

V(A). Planned Program (Summary)

Program # 7

1. Name of the Planned Program

Natural Resources And The Environment

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
102	Soil, Plant, Water, Nutrient Relationships	25%		15%	
112	Watershed Protection and Management	15%		10%	
123	Management and Sustainability of Forest Resources	10%		10%	
132	Weather and Climate	15%		10%	
133	Pollution Prevention and Mitigation	10%		10%	
134	Outdoor Recreation	0%		10%	
135	Aquatic and Terrestrial Wildlife	5%		15%	
211	Insects, Mites, and Other Arthropods Affecting Plants	0%		10%	
405	Drainage and Irrigation Systems and Facilities	5%		5%	
605	Natural Resource and Environmental Economics	0%		5%	
806	Youth Development	15%		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	0.0	0.0	4.0	0.0
Actual Paid	0.0	0.0	7.0	0.0
Actual Volunteer	0.0	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
211582	0	1099255	0
1862 Matching	1890 Matching	1862 Matching	1890 Matching
211582	0	1099255	0
1862 All Other	1890 All Other	1862 All Other	1890 All Other
1698819	0	3081099	0

V(D). Planned Program (Activity)

1. Brief description of the Activity

Activities in 2014 included ongoing wet atmospheric deposition monitoring at three sites in Illinois as part of a nationwide project [these results continue to be part of a national program that leads to a complete understanding of atmospheric inputs of nutrients, and is needed to develop appropriate policies], preliminary analysis of data that will provide information about short-term agronomic responses to urban soil management systems, an evaluation of the additional ecosystem services such as carbon sequestration, water infiltration, visual quality, and food production provided by community gardens and other urban agriculture systems, ongoing efforts to enhance the usefulness of existing online interactive keys to Empoasca and related typhlocybina leafhoppers, a study of the immune response of the gypsy moth, Lymantria dispar, to a microsporidian pathogen using proteomic analysis of midgut tissues during the first 72 hours of infection, continued monitoring of the success in establishing new soils in a brownfield that was formerly the U.S. Steel production facility in South Chicago, research focused on determining how landscape level cues [such as the amount of grassland within an area or the juxtaposition of grasslands] affect the occupancy and density of grassland birds, work demonstrating that there is a strong, clear link between habitat quality and physiological properties of resident stream fish [more specifically, the proportion of forest cover in a watershed was the best predictor of blood parameters representing free energy and resistance to oxidative stress, whereas wetland proportion was the best predictor of glucocorticoid function for fish], and research to estimate the value of grassland restoration and exploring how conservation planning could be improved by incorporating an understanding of leakage into its practice.

Activities also included a study designed to quantify the export of MeHg [and total Hg] from selected bioreactors over a full year and compare the flux to free-flowing tiles for a variety of bioreactor designs, operating conditions, and environmental settings, work to identify patterns in diversity [alpha- and beta-diversity] and composition of soil microbial communities associated with invasive and nuisance plant species across broad geographic areas and soil types, the development of models that will be extremely useful in determining which habitats need to be protected to promote connectivity within historical dispersal corridors [improving these corridors will help dispersal through natural migration and/or assisted migration], the development of new knowledge about how forest ecosystems respond to disturbances associated with pest-induced tree mortality, research with a long-term goal of developing sustainable ways to manage lepidopteran corn pests, and a project with the primary objective of predicting changes in soil organic carbon [SOC] and total soil nitrogen [TSN] stocks as a result of land use change from prairie to agricultural land if the mesic-frigid temperature line moved north in the U.S. and the formerly-frigid soils were

cultivated.

Conference presentations included the American Society of Agronomy, Crop Science Society of America, Soil Science Society of America, American Chemical Society, Ecological Society of America, American Society for Microbiology, Freshwater Science, Entomological Society of America, Indiana Dunes National Lakeshore, Entomological Collections Network, St. Charles Twilight Field Tour, Illinois Mosquito and Vector Control Association, German Society for Protozoology, 47th Annual Meeting of the Society for Invertebrate Pathology, North Central Branch of the Entomological Society of America, American Society of Mining and Reclamation, Beijing International Symposium on Land Reclamation and Ecological Restoration, American Ornithological Union, Livingston County Farm Bureau Agronomy Day, and the NIREC Corn Rootworm Session.

Extension activities encompassed a variety of delivery methods to provide education regarding climate, soil and water management, forestry, and environmental stewardship. A description of some of these major areas of focus follows.

