APPENDIX F

Project or Activity Number: NC-500

Administrative Advisor: Wendy Wintersteen, Iowa State University

Date of Submission: 04/03/2015

Title: MONARCH BUTTERLY CONSERVATION IN THE MIDWEST

Statement of Issue and Justification: Declines in monarch butterfly populations over the past decade in North America has been documented in the scientific literature. Based on these trends, the U.S. Fish and Wildlife Service (USFWS) was petitioned in the summer of 2014 to list the monarch as a threatened species under the Endangered Species Act. The USFWS determined a status review for a potential listing was warranted and recently completed a public comment period.

Current research indicates that expanded breeding habitat in rural landscapes in the United States will have the greatest positive impact on stabilizing and enhancing monarch butterfly populations. To date engagement by the agricultural community has been limited. Accelerated research and extension efforts with the agricultural community can support a proactive, science-based conservation program that would significantly enhance North American recovery of the monarch and perhaps preclude the need for listing. If listing is required, a scientifically robust, proactive pre-listing conservation program could mitigate future land management requirements for farmers, ranchers and other non-Federal landowners.

A NC rapid response program developed and launched by the North Central Land Grant Institutions over the next two years will establish the needed research and extension/outreach framework to enhance monarch populations through habitat management in rural landscapes and in concert with productive agricultural practices. A conservation consortium for the monarch butterfly has been launched in Iowa (Iowa Monarch Conservation Consortium, 2015) and could be expanded across other North Central states. This NC effort will ensure that the initial stages of conservation efforts across agricultural landscapes in the monarch's summer breeding range will result in science-based, cost-effective, land management practices that lead to population recovery across the region and North American. The effort will be instrumental to establishing a coordinated research and extension effort tailored to local farming and ranching conditions that complement citizen-led efforts in urban and suburban landscapes.

Types of Activities: Habitat improvements in rural landscapes will target underutilized areas that are sufficient in scale to support improved monarch breeding success, and strive to complement other conservation programs. A coordinated NC500 rapid response program will serve as an efficient focal point for collaboration with national conservation efforts being undertaken by the USGS monarch population and habitat research program, the USFWS monarch conservation campaign and anticipated NRCS conservation initiatives.

Objectives: Objectives of the research include developing: 1) Cost-effective methods to establish and maintain milkweeds and companion plants in rural, suburban and urban landscapes; 2) Optimal milkweed species and companion plants patch characteristics and spatial arrangements to maintain and promote larval productivity and population viability; and 3) survey and sampling protocols to monitor milkweed and larval and adult monarch populations. The extension program will ensure the distribution of practical, science-based information on conservation approaches in agricultural landscapes.

Expected Outputs, Outcomes and/or Impacts: During the two years of this rapid response project the research and extension/outreach efforts to support the conservation program will be initiated. It is anticipated that this rapid response project will subsequently be converted to a multi-state research or research activity project (e.g., NC or NCCC type project).

Research outcomes will include: proposed milkweed (*Asclepias*) species and monarch seed mixes for monarch population enhancement and adaptation for North Central states' environments; a framework for developing optimum monarch breeding, forage and roosting habitat characteristics and spatial arrangement of patches for the North Central states; pilot survey sampling designs and protocols to support annual surveys of milkweed species occurrence, plant density, and monarch larval and adult populations and seasonal occurrence. Extension outcomes will include: an outreach framework and delivery system for rural landscapes and communities in the North Central states and demonstration plots and initial guidance for establishing milkweed habitat available for selected agro ecosystems across the North Central states. This mission-driven collaboration across the North Central states and with the related Federal programs will leverage and optimize collective resources and expertise and ensure conservation efforts tailored to local landscapes can be aggregated to state, region and national scales to achieve a scientifically-robust approach for achieving monarch population recovery.

List of Initial Participants:

Iowa State University
University of Minnesota

USDA- ARS (ISU-Ames)

Review:

Attachment: See attached detailed project description.

Authorization:

APPENDIX F ATTACHMENT
NC 500 RAPID RESPONSE PROJECT
TITLE: MONARCH BUTTERLY CONSERVATION IN THE MIDWEST

STAKEHOLDER NEEDS, IMPORTANCE AND CONSEQUENCES: Declines in monarch butterfly populations over the past decade in North America has been documented in the scientific literature (Brower et al. 2012) and popular press (e.g., Des Moines Register, 2014; NY Times 2013, 2014). While the 2014 overwintering adult populations improved somewhat as compared to 2013, the trend of 20 years with overwintering levels are at or near record lows continues (Monarch Watch, 2015). Based on these trends, the U.S. Fish and Wildlife Service (USFWS) was petitioned in the summer of 2014 to list the monarch as a threatened species under the Endangered Species Act (USFWS, 2014a). The USFWS determined a status review for a potential listing was warranted and recently completed a public comment period (USFWS, 2014b).

