Aquatic and Terrestrial Wildlife

Outcome #6

1. Outcome Measures

Number of research programs that deal with the security, stewardship and management of Michigan's water resources.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	12

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

With growing concern about the connection between health and the marine environment, there is a corresponding emphasis on large freshwater lake ecosystems and human health. The Great Lakes serve as a highway for international maritime commerce and support a \$1 billion per year recreational and commercial fishing industry. They also supply drinking water for more than 15 million people. Holding about 20 percent of the world's fresh surface water, the degradation of the Great Lakes ecosystem through chemical and biological contamination presents an enormous challenge for the future.

What has been done

Research to: enhance the current water resources management structure through the

ecosystems approach, development of a system to help create sustainable water resource management, understand how anthropogenic actions can affect food web structure and function, address critical questions that have relevance to specific problems in Michigan inland lake and Great Lakes integrity; help develop dynamic, interactive computer interfaces in resource-based recreation management; construct and evaluate a knowledge management system in resource-based recreation management; develop a landscape-based ecosystem management framework that integrates landscape ecology with natural resource policy and management; determine why sport fish populations, fish assemblages and lake food webs, and their response to perturbation vary among lakes; determine if pheromones can be used to control sea lamprey in streams, with a view to developing a viable new control strategy; and to improve design of engineered phytoecosystems for treatment of wastewaters and stormwaters.

Results

Before the advent of big data, ecologists commonly studied single sites, such as a specific lake or river. Though that approach yielded incredible insight into one site, a big data approach provides the opportunity to apply the detailed knowledge to entire systems. Bringing big data research into ecology will help researchers track the spread of invasive species such as zebra mussels and Asian carp across waterways and from one freshwater system to another. By studying lake systems as a population, researchers can also gain insight into their significance in larger issues such as climate change and the global carbon cycle.

Another study, investigating West Nile Virus (WNV), discovered that the disease was only in certain locations ? it was not widespread across metropolitan areas. They gathered data on the number and location of confirmed human cases of WNV and found that those locations correlated with areas where mosquito infections were also the highest. The group then categorized the urban landscapes by demography, density of houses and types of buildings. When all of this information was combined, researchers could further delineate where, how and why the virus set up among human populations as well as using the weather (increased temperature and precipitation events). The hope is that the findings will guide public health decisions.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation

Outcome #7

1. Outcome Measures

Number of research programs that analyze key soil characteristics to better assess their agricultural and environmental contribution, including crop yield.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	5

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Understanding the variability of soil and landscape properties and their effect on crop yield is a critical component of site-specific agricultural and environmental management systems. This includes factors such as nitrogen management, soil absorption and environmental interactions.

What has been done

Research to: study herbivore suppression of cyanobacteria and total phytoplankton biomass; effectiveness of nitrogen rates on soil quality and plant nutrition; study the characteristics of high content soil blends used in athletic fields and golf putting greens and how the properties of these soils change with time and use; and to explore diversification with cover crops to enhance nutrient cycling efficiency and rhizosphere traits for resilient, productive row crop systems.

Results

Research showed that rotating crops and using reasonable levels of fertilizer could bring about beneficial changes in soil composition. Most improvements were not immediately apparent. After 20 years of study, their patience was rewarded. The researchers observed significant improvements in both the soil's organic matter and nitrogen efficiency, reaching a new peak level of productivity. Researchers determined that the experiment was over when the soil would not improve beyond that point. It had reached a new plateau but was now operating on a much healthier, more productive level than ever before.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources

102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
133	Pollution Prevention and Mitigation

Outcome #8

1. Outcome Measures

Number of research programs that explore the occurrence, transport and fate/effect of organic contaminants, chemicals, pesticides, pharmaceuticals and particulates in soils.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	8

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Michigan's 37 million acres of land support the plants and animals that provide our shelter, food and fiber. The land provides us with minerals and foods for our industry and our businesses. At the same time, human activities are generating and releasing large amounts of pollutants -- including pesticides, antibiotics and dioxins, and other industrial emissions -- that may end up in the soil. Research to investigate the fate and effect of these pollutants is critical to sustaining soil viability and health, and minimizing consequences to human health.