Seventeen self-study modules were made available online for Certified Crop Advisers [CCA's] to access to maintain their certification. Approximately half of the modules address natural resource area topics including nutrient management and soil and water management. The annual **Soil and Water Management Workshop** for CCA's was hosted via webinar in 13 locations in the state with approximately 80 in attendance and included topics on cover crops, managing soils to reduce weather variation, using wetlands to reduce nutrient loading, vertical tillage equipment, and the effect of intentional Mississippi River levee breaks on adjacent cropland. In addition, four pond management workshops were conducted and attended by 150 individuals.

The **Illinois Master Naturalist** [ILMN] program completed a seventh year of statewide implementation. Using the twenty-chapter curriculum [that included one on weather and climate], training offered in eleven multi-county locations to certify new Master Naturalists was completed. Nearly 600 Master Naturalists are actively engaged in a wide variety of projects as environmental stewards. They invested a total of 46,850 hours, 4,529 of which reflected educational efforts and another 36,668 were devoted to natural resource stewardship delivered to a reported 1,782 adults and 1,702 youth. A web-based reporting site is used to collect information on all Master Naturalists' and Master Gardeners' training, volunteer hours, contacts, and projects.

In November of 2013 a tornado raced through three towns in West Central Illinois, destroying or damaging an estimated 1,000 homes. Extension responded by providing 100 financial toolkits to victims. Extension staff also served on the long term recovery committee and presented information on remediation of soils imbedded with dangerous small debris from the tornado, a safety concern for home owners, school yards, and park districts. Removal of all the affected soil and replacing it with clean top soil and fall reseeding or sod replacement was recommended.

A climatologist with the Illinois State Water Survey presented 'The Unusual Weather of 2013 and the Outlook for 2014' at the six **Corn and Soybean Classics** and 'Extreme Weather Events and Their Connection with Climate Change or Normal Viability' at the four regional **Crop Management Conferences**. Additional topics presented at the Crop Management Conferences related to natural resources included response to risks associated with excess precipitation, effects of cover crops and no-till on soil organic carbon sequestration, and advanced soil and water management. **Weather Observer Course** classes were held in two counties this year to provide information on the weather as well as training on the volunteer precipitation monitoring program that is a part of the national volunteer precipitation monitoring program. YouTube videos on 15 weather/climate topics were developed this past

year as an additional educational effort to address climate and weather. Climate education was also a part of the Master Naturalist volunteer training.

Educational efforts carried out with respect to air quality addressed recent radon testing and reporting requirements that impact day care facilities and new construction. Workshops were held in six counties in Northwest Illinois and were attended by approximately 130 individuals. The workshops were supported using grant dollars and through a partnership with the Illinois Department of Public Health with leadership provided by an Extension staff member. Other radon educational efforts this past year included two radon awareness billboards. These radon education efforts are also relevant to the Human Health and Human Development planned program area.

Extension campus and field staff continued to conduct six **First Detector** trainings delivered across the state this year that focused on increasing awareness of emerging and current oak problems in Illinois [Oak Splendor Beetle, Goldspotted Oak Borer, European Oak Borer, and Sudden Oak Death] to prevent the loss of shade trees that remove and sequester carbon from the atmosphere [also see the Plant Health, Systems, and Production planned program section]. The Extension pesticide training program reached 1,318 private [farmer] pesticide applicators and 9,164 commercial applicators this past year and provided them with information on the proper and safe use of pesticides that is vital in protecting public health and promoting environmental stewardship.

This past year a forestry field workshop, the first of its kind in several years and attended by 35 individuals, was conducted in West Central Illinois in March. The Extension Forester presented information for forest land owners on selling and marketing their timber and provided sustainable techniques on optimizing timber value. An outdoor afternoon session discussed timber grading, giving attendees information on what foresters/timber buyers look at in valuing timber. The majority of additional forestry-related education focused on forest landowner education and outreach that extends beyond management to include urban forestry, forest product marketing and utilization, and carbon sequestration by providing technical assistance through woodland owner conferences, seminars, workshops, field days, and Extension forestry bulletins. Many of the face-to-face programs included information on control of invasive plant species in woodlands. **Ask A Forester** is a key feature of the Extension forestry website that received over 163,000 page views. Seven chainsaw safety and directional felling classes/trainings were conducted for 149 woodland owners and farmers. Iowa State University Extension and University of Illinois Extension again partnered to offer the **20th Tri-State Extension Forest Stewardship Conference** that included 21 session choices related to tree diseases and pests, pruning and grafting, forest management plans, planting techniques, and timber sale contracts and marketing. It was attended by over 500 woodland owners and tree enthusiasts from Illinois, Iowa, and Wisconsin.