The declines in monarch populations east of the Rocky Mountains have been attributed to loss of overwintering forest habitat in Mexico as well as the loss of milkweed in the monarch's spring and summer breeding habitat in the southern, central and northern United States. Efforts to enhance conservation of monarch butterflies and their habitat, primarily in gardens, urban and suburban greenspace, and highway right of ways, are being undertaken by numerous multi-partner organizations (e.g., Monarch Watch, 2015; Monarch Joint Venture, 2015). Research to enhance the scientific basis for monarch conservation is being actively pursued in the scientific community (e.g., Entomological Society of America symposium, Nov. 2014) and is a specific component of the U.S. Government's pollination protection initiative released in June, 2014 (USG, 2014). Consistent with the Federal initiative, USFWS announced a save the monarch campaign (USFWS, 2015).

Current research indicates that while breeding habitat in gardens, urban and suburban greenspace, and highway right of ways is important to maintain monarch populations, expanded breeding habitat in rural landscapes in the United States will have the greatest positive impact on stabilizing and enhancing monarch butterfly populations (Flockhart et al., 2014). However, to date engagement by the agricultural community has been limited. Accelerated research and extension efforts with the agricultural community can support a proactive, science-based conservation program that would significantly enhance North American recovery of the monarch and perhaps preclude the need for listing. If listing is still required, a scientifically robust, proactive pre-listing conservation program could mitigate future land management requirements for farmers, ranchers and other non-Federal landowners.

A rapid response program developed and launched by the North Central Land Grant Institutions over the next two years will establish the needed scientific and outreach framework to enhance monarch populations through practical and cost-effective habitat management in rural landscapes and in concert with productive agricultural practices.

TECHNICAL FEASIBILITY:

The NC rapid response effort will ensure that the initial stages of conservation efforts across agricultural landscapes in the monarch's summer breeding range will result in cost-effective, land management practices that lead to population recovery across the region and North American. The North Central Land Grant Institutions, in collaboration with State Departments of Agriculture and Natural Resources, will be instrumental leading a coordinated research and extension effort tailored to local conditions in agricultural landscapes that complements citizen-led efforts (e.g., Monarch Watch, 2015; Monarch Joint Venture, 2015).

To support a North American monarch population more resilient to weather extremes and other stressors will require expansion of breeding habitat in agricultural areas in the Midwest (Flockhart et al., 2014), which is predominately owned by private, non-Federal landowners, and more specifically farmers and ranchers. While recent studies indicate the eastern Great Plains is already highly cultivated and natural areas that may support untamed breeding habitat will continue to decline (Sohl et al., 2012), there are options to advance habitat improvements that target underutilized areas that do not conflict with agricultural land use.

The rapid response effort will address a wide variety of landscape scenarios to expand productive monarch breeding habitat in a practical and cost-effective manner. Habitat improvements in rural landscapes will target underutilized areas that are sufficient in scale to support improved monarch breeding success, and strive to complement other conservation programs.

Objectives of the research and extension efforts will build from existing methods, models and knowledge to develop and implement: 1) Cost-effective methods to establish and maintain milkweeds and companion plants; 2) Optimal milkweed species and companion plants patch characteristics and spatial arrangements to maintain and promote larval productivity and population viability; and 3) Survey and sampling protocols to monitor milkweed and larval and adult monarch populations to evaluate success of the conservation program.

The research portion of the project seeks to develop the scientific foundation for a North Central monarch butterfly conservation plan. A pro-active approach to develop a conservation consortium for the monarch butterfly has been launched in Iowa (Iowa Monarch Conservation Consortium, 2015) and could be expanded across other North Central states that are part of the summer breeding range. Results of the research will contribute to national research and extension/outreach programs designed to aggregate conservation efforts across States.

During the two years of this rapid response project the research and extension/outreach efforts to support the conservation program will be initiated, as described below. It is anticipated that this rapid response project will subsequently be converted to a multi-state research or research activity project (e.g., NC or NCCC type project).

Research Components

Objectives of the research include developing: 1) Cost-effective methods to establish and maintain milkweeds and companion plants in rural, suburban and urban landscapes; 2) Optimal milkweed species and companion plants patch characteristics and spatial arrangements to maintain and promote larval productivity and population viability; and 3) Survey and sampling protocols to monitor milkweed and larval and adult monarch populations.