What has been done

Research to: investigate the transport of a group of engineered nanomaterials in the soil and water environments and develop an understanding of their interactions with other elements; evaluate the occurrence and human health risks of historic pesticide contamination of agricultural soils; understand the mechanisms by which chronic estrogen exposure brings about reproductive failure; determine the mechanistic functions and contributions of soil humus and clays to the immobilization of pesticides and POPs found in soils; evaluate the occurrence of antibiotics in animal farms and their mobility; and to control and convert rural waste to resources.

Results

Soil and surface waters are other important areas of investigation. MSU AgBioResearch soil chemist researches soil contaminants, including antibiotics. A key instrument in this work is a

liquid chromatograph with tandem mass spectrometers (LC-MS/MS), which gives specific analytical information and has a higher throughput analysis than gas chromatography, another laboratory technique for the separation of mixtures. The LC-MS/MS, purchased with funds from MSU AgBioResearch and other sources for the lab, helps to identify antibiotics and many other pharmaceuticals in the environment and measure their quantities in water and soil.

Researchers have focused on emerging organic contaminants in soil and water, especially identifying and measuring antibiotics in the environment. Tetracyclines, broadspectrum antibiotics used in the treatment of numerous infections and also in animal feeding operations, are the focus of much of the research.

In another study, consideration of soil organic matter and clays as sorptive phases for pesticides in soils will allow development of better pesticide fate and transport models. Polychlorinated dioxins, especially octachlorodioxin and the highly toxic 2,3,7,8-tetrachlorodioxin, are found at inexplicably high levels even in "pristine" rural and agricultural soils, but their origins are unknown. The potential for clay-mediated in-situ formation of dioxins has important implications for past, present and future contamination of rural soils.

4. Associated Knowledge Areas

KA Code	Knowledge Area
101	Appraisal of Soil Resources
102	Soil, Plant, Water, Nutrient Relationships
111	Conservation and Efficient Use of Water
112	Watershed Protection and Management
132	Weather and Climate
133	Pollution Prevention and Mitigation
216	Integrated Pest Management Systems

Outcome #9

1. Outcome Measures

Number of research programs to develop new land use models for Michigan communities.

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	4

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

What we do to our land is intimately tied to our drinking water quality, wildlife habitat, potential for flooding, our recreational open space and tourism, and many other quality of life issues. For example, urbanization of the rural landscape is claiming some of the country's richest farmland and creating challenges for areas where rural and urban interests collide. Some recipients indicate the, by 2020, farmers will only have enough land to meet the nation's domestic food needs.

What has been done

Research to: better understand how regional and continental processes affect local processes; increase management capacities among agencies to better integrate biological and human dimensions of management in dealing with wicked problems, such as wildlife health; and to help develop sustainable agro-ecosystems that protect public health, environmental quality and promote efficient and profitable resource use.

Results

We analyzed and subsequently better understood the role of land use and and cover change, as well as its interaction with climate, in the environmental assessment. Through process-based models and large-scale remote sensing technologies we better understood the spatial patterns of grassland degradation, water pollution, and soil sealing dynamics. We presented these research results in various conferences and used them as examples in anumber of international land use and land cover change training workshops.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
123	Management and Sustainability of Forest Resources
131	Alternative Uses of Land
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

During the 2013-2014 fiscal year, ABR and MSUE was able to start rebuilding some of its resources after several years of either flat or funding cuts at both the state and federal levels. ABR was able to **fill voids in its research and support teams by hiring quality, skilled people for a variety of positions ranging from farm managers and grant coordinators to faculty and research technicians. Much needed equipment and infrastructure updates were also conducted at many on-campus and outlying research facilities**, helping to keep operations to full capacity. In 2014, ABR and Project GREEN funds helped bridge operating budget gaps at five of the 13 outlying research centers, enabling the repairs of equipment and several buildings. Together, the organizations look to re-invigorate the MSUE presence at the 13 outlying research centers throughout the state.