The **Return of the Large Predator** program was developed this past year to focus on physiology, behavior, and habitat requirements of wolves, cougars, and black bears in response to their migration into Northern Illinois. Multiple presentations engaged over 130 individuals who were able to discuss wildlife values and different perspectives on wildlife.

Youth conservation days with hands-on activities were held in many locations in the state reaching 600 youth, with additional outreach in classrooms, summer education programs, and special events. The **I Think Green** curriculum was used to engage youth in investigating how living things interact with each other and with their environment and reached 1,351 3rd through 5th graders [discussed in more detail in the Evaluation section of this planned program]. Through a new partnership with Cornell, Teen Teachers were trained in the **Nature Detectives** program and conducted summer program activities in two counties. **Nature Detectives** and **Habitat Connections** will be incorporated into the **I Think Green** curriculum in the coming year. The Cook County Extension Educators who focus on science, technology, engineering and

math [STEM] as a priority issue also initiated **Inquiry Adventures**, an inquiry-based nature exploration project for youth. A total of 364 urban youth from ten different organizations received instruction on the inquiry process [part of the Science and Engineering Practices in the Next Generation Science Standards] and an opportunity to practice the process and develop positive attitudes toward local nature and the environment on a subsequent field trip to a nearby Cook County Forest Preserve site.

2. Brief description of the target audience

Members of the target audience included gardeners/farmers growing fresh produce in an urban environment, community groups that support urban food production, Extension agents serving the urban audience, community-based organizations [Advocates of Urban Agriculture, Growing Power, Growing Home], urban planners [City of Chicago Department of Housing and Economic Development] and urban gardeners, professional insect taxonomists, Extension specialists, professional insect diagnosticians, students, amateur naturalists, insect ecologists, academic ecologists, land managers, restoration practitioners, government agency personnel involved in planning, implementing, and regulating wetland restoration programs, conservation groups, federal conservation agencies, city storm water managers, scientists and regulators working in the area of agricultural non-point pollution control, the scientific research and regulatory community working in the area of mercury pollution, researchers working in the areas of ecology, microbial ecology, invasion biology, restoration, weed science, and agroecology, aquatic scientists, students, conservation biologists at the state, regional, and national levels, Illinois and Corn Belt corn producers, Illinois crop consultants, seed technology/biotechnology professionals, policymakers, USDA Forest Service scientists, regional and state natural resource professionals who manage forest lands, and the general public who use these forests for recreation. Extension activities targeted pesticide applicators, forest landowners, public officials, representatives from land management agencies, residents interested in natural resource stewardship, home owners, child care facility employees, and youth.

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	27158	65968	54613	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	0	31	31

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Number Of Completed Hatch Projects

Year	Actual
2014	9

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number Of Individuals That Increased Knowledge Of Human Actions That Negatively Affect The Environment
2	Actions Taken By Program Participants To Protect The Environment [Water Quality, Air Quality, Soil Loss, Wildlife, And Natural Vegetation]
3	Development Or Revision Of Climate-Relevant Databases
4	Dissemination Of Air Quality And Atmospheric Data Through Web Hits On The National Atmospheric Deposition Program Website
5	Nontarget Effects Of Pesticides And Fertilizers On Aquatic Communities
6	Improvement Of Fertilizer Usage Recommendations To Increase Profitability And Reduce Environmental Impacts
7	Ongoing Monitoring Of Wet Atmospheric Deposition
8	Enhancing The Useability Of The Existing Online Interactive Keys To Empoasca And Related Typhlocybina Leafhoppers
9	Demonstrating The Usefulness Of Sub-Lethal, Physiological Metrics In Assessments Of Habitat Quality And Restoration Success
10	Investigating The Ability Of Plants To Alter The Structure Of Microbial Communities
11	Applying Statistical Tools To Aid In The Discovery Of Novel Plant-Microbe Interactions
12	The Development Of Sustainable Practices To Manage Lepidopteran Corn Pests
13	Developing Land Use And Agricultural Management Practices That Would Increase Soil Organic Carbon Sequestration
14	Number Of Pesticide Applicators Making Decisions To Avoid Harming The Environment

Outcome #1

1. Outcome Measures

Number Of Individuals That Increased Knowledge Of Human Actions That Negatively Affect The Environment

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	370

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Increasing concern over degradation of the environment addresses a critical issue related to sustaining life for future generations.