Objective 1: Monarch habitat propagation: Cost-effective methods to establish and maintain milkweeds and companion plants in rural landscapes. Monarch butterflies rely on milkweed species exclusively as larval host plants, while flowering forbs provide nectar sources for adults. Research is needed to establish cost-effective planting and habitat maintenance practices. Research is needed on best management practices for establishing and supporting breeding habitat that is consistent with weed management needs in row crop production agriculture. A number of private and public sector organizations, including USFWS and NRCS, have or are developing seed mixes and restoration protocols for milkweed habitat across the North Central states (e.g.; http://nctc.fws.gov/topic/online-training/webinars/monarch-conservation.html ; http://www.xerces.org/milkweeds-a-conservation-practitioners-guide/). Coordinated research efforts are needed to address optimal seed mixes for larval and adult monarchs across varying landscapes to assess environmental and agronomic variables that influence germination, propagation, succession and persistence of forage and host plants. The potential incorporation of adapted milkweed species in prairie strips/STRIPS (website in reference section), developed for improved biodiversity, water, nutrient and carbon cycling, while minimizing weed development (e.g., Asbjornsen et al., 2013; Hirsh et al. 2013; Prasifka et al., 2006; Tomer et al., 2009), is an example of an opportunity to establish monarch habitat in concert with other conservation efforts.

On-going and planned efforts during the next two years include:

- Nine milkweed (*Asclepias*) species have been identified for initial testing and will be transplanted into small demonstration plots at 10-15 Iowa sites including ISU Research Farms in 2015. Three species will be transplanted or direct seeded into larger research plots (other species may follow depending on initial screening results). Observations will be made on plant emergence from seed, plant height, flowering dates and visual counts of monarch eggs, larvae, pupae and adults during the growing season. Studies for plant persistence, proliferation, and adaptation will be continued in subsequent years. Results of these preliminary studies can be adapted for studies in other agro ecosystem settings across the North Central region.
- Monarch seed mixes will be formulated that emphasizes milkweed (*Asclepias*) species and a continuous supply of adult nectar sources with an emphasis on prairie, wetland, meadow blends suitable to North Central states' landscapes and planted in larger ca. 0.5 – 2 acre patches in representative locations. Observations will be made on plant stand composition, flowering dates and visual counts of monarch life stages as appropriate during the growing season. Subsequent years will provide information on persistence, proliferation, and adaption.
- **NC 500 Outcome:** Milkweed (*Asclepias*) species and monarch seed mixes will be proposed and evaluated for monarch population enhancement and adaptation for a variety of North Central states environments.

Objective 2: Monarch metapopulation projections in Iowa Landscapes: Optimal milkweed species and companion plants patch characteristics and spatial arrangements to maintain and promote larval productivity and population viability. A significant knowledge gap exists relating to the interactions of plant composition, milkweed spatial arrangement, and habitat

continuity on stabilizing and enhancing monarch butterfly populations. A significant knowledge gap concerns the relationship between monarch breeding success, milkweed density and species composition, adult foraging and roosting habitat patches, and their spatial distribution across urban, suburban and rural landscapes within Iowa. The conservation plan will incorporate knowledge of known resident milkweed species, monarch species preference (e.g., Zalucki et al. 2001; Vickerman and Boer, 2002), and the relationship of monarch breeding success to availability of milkweed habitat patches (Pleasants and Oberhauser, 2013). Optimum milkweed stand density, plot size, and distribution coupled with monitoring monarch life stages is needed to determine optimum habitat to support a viable monarch population. The research plan will build on recently published modeling studies that address monarch habitat needs, but at larger spatial scales and/or in different locations (e.g., Flockhart et al., 2014; Zipkin et al., 2012; Zalucki and Lammers, 2010). This research effort will be coordinated with the USGS Monarch Population and Habitat Science project (USGS, 2014).

- Research at multiple Midwestern locations will provide the quantitative basis for evaluating key habitat/patch characteristics and their spatial arrangement. Milkweed plants will be mapped in the planted and surrounding areas and arranged in a variety of densities (isolation and connectivity) to support modeling efforts for an optimum spatial arrangement for monarch habitat to support statewide monarch larval productivity and adult reproductive performance.
- Meta-population modeling research will evaluate potential monarch population responses based on varying milkweed/companion plant species combinations, patch sizes and spatial arrangements in rural, urban and suburban landscapes, including bikeway and highway right of ways.
- **NC 500 Outcome:** A framework for developing optimum monarch breeding, forage and roosting habitat characteristics and spatial arrangement of patches for the North Central states will be identified through preliminary population modeling and targeted laboratory and field studies. Initial model forecasts and proto-type habitat decision-support system development will be undertaken in collaboration with USGS efforts to integrate and aggregate monarch models across local, state, regional and national scales.

