Environment and Natural Resources Trust Fund
2016 Request for Proposals (RFP)

Project Title: **ENRTF ID: 143-E**

Management to Prevent Biofuels from Becoming Invasive Species

Category: E. Air Quality, Climate Change, and Renewable Energy

Total Project Budget: $ 257,837

Proposed Project Time Period for the Funding Requested: 3 years, July 2016 to June 2019

Summary:

Biofuel are an important invasive species threat in Minnesota and we will evaluate three potential crop options (Miscanthus, switchgrass and native prairie) to determine optimal management practices to prevent invasions

Name: James Forester

Sponsoring Organization: U of MN

Address: 135 Skok Hall 2003 Upper Buford Circle

St. Paul MN 55108

Telephone Number: 612-626-6721

Email jdforest@umn.edu; awards@umn.edu

Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

The figure shows the relative invasion risks production costs and potential yields of the three types of biofuel crops being considered (Miscanthus x giganteus, Switchgrass and native prairie polycultures).

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%

PROJECT TITLE: Management to prevent biofuels from becoming invasive species

I. PROJECT STATEMENT

Biofuels have been publicized as important, carbon-neutral energy sources and both state and federal statutes currently require their production. This interest has led to the breeding of different plant species to select for traits that make efficient biofuel crops such as low nutrient requirements, high growth rates and broad environmental tolerances. These traits are also associated with high invasion risks and make biofuel crops a major invasive species threat. Previous ENRTF supported work (Tilman 2010, Eckberg 2011-12) has considered the benefits and risks of two particular candidate plant species, *Panicum virgatum* (switchgrass) and *Miscanthus* × *giganteus* that have the potential to become invasive species, while another project (Lehman 2011-12) considered an alternate approach that used native communities of prairie grasses as a biofuel source. The native prairie approach has much lower invasion risks while it also helps maintain native biodiversity.

These projects have provided a wealth of data about each species or crop type, yet there has not been a comparison of these species that integrates this information. We will leverage this previous work and extend their efforts by evaluating the tradeoffs in risks and benefits of different crops with a specific focus on developing management strategies for producing biofuels while reducing spread risk. This will prevent biofuel crops from becoming invasive species, while also aiding in the conservation of native Minnesota biodiversity as their use for biofuel production provides an additional rationale for maintenance of native prairie flora. Biofuel crops are becoming broadly established across Minnesota and in order to prevent them from spreading as invasive species, their cultivation needs to be managed, both in terms of decisions about what crops to plant and what control measures are put in place during production.

Our goal is to identify optimal strategies for biofuel crop (*Miscanthus*, switchgrass, and native prairie) cultivation that prevent invasive spread, including species choices, sizes of field buffers, effort levels for surveillance of escapes and identification of low-risk siting locations.

We will evaluate three major questions in a risk analysis of potential biofuel species:

1) **How quickly and broadly can each crop spread in specific landscapes?**
2) **What combinations of control measures are necessary to prevent invasive spread?**
3) **What are the economic tradeoffs between yields and control costs for each crop?**

These efforts will help prevent the invasive spread of biofuel crops by characterizing the patterns of escape and spread (based on invasive traits) in the context of real landscapes and then identifying optimal control measures. Using these results, we will develop best management practices for biofuel cultivation to prevent invasions. To evaluate the economic feasibility of different strategies, we will compare potential yields against costs of control efforts for specific cultivation projects. We will disseminate data about these tradeoffs to help inform decisions of landowners who cultivate biofuels. The potentially high costs of control efforts can drive a shift toward crop options that have less invasive traits, such as native prairie communities, further reducing the risk of spread of new invasive species.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Risk analysis and identification of optimal control strategies for Miscanthus, switchgrass and native prairie **Budget: $155,225**

Leveraging the previous work of the Tilman, Lehman and Eckberg groups on growth, survival and dispersal of different crop species we will predict biofuel production and invasive spread rates. We will then compare different control strategies to identify the levels of control effort necessary to prevent invasive spread outside of established fields and through the surrounding landscape. We will compare the relative costs and benefits of growing different species in a variety of configurations and in a range of landscapes to identify high risk vs low risk scenarios and locations for biofuel cultivation. We will use this information to develop a set of best practices for the cultivation of each biofuel species that will prevent invasive spread.

Outcome	Completion Date
1. Comparative risk analysis of invasion potential for different biofuel species	March 2017
2. Comparison of different management an control options for each biofuel crop	December 2017
3. Develop best practices guidelines for biofuel cultivation	March 2018
4. Disseminate general findings through presentations and scientific reports	June 2018

Activity 2: Development of a web application for identifying optimal management decisions. Budget: $102,612
Based on our findings from Activity 1 we will develop a web-based application that can be used by individual landowners to identify optimal management choices and potential revenues from biofuel production for specific siting locations. This application will link the general analyses of biofuel production to remote-sensing data of landscapes for specific locations and then calculate potential invasion risks, necessary control measures and potential yields from biofuel production. This will provide landowners information about optimal crop choices and economic feasibility, when prevention of invasive spread is considered, for decisions about biofuel cultivation.

Outcome	Completion Date
1 Risk analysis of biofuel production for specific geographic locations	November 2018
2. Develop web interface for model	March 2019
3. Live website for users to evaluate biofuel production costs and benefits for their land	June 2019

III. PROJECT STRATEGY

A. Project Team/Partners

The research team will be made up of scientists at the University of Minnesota, Twin Cities. Dr. Ranjan Muthukrishnan from the Department of Fisheries, Wildlife and Conservation Biology will play the central role in model development and analysis and Dr. James Forester, from the same department, will manage the project and provide technical expertise on spatially explicit modeling and computational issues. Dr. Nick Jordan, from the department of Agronomy and Plant Genetics, will provide expertise on plant biology and agricultural issues. All three researchers will receive salary support (partial for Drs. Forester and Jordan). In addition we will hire an outside consultant with web development expertise to build our web application and interface.