What has been done

The I Think Green curriculum was developed by 4-H and horticulture Extension specialists to engage 3rd through 5th grade youth in investigating how living things interact with each other and with their environment. This program includes three tracks: [1] Worms; [2] Butterflies; and [3] Insects. All three tracks are aligned to Illinois State Educational Goals and follow a sequence of four 40-60 minute investigations in which youth practice observation skills, conduct hands-on investigations with living things, explore different life cycles, identify how living things function/adapt/change, and compare how living things interact with each other and with their environment. The objectives of the program include: [1] To develop youth skills in scientific observation; [2] Increase youth knowledge of concepts that explain how living things function, adapt, change and interact within the environment; and [3] Increase youth knowledge of things they can personally do to help protect the environment. The program was delivered by 4-H and Master Gardener trained volunteers and involved 1,351 youth this past year.

Results

In responding to a ten-question evaluation given to the youth participants at the end of each of the three tracks, 83% [370] reported that the activities helped them learn how butterflies, worms, or insects contributed to the environment, 80% [356] reported being more excited about helping to care for the environment, 77% [343] reported having more ideas about ways they could help care for the environment, and 71% [316] reported that they would like to get involved in food composting, recycling, or other activities to help take care of the environment in their community.

4. Associated Knowledge Areas

KA Code	Knowledge Area
134	Outdoor Recreation
211	Insects, Mites, and Other Arthropods Affecting Plants
806	Youth Development

Outcome #2

1. Outcome Measures

Actions Taken By Program Participants To Protect The Environment [Water Quality, Air Quality, Soil Loss, Wildlife, And Natural Vegetation]

Not Reporting on this Outcome Measure

Outcome #3

1. Outcome Measures

Development Or Revision Of Climate-Relevant Databases

Not Reporting on this Outcome Measure

Outcome #4

1. Outcome Measures

Dissemination Of Air Quality And Atmospheric Data Through Web Hits On The National Atmospheric Deposition Program Website

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	1294000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Acidic atmospheric deposition continues to be a serious environmental concern. Sulfur and nitrogen oxides emitted from industrial and transportation sources, utilities, and metropolitan areas enter the atmosphere and are transformed into acidifying compounds. These pollutants are transported in the atmosphere and are removed, in part, as acidic wet deposition. Ecological impacts from this deposition include changes to lake and stream chemistry, reduced forest growth, reduced soil fertility, and increased weathering and corrosion of exposed structures. Aerosols resulting from the emissions reduce visibility and alter the radiative balance of the Earth's climate system. Epidemiological studies link adverse human health impacts with fine particles containing sulfate and nitrate. Deposition of atmospheric mercury has been identified as the major contributor of mercury to ecosystems, where toxic methyl mercury can accumulate in the food chain and have a measureable impact upon human and wildlife health. The goal of the NADP is to monitor the nation's precipitation for these constituents, report our findings to support scientific research, and to determine whether spatial and temporal trends in concentration and wet deposition are present.

What has been done

Since 1978, the National Atmospheric Deposition Program [NADP] has provided fundamental measurements to support informed decisions on environmental and agricultural issues related to the ambient concentration and wet deposition of atmospheric pollutants in North America. The NRSP-3 provides a framework for cooperation among State Agricultural Experiment Stations, the U.S. Department of Agriculture, and other governmental and non-governmental organizations.

Results

During 2014, NADP data were cited in over 150 peer-reviewed journal articles and other scientific and policy publications. Data and map products from the NADP's five monitoring networks, namely the National Trends Network [NTN], Mercury Deposition Network [MDN], Atmospheric Mercury Monitoring Network [AMNet], Ammonia Monitoring Network [AMoN], and Atmospheric Integrated Research Monitoring Network [AIRMoN] were again downloaded over 28,000 times during the year. Each year, NADP data are used by policy makers to make informed decisions on agriculturally-important topics, including the impact of atmospheric pollutant fallout on the North American food supply. All data are available free of charge at <http://nadp.isws.illinois.edu>.

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
132	Weather and Climate
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife

Outcome #5

1. Outcome Measures

Nontarget Effects Of Pesticides And Fertilizers On Aquatic Communities

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)

In the United States and throughout the world fertilizers and pesticides are used to improve crop production through nutrient enhancement and control of pest organisms. In general, fertilizers and pesticides are applied in terrestrial environments but they also reach water sources, including ditches, livestock watering ponds, and troughs used in agricultural practices. Some of these water sources are potential breeding sites for the immature stages [larvae] of mosquitoes. Little is known about how these nontarget effects of pesticides and fertilizers affect aquatic communities. Therefore there is a need to study these aquatic systems, especially when considering mosquitoes are transmitters of human diseases. We used a series of experiments to test how pesticides and nitrogen enhancement in the larval stages affect mosquito performance [adult life span] and susceptibility to infection with disease agents [viruses].