Objective 3: Monitoring: Survey and sampling protocols to monitor milkweed and larval and adult monarch populations. Establishing baseline monarch population estimates for the summer breeding range will enable evaluation of research and implemented habitat conservation efforts.

- A milkweed survey will be conducted throughout the summer breeding range to assess plant species, population density, and environmental adaptations. The proposed milkweed survey will be adapted from previous surveys conducted in Iowa (Hartzler 2010; Hartzler & Buhler 2000) and will provide baseline information on milkweed species occurrence and distribution within states and across the summer breeding range. Milkweed populations will be geo-referenced and conducted in proximity to spatial study sites. Both field- and remote sensing-based approaches will be evaluated.
- Surveys of monarch larvae, adults and milkweed in the Objective 2 study locations will provide data needed to evaluate model performance for monarch population development.

- A monarch population survey will be adapted from state-based (e.g., IDNR-Multiple Species Inventory, 2015) and USGS protocols under development to support monarch butterfly population, abundance and habitat assessments that can be aggregated from individual states to the entire summer breeding range. All milkweed sites will be geo-referenced to enable follow-up larval surveys.
- **NC 500 Outcome:** Survey sampling designs and protocols will be piloted to support annual surveys of milkweed species occurrence, plant density, and monarch larval and adult populations and seasonal occurrence will provide needed baseline data and enable habitat restoration efforts to be evaluated. The effort will include developing approaches to integrate citizen-based surveys (e.g., Monarch Joint Venture, 2015) with surveys undertaken by USGS and state-based conservation programs.

Extension/Outreach Components

A broad-based conservation plan requires practical and science-based 'how to' guidelines and demonstrations for citizens and organizations conserving and restoring monarch butterfly breeding habitat. A robust extension program will ensure the distribution of practical, science-based information on conservation approaches in agricultural landscapes. This information will help ensure that resources invested in habitat conservation across the summer breeding range have a high likelihood of successfully supporting monarch butterfly populations.

Extension/outreach activities focused on general audiences will be coordinated with ISU 4H Youth, ISU STEM, FFA, State Natural Heritage Foundations and State Nature Conservancy chapters. Activities will include the following: Webpage and Facebook presence, timely press releases, webinars, demonstration milkweed gardens and other appropriate activities. Extension/outreach will be conducted through Land Grant extension, state agencies, with leadership by farmer organizations. These efforts will complement citizen-science programs undertaken Monarch Watch and Monarch Joint Venture.

NC 500 Outcome: An extension and outreach framework and delivery system will be established for rural landscapes and communities in the North Central states. Demonstration plots and initial guidance for establishing milkweed habitat available for selected agro ecosystems across the North Central states will be developed.

ADVANTAGES AND IMPACT OF A MULTI-STATE EFFORT: A pro-active research and extension effort across the North Central states is needed to advance monarch conservation through a consortium of Land Grant Universities, State Departments of Agriculture and Natural Resources, farmer and commodity associations, and other landowners, and will provide the foundation from which to develop and implement a conservation plan that could reverse the monarch decline by improving reproductive performance in the summer breeding range. The time frame in which to develop and implement a coordinated research and extension plan to support monarch conservation in the Midwest is closing. A timely, pro-active and science-based effort may preclude the need to list the species under the ESA or ameliorate future impacts incurred by farmers and non-Federal landowners, if USFWS determines listing is needed.

Establishment of a rapid response NC 500 committee to develop and initiate an integrated monarch conservation research and extension effort provides the means to proactively address this issue. A rapid response program developed and launched by the North Central Land Grant Institutions over the next two years will establish the needed scientific and outreach framework to enhance monarch populations through practical and cost-effective habitat management in rural landscapes and in concert with productive agricultural practices.

A coordinated NC500 rapid response program will serve as an efficient focal point for collaboration with national conservation efforts being undertaken by the USGS monarch population and habitat research program (USGS, 2014), the USFWS monarch conservation campaign (USFWS, 2015) and anticipated NRCS conservation initiatives. This mission-driven collaboration across the North Central states and with the related Federal programs will leverage and optimize collective resources and expertise and ensure conservation efforts tailored to local landscapes can be aggregated to state, region and national scales to achieve a scientifically-robust approach for achieving monarch population recovery.

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