B. Project Impact and Long-Term Strategy

This project will provide a framework to compare invasion risks and potential benefits for multiple biofuel crops while also evaluating the level of control efforts necessary to prevent their spread as invasive species. Through our web application, this information will be available to individual landowners and will provide advice on when and how to grow biofuels. By providing the economic breakdown of costs and benefits of different crops this will incentivize cultivation of lower risk crops reducing the likelihood of biofuel crops becoming invasive species. We will also develop best management practices that can be applied in cultivation efforts to prevent escape and spread. In addition, this work will provide insight that can be used by regulatory agencies when developing broad regulations about biofuel cultivation. Our project offers an approach to synthesize an extensive body of knowledge on biofuels in a practical and accessible manner that will directly influence decision about cultivation. This will prevent these crops from becoming invasive species and help maintain native biodiversity.

C. Timeline Requirements

The duration of the project is three years. This time is required to develop the computational approach and analyze different management strategies as well as building the web application to make the work readily accessible to individual landowners making decision about biofuel cultivation.

2016 Detailed Project Budget

Project Title: Management to prevent biofuels from becoming invasive species

IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM	AMOUNT	
Personnel:		
Project Manager (Prof. James Forester)- 8%FTE = 1mo summer salary ($5,887) plus 33.8% fringe ($1,990) each year for 3 years: Will oversee project and provide technical expertise on modeling efforts and computational issues. Will aid in analysis, particularly on issues of landscape patterns	$ 23,631	
Faculty (Prof. Nicholas Jordan) 8%FTE = 1mo summer salary ($8,567) plus 33.8% fringe ($2,896) each year for 3 years: Will provide technical expertise in agricultural landscape design and management of biofuel production. Will aid in analysis, particularly on issues of management and decision making.	$ 34,390	
Post-doc (Dr. Ranjan Muthukrishnan) - 100% FTE ($48,000) plus 21.4% fringe ($10,272) for 3 years: Will coordinate project and be the lead on model development and analysis	$ 174,816	
Professional/Technical/Service Contracts:		
Web design consultant- Will be hired in the final year of the project in order to develop web application and interface that will allow our general model to be accessed by landowners over the internet to identify optimal management decisions and control strategies for specific locations where biofuels may be grown.	$ 25,000	
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$	257,837

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period: USDA-NIFA grant "Dynamics Of Weedy Flora In Agricultural Landscapes: Ecosystem Services And Disservices" (associated project to develop modeling framework)	$ 379,320	*Pending*
Other State $ To Be Applied To Project During Project Period:	NA	
In-kind Services To Be Applied To Project During Project Period:	NA	
Funding History: $493,000 - USDA 2012-2015 "Landscape configurations: A new approach to manage invasion by biofuel crops?" Supported empirical studies that will be leveraged for this project.	$ 493,000	
Remaining $ From Current ENRTF Appropriation:	NA	

Potential costs and benefits of alternate biofuel crops

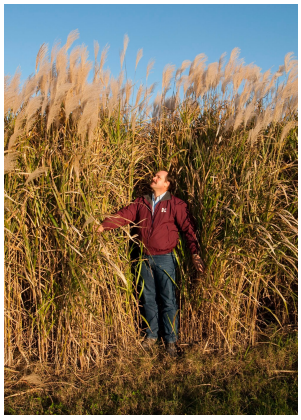
Biofuel crop	Control costs	Production costs	Potential yield
 Miscanthus	High/low (depending on strain)	High/moderate (depending on strain)	High
 Switchgrass	Moderate	Moderate	Moderate
 Native prairie polyculture	Low	Low	Moderate

Figure 1. Relative risks and benefits of production for three candidate biofuel crops.

Management to prevent biofuels from becoming invasive species

Project Manager Qualifications

James D. Forester

I. QUALIFICATIONS

Professional Preparation

Frostburg State University	Wildlife/Fisheries, Biology	B.S.,1997
University of Wisconsin – Madison	Zoology	M.S., 2002
University of Wisconsin – Madison	Zoology	Ph.D., 2005
University of Chicago	Ecology & Evolution, Statistics	Post-doc 2005-2008
Harvard University	Organismic & Evolutionary Biology	Post-doc 2008-2010

Professional Appointments

Asst. Prof., Dept. Fisheries, Wildlife & Cons. Biol., Univ. of Minnesota July 2010 – present

Expertise Related to the Proposed Research

Forester has a broad background in field ecology, having worked on projects related to intertidal community dynamics, terrestrial plant community composition, amphibian population distributions, and the resource selection and movement patterns of large mammals (with specific expertise related to elk). He has extensive experience with quantitative and computational methods and has published numerous peer-reviewed articles that cover a range of spatial and temporal scales.

II. RESPONSIBILITIES

Forester will coordinate and manage the overall project, supervise the postdoctoral associate who will collect spatial data an develop the simulation models. He will coordinate quarterly meetings with the co-PIs, postdoctoral associate.

III. ORGANIZATION DESCRIPTION

The Department of Fisheries, Wildlife, and Conservation Biology is part of the University of Minnesota, one of the largest and most recognized public research universities in the United States. Its mission is to conduct high-quality research and scholarship that can then be shared, extended and applied to challenges faced by organizations and individuals in the community.