What has been done

Pesticides are widely used around the world to control undesired plants and animals including mosquitoes. The United States accounts for one-third of the total amount of pesticides used to control agricultural and public health pests around the world. In this reporting period, we generated data on non-target effects of agricultural use of pesticides on the ecology of vector mosquitoes.

Results

This data was disseminated to local public health agencies and Mosquito Abatement Districts [MADs] to assist in the development of policies on how to converge integrated pest management with integrated vector management to promote crop production while mitigating the risk of mosquito-borne diseases.

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
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife
605	Natural Resource and Environmental Economics

Outcome #6

1. Outcome Measures

Improvement Of Fertilizer Usage Recommendations To Increase Profitability And Reduce Environmental Impacts

Not Reporting on this Outcome Measure

Outcome #7

1. Outcome Measures

Ongoing Monitoring Of Wet Atmospheric Deposition

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)

A better understanding of the chemical inputs resulting from atmospheric deposition is critical to understanding nutrient cycling in both crop and forest systems. This can lead to improved nutrient utilization in these systems. The comprehensive monitoring system that Illinois takes part in is

also an early warning system for excessive nutrient loadings through atmospheric deposition, and provides an indication of the recovery from acidification in many ecosystems.

What has been done

Wet atmospheric deposition continues to be monitored at three sites in Illinois as part of this nationwide project. Data include weekly collection of precipitation with pH and complete chemistry measured. A long-term record [35 years] is now available at some of these sites, allowing for a better understanding of long-term changes in chemistry.

Results

These results continue to be part of a national program that leads to a complete understanding of atmospheric inputs of nutrients, and is needed to develop appropriate policies. Results continue to show a decline in both nitrate and sulfate deposition across the Midwestern and Eastern U.S. in response to Clean Air Act regulations. This is one of the few projects that can show a clear environmental outcome to a change in national policies.

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
132	Weather and Climate
133	Pollution Prevention and Mitigation
135	Aquatic and Terrestrial Wildlife

Outcome #8

1. Outcome Measures

Enhancing The Useability Of The Existing Online Interactive Keys To Empoasca And Related Typhlocybina Leafhoppers

2. Associated Institution Types

- 1862 Extension
- 1862 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	15000

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Empoasca is one of the most economically-important genera of leafhoppers, with the potato leafhopper and other polyphagous species causing substantial damage to field and horticultural crops annually. The current lack of reliable identification aids and doubts about the identities of numerous previously-described species hinders the ability of economic entomologists and quarantine officers to manage these potential pests and prevent accidental introductions of invasive species. Because few specialists are available to do routine identifications [there are only three full-time leafhopper taxonomists in North America] user-friendly identification tools that can be used by non-specialists are urgently needed. Because they require only a computer with Internet connection and basic knowledge of insect morphology, online interactive keys provide the means for non-specialists to identify insects quickly and efficiently.

What has been done

To enhance the useability of the existing online interactive keys to Empoasca and related typhlocybina leafhoppers, a major effort was undertaken over the past year to obtain images illustrating diagnostic morphological characters included in the keys.

Results

Approximately 15,000 images were added to the database and linked to character states and species. This brings the total number of images to more than 40,000 for the 462 genera and more than 4,700 valid species now included in the database. To enhance performance, the leafhopper databases were migrated to a new web server.

4. Associated Knowledge Areas

KA Code	Knowledge Area
134	Outdoor Recreation
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #9

1. Outcome Measures

Demonstrating The Usefulness Of Sub-Lethal, Physiological Metrics In Assessments Of Habitat Quality And Restoration Success

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The objective of this research project is to demonstrate the usefulness of sub-lethal, physiological metrics in assessments of habitat quality and restoration success. This has the potential to provide restoration practitioners with another suite of tools and techniques that can be helpful in assessing the success or failure of restoration projects.

What has been done

This work has demonstrated that there is a strong, clear link between habitat quality and physiological properties of resident stream fish. More specifically, the proportion of forest cover in a watershed was the best predictor of blood parameters representing free energy and resistance to oxidative stress, whereas wetland proportion was the best predictor of glucocorticoid function for fish. Interestingly, anthropogenic land use categories, such as urban and agriculture, were not the best predictor for any blood parameters.

Results

Together, our results indicate that fish health is largely driven by natural features of a landscape rather than anthropogenic land uses. Furthermore, these findings suggest that physiological methods could supplement traditional population and community assessments to develop a more comprehensive understanding of ecosystem interactions and improve stream management.