The **ongoing economic challenges** faced by Michigan continue to affect this planned program area. Consequences have included fewer new hires, delaying the award of new financial obligations, reducing levels of continued funding, and renegotiating or reducing the current scope of assistance through formula funds or block grants. Specifically, a 15 percent decreases in state funding FY2011-2012 coupled with a flat federal funding line for the following two years resulted in the elimination of 72 Extension educator positions across 83 counties, 22 academic and faculty positions on campus and 15 support staff. Administrative positions were reduced from 45 to 19 FTEs. Impacts on ABR came largely in the form of reductions in research infrastructure support. Investments in facility maintenance and equipment were postponed in an effort to avoid eliminating more than 45 research positions (faculty, support staff and graduate assistants) and one research facility had to be closed in light of the reductions. There were also fewer funds to seed research on emerging issues.

Recent **extreme weather events** also caused extensive hardship to the agriculture industry. The spring 2012 ranks among the most destructive weather periods in Michigan fruit production history, with crop losses valued at more than \$500 million. Peach production suffered a 95 percent loss; tart cherry, a 90 percent crop loss; apple production, an 88 percent loss; and grapes, an 85 percent loss. The summer 2012 brought the worst drought in Michigan since 1988 with many crops suffering substantial losses.

And the winter of 2013-14 brought a series of bitterly cold air masses rolled down from the

Arctic, through Canada and into Michigan. The period between November 2013 and February 2014 was the coldest in Michigan since 1911 and among the five coldest periods on record in the state.

Together, MSUE and ABR continue to serve as the primary research and development arm for the agriculture and food industries in Michigan, valued at more than \$100 billion annually.

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Research

As Hatch dollars are base funding for faculty salaries, there is a built-in evaluation mechanism through annual reviews of overall performance, research productivity and the leveraging of additional research dollars. In addition, many of the research projects have an evaluative element that is required by state and federal-level funding sources that provides documentation related to project assumptions, goals and outcomes. This information is used to determine the overall success of the research initiatives; their contribution to providing practical, real-world solutions and resources to address challenges and problems; and whether continuation funding and/or new dollars are appropriate and necessary as funds are available.

Extension

Other examples of evaluation results:

ECONOMIC VALUE of the MASTER GARDENER BASIC TRAINING COURSE

For many years, anecdotal information has suggested that some people take the MSUE Master Gardener basic training course for economic reasons. To verify the economic value of this course, these observations have been documented through the course application process.

2014 Summary:

453 people from 41 counties attended 11 training courses in the following sites: Harper Woods (Wayne County), Novi (Oakland County), Mt Pleasant (Isabella County), Clinton Twp. (Macomb County), Grand Rapids (Kent County), Holland (Ottawa County), Traverse City (Leelanau County), Marquette (Marquette County), and East Lansing (Ingham County). N=435

- 19% (85) - enrolled in the MG course to enhance their profession
- 9% (40) - are currently employed by a green industry business
- 16% (40) - indicated that MSUE MG credentials and skills will help them in their current position
- 11% (52) - indicated that MSUE MG credentials and skills will help advance their position or employment
- 10% (46) - indicated that MSUE MG credentials will help market their business
- 20% (92) - indicated they are considering starting a green industry business or working in the green industry

This data documents the economic development value of the MSUE Master Gardener course and will help market the value of MSUE MG Programs to internal and external decision-makers.

Issue (who cares and why)? Advancing Great Lakes literacy and stewardship. A priority of both the National and Michigan Sea Grant strategic plans.

What has been done? Great Lakes Education Program

Results/Impact?