4. Associated Knowledge Areas

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

Outcome #10

1. Outcome Measures

Investigating The Ability Of Plants To Alter The Structure Of Microbial Communities

2. Associated Institution Types

- 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)

Soil microbial diversity is strongly shaped by both local and regional factors [climate, soil type, and soil chemistry], but our broad comparison of natural and agricultural ecosystems has demonstrated that plants can significantly alter the structure of microbial communities. Our work has demonstrated that soil bacterial communities and soil fungal communities respond to the presence and density of invasive plants, including *Lespedeza cuneata*, *Rhamnus cathartica*, *Microstegium vimineum*, *Elaeagnus umbellata*, and *Alliaria petiolata*. We also demonstrated that encroachment of native shrubs [*Cornus drumondii*, *Rhus* spp., and *Juniperus virginiana*] alters grassland soil fungal community composition.

What has been done

Shrub encroachment threatens remnant hill prairie ecosystems in Illinois, Missouri, Minnesota, and Wisconsin. Fungal communities under shrub encroachment begin to resemble fungal communities found in forests, and this shift from 'grassland' to 'woodland' fungi play a role in the loss of hill prairie plant communities. We demonstrated that certain agricultural weeds [*Ambrosia trifida* and *Helianthus annuus*] change soil microbial community composition in ways that affect the performance of these plants [this phenomenon is what plant ecologists call 'plant-soil feedback'].

Results

Our work has further demonstrated that the use of cover crops and green manures in agricultural systems can change microbial community composition with potential consequences for weed germination and seedling emergence. By investigating these phenomena across different spatial scales, we have been able to demonstrate that these specific plant-induced changes are robust in the face of large-scale geographic and environmental variability, and we have pioneered the use of statistical tools to help tease out the signal from the noise in these coupled plant-microbe datasets.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
123	Management and Sustainability of Forest Resources

Outcome #11

1. Outcome Measures

Applying Statistical Tools To Aid In The Discovery Of Novel Plant-Microbe Interactions

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

One of the most challenging aspects of plant-microbe work is uncovering important species interactions from the vast species diversity of soil microorganisms. We have made significant advances in applying statistical tools to aid in the discovery of novel plant-microbe interactions and identifying key microbial 'signals' from the background 'noise' of high-diversity datasets. We demonstrated that multivariate tools can be used to define an index of 'affinity' for microorganisms for particular plant species; that is, does the microorganism respond positively or negatively [or not at all] to the presence of a given plant species? We also showed how 'home and away' experiments can be used to assign an index of 'effect' to microorganisms; that is, does the microorganism have a positive or negative [or neutral] influence on the growth of a particular plant?

What has been done

We demonstrated that the agricultural weeds *Ambrosia trifida* and *Helianthus annuus* can alter microbial communities in ways that are consistent with plant-microbe feedback loops, and by combining the 'affinity' and 'effect' indices of microorganisms that respond to these plants, we were able to identify key microbial players that accounted for over 70% of the variation in growth rates for these plants. In addition, we have been applying multivariate data analyses to characterize key microbial actors in early season weed seed germination and seedling growth. As a result of these analyses, we have discovered that a bacterial strain of *Chryseobacterium*, a strain of *Xanthomonadaceae*, a strain of *Agrobacterium*, and several strains of *Pseudomonas* all play large roles in suppressing the growth of weed seedlings. We have also identified several fungal species in the classes *Sodariomycetes* and *Agaricomycetes* with similar weed-suppressive roles.

Results

These microorganisms respond positively to the addition of red clover green manures, which indicates that cover crop management can influence soil bacterial communities, which can then interact with weed seedlings to reduce weed pressure on crop plants. We also applied classical inoculation experiments to show that invasive *Lespedeza cuneata* derives a greater benefit from bacteria in the genus *Bradyrhizobium* than from other closely related nitrogen-fixing Rhizobia; this association between non-native plants and *Bradyrhizobium* has been noted previously for other invasive species, and it may be a general pattern in plant-microbe interactions for non-native legumes.

4. Associated Knowledge Areas

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

Outcome #12

1. Outcome Measures

The Development Of Sustainable Practices To Manage Lepidopteran Corn Pests

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The impacts of exotic insects and pathogens on forest ecosystems are increasingly recognized, yet the factors influencing the magnitude of effects remain poorly understood. Eastern hemlock [*Tsuga Canadensis*] exerts strong control on nitrogen [N] dynamics, and its loss due to infestation by the hemlock woolly adelgid [*Adelges tsugae*] is expected to decrease N retention in impacted stands. We evaluated the potential for site variation in N availability to influence the magnitude of effects of hemlock decline on N dynamics in mixed hardwood stands. Contrary to expectations, we found that hemlock decline increased ecosystem N retention by stimulating N uptake and growth by healthy vegetation within mixed forests. Our findings contribute new knowledge about how forest ecosystems respond to disturbances associated with pest-induced tree mortality. Our findings suggest that tree mortality may contribute to decoupling the relationship between N deposition and ecosystem N flux.

What has been done

We measured N pools and fluxes at three elevations [low, mid, and high] subjected to increasing atmospheric N deposition where hemlock was declining or absent [as reference] in western North Carolina. Nitrogen pools and fluxes varied substantially with elevation and increasing N availability. Total forest floor and mineral soil N increased [p<.0001, p=0.0017, resp.] and forest floor and soil carbon [C] to N ratio decreased with elevation [p<.0001, p=0.0123, resp.], suggesting that these high elevation pools are accumulating available N. Contrary to expectations, subsurface leaching of inorganic N was minimal overall [$<1 \text{ kg ha}^{-1} \text{ 9 mo.}^{-1}$], and was not higher in stands with hemlock mortality. Mean subsurface flux was 0.16 ± 0.04 [SE] [$\text{kg N ha}^{-1} \text{ 100 d}^{-1}$] in reference and 0.17 ± 0.05 [$\text{kg N ha}^{-1} \text{ 100 d}^{-1}$] in declining hemlock stands. Moreover, although subsurface N flux increased with N availability in reference stands, there was no relationship between N availability and flux in stands experiencing hemlock decline. Higher foliar N and observed increases in the growth of hardwood species in high elevation stands suggest that hemlock decline has stimulated N uptake and growth by healthy vegetation within this mixed forest.

Results

We also measured phosphorus [P] pools and fluxes. While total soil P was similar across the study area, phosphorus fractionation revealed distinct differences in the distribution of soil P fractions as elevation and N availability increased. Soils from high elevation plots where N availability was greatest had 139% larger organic P pools and 55% smaller residual and refractory P pools than soils from low elevation plots with less N availability, suggesting that increased N availability has driven the depletion of recalcitrant P pools by stimulating biotic demand and sequestration. These differences in P distribution among fractions influenced how tree mortality affected P dynamics. At high elevations, plots containing declining hemlocks had significantly greater foliar P concentrations and fluxes of P from the forest floor than reference plots at similar elevations, whereas at low and mid-elevations there were no consistent differences between plots. Across all elevation classes, hardwood foliar N:P ratios were lower in plots with declining hemlocks. Collectively, these results suggest that increased N availability enhances bioavailable P, which is sequestered in vegetation until disturbances liberate it.

4. Associated Knowledge Areas

KA Code	Knowledge Area
123	Management and Sustainability of Forest Resources
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #13

1. Outcome Measures

Developing Land Use And Agricultural Management Practices That Would Increase Soil Organic Carbon Sequestration

2. Associated Institution Types

- 1862 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Our primary objective is to assess the impact of land use change on SOC dynamics and greenhouse gas emissions on the sloping, nearly level, and pothole landscapes subjected to clearing, drainage, soil erosion, cultivation, or grazing. As a result of our findings, we would then recommend land use and agricultural management practices that would increase SOC sequestration and storage and decrease greenhouse gas emissions while sustaining or improving agricultural production, maintaining soil productivity, and reducing soil erosion under changing climate conditions.

What has been done

The 24-year study was conducted in southern Illinois on land similar to that being removed from the Conservation Reserve Program [CRP] to evaluate the effects of conservation tillage systems on: [1] Amount and rates of soil organic carbon [SOC] storage and retention; [2] The long-term corn and soybean yields; and [3] Maintenance and restoration of soil productivity of previously eroded soils. The no-till [NT] plots did store and retain 7.8MgCh⁻¹ more and chisel plow [CP] - 1.6MgCha⁻¹ less SOC in the soil than moldboard plow [MP] during the 24 years. However, no SOC sequestration occurred in the sloping and eroding NT, CP, and MP plots since the SOC level of the plot area was greater at the start of the experiment than at the end. The NT plots actually lost a total of -1.2MgCha⁻¹, the CP lost -9.9MgCha⁻¹, and the MP lost -8.2MgCha⁻¹ during the 24-year study. The long-term productivity of NT compared favorably with that of MP