Program Evaluation - Teachers were asked to rate individual learning activities on a 1 (poor) to 4 (excellent) scale in terms of how well they help achieve curriculum goals. Average ratings ranged from a low of 3.54 to a high of 3.81, with a mean of 3.64 (3.42 to 3.68 for chaperones, with a mean of 3.57). When asked to rate the overall GLEP experience, the mean teacher response was 3.90 (3.81 chaperones). Teachers were asked to rate GLEP compared with other "field trip" experiences they have had on a 1 (much worse) to 5 (much better) scale, with the mean response being 4.55 (4.32 for chaperones). Teachers were asked how well GLEP education helps them meet Michigan educational benchmarks on a 1 (poor) to 4 (excellent) scale, with the mean response being 3.53. Of the 77% of teachers who reported using the GLEP curriculum, teachers completed an average of 2.5 learning activities prior to their field day, and an additional 2.0 following.

Behavior Change - Of the 80% of the teachers who had previously participated in GLEP education, 90% shared GLEP information with other teachers and/or school administrators; 62% sought more information on Great Lakes and/or ocean science; 71% included more Great Lakes and/or ocean science content in their classroom (beyond the GLEP curriculum); 89% encouraged other teachers to participate; 38% visited the Great Lakes more, 39% visited the Metroparks more often; and 94% felt a greater responsibility for the Great Lakes.

What difference did it make - public value?

Stewardship depends on understanding and experience with natural resources such as the Great Lakes.

Key Items of Evaluation

Research

Michigan State University (MSU) AgBioResearch evolutionary ecologist Kim Scribner studies lake sturgeon, a bottom-feeding Great Lakes fish species that can grow longer than 8 feet, weigh up to 300 pounds and live for nearly a century. Despite long lives, however, lake sturgeon populations have been in serious decline since the late 19th century. The U.S. Fish and Wildlife Service reports that in 1910, 80 percent of the species had disappeared from Lake Erie, and by 1929 the amount of sturgeon caught in Lake Michigan had dwindled from 3.8 million pounds to just 2,000. Numerous causes for the sturgeon decline are known. Scribner and his research team are trying to find a way to bring back the ancient fish.

"Sturgeon migrate from the Great Lakes to the rivers for spawning, which makes them an important part of that coupled ecosystem," he said. "The species is a poster child for humans decreasing the population through overfishing and pollution, and we're trying to help turn that around."

Though female lake sturgeons lay thousands of eggs at a time, Scribner's team has found that 95 to 98 percent never survive to hatching, and of those that do, 99 percent die in the larval stage. Those survivors must live 15 years before achieving sexual maturity and the ability to reproduce.

"Our primary focus is finding the factors that limit sturgeon survivability in the early stages of their life cycles," Scribner said. "If we can identify the sources of mortality, we can create better management plans to help increase their numbers."

Extension

MSUE utilizes the Institute Work Teams for planning, evaluating and reporting. Work Teams in this area found:

Children and Youth Institute

- 3,337 youth demonstrate the ability to apply science knowledge and problem solving, critical thinking, and decision-making life skills.
- 483 adults and teen leaders demonstrate the ability to apply knowledge to engage youth in experiential, inquiry based science learning.
- 1,591 youth participants increased their awareness of life skills and demonstrated the ability to identify the life skills acquired.

Greening Institute

- 2,185 adult and youth participants implement a practice to mitigate an ecosystem threat.
- 288 participants show improved awareness or knowledge of NR or ecosystems.
- 120 participants initiate or contribute to ecosystem-related planning in their local area.
- 113 adult and youth participants indicate a high or very high level of understanding of potential human impacts on ecosystems and ecosystem health.
- 98 Sea Grant facilitated curricula adopted by formal and informal educators.
- 373 formal and informal educators engaged in Sea Grant supported professional development.

Agriculture and Agribusiness Institute

- 4,133 new acres under irrigation management
- 2,386 improved existing irrigation system
- 1,052 new adoptions of sustainable landscapes
- 156,143 change in nutrient use (lbs)
- 783,881,672 change in water use (gallons)*
- 51,989 change in \$ expended on water withdrawal
- 49,049 change in \$ expended on energy