Results

The primary objective of this research was to predict changes in soil organic carbon [SOC] and total soil nitrogen [TSN] stocks as a result of land use change from prairie to agricultural land if the mesic-frigid temperature line moved north in the U.S. and the formerly frigid soils were cultivated. The conversion of prairie to agricultural use, as a result of climate shift, would release SOC into the atmosphere and enhance greenhouse gas emissions. The SOC and TSN differences between the prairie site and agricultural land were compared in South Dakota. The agricultural land had 18% less SOC and 16% less TSN [or only half of the expected loss from prairie levels]. An attempt was made to document the land use history of the prairie site to understand why SOC and TSN losses were less than anticipated. The fly ash concentration levels on prairie side slopes suggested that the prairie was historically disturbed and eroded. Intensive grazing and burning contributed to the disturbance. The SOC and TSN stock losses appear to represent the minimal change that would occur in the next 100-year time period if a prairie was

shifted to agricultural use as a result of climate shift and the mesic-frigid temperature line in the U.S. was to move north.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
132	Weather and Climate
133	Pollution Prevention and Mitigation

Outcome #14

1. Outcome Measures

Number Of Pesticide Applicators Making Decisions To Avoid Harming The Environment

2. Associated Institution Types

- 1862 Extension

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2014	9199

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Use/application of pesticides has potential adverse impacts on the environment, crops grown, and the pesticide applicator.

What has been done

Private applicator training was delivered by Extension staff in 14 settings across the state to a total of 1,318 individuals in 2013-2014 that included agricultural producers, agriculture and horticulture sales associates, and Extension master volunteers. Commercial applicator training was offered by Extension staff through 50 clinics located in 26 settings across the state to a total of 9,164 individuals that included operators and applicators who apply pesticides to turfgrass, field crops, ornamentals, and road right-of-ways. Following these trainings, Illinois Department of Agriculture staff administered a certification test.

Results

Based on findings from a 2013 survey mailed to a random sample of commercial pesticide training participants, 90% of this year's 9,164 [8,211] Commercial Pesticide Applicator training

participants likely improved one or more of their practices as a result of training participation. In addition, based on previous findings on improvements in practices, more than sixty percent of the participants most likely improved calibration procedures, pest control decision-making, mixing pesticides properly, and compliance with laws.

Based on findings from a survey of 16 practice changes that was conducted in 2010, 2011 and 2012 at the private applicators safety education programs, three fourths of this year's 1,318 private applicator training attendees will likely have: [1] Read and followed label directions for proper pesticide application; [2] Taken precautions to minimize spray drift when applying pesticides; [3] Scouted to determine proper identification of pests before determining if control is needed; and [4] Understand how pesticides can cause contamination and taking steps to prevent it. Using the average figure of \$11,000 from the three-year study regarding training participants' estimate of what they are able to save by being able to protect their production and apply appropriate pesticides when necessary, the total estimated dollars for the six percent [79] of the training attendees last year, may well be nearly \$900,000 saved.

4. Associated Knowledge Areas

KA Code	Knowledge Area
102	Soil, Plant, Water, Nutrient Relationships
112	Watershed Protection and Management
133	Pollution Prevention and Mitigation
211	Insects, Mites, and Other Arthropods Affecting Plants

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Appropriations changes
- Government Regulations
- Competing Public priorities
- Competing Programmatic Challenges

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

A ten-question evaluation was completed by 445 youth who participated in the **I Think Green** program comprised of 208 who participated in the butterfly track and 237 in the worm track. Response tallies for the six questions that were identical for all three groups follow.

Environment Related Questions

77% [343] of youth reported having more ideas about ways they could help care for the environment.

80% [356] of youth reported being more excited about helping to care for the environment.

71% [316] of youth reported that they would like to get involved in food composting, recycling, or other activities to help take care of the environment in their community.

Participation Related Questions

93% [414] of youth reported that the **I Think Green** activities were fun to do.

85% [378] of youth reported that they would like to do more activities like the ones in **I Think Green**.

79% [352] of youth reported that they would like to help with a community garden project.

Butterfly Track Questions

92% [191] of youth reported that the activities helped them learn about butterflies and how they grow.

75% [156] of youth reported that the activities helped them to learn how butterflies interact with other living things.

83% [173] of youth reported that the activities helped them learn about how butterflies contribute to the environment.

73% [152] of youth reported that they were encouraged to ask questions about butterflies and the environment.

Worm Track Questions

92% [218] of youth reported that the activities helped them learn about worms and how they grow.

82% [194] of youth reported that the activities helped them to learn how worms interact with other living things.

83% [197] of youth reported that the activities helped them learn how worms contribute to the environment.

53% [126] of youth reported that they were encouraged to ask questions about worms and the environment.

Key Items of Evaluation

Nearly all of the youth participants in **I Think Green** learned about how butterflies and worms grow, interact with other living things, and contribute to the environment. Although

fewer youth reported changes in how they felt, ideas gained, and interest in how they could care for the environment, more than 90% of those responding did report changes in one of the three questions related to the environment.