Environment and Natural Resources Trust Fund
2012-2013 Request for Proposals (RFP)

Project Title: **ENRTF ID:** **052-C2**

Developing Economic Incentives for Eradicating Buckthorn

Topic Area: C2. Invasive Species - Terrestrial

Total Project Budget: $ 366,766

Proposed Project Time Period for the Funding Requested: 3 yrs, July 2013 - June 2016

Other Non-State Funds: $ 0

Summary:

Our project aims to find economic value for removing invasive buckthorn, in order to incentivize eradication. We will target markets that motivate removal from private as well as public lands.

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Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

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

PROJECT TITLE: Developing economic incentives for eradicating buckthorn

I. PROJECT STATEMENT

Buckthorn is a non-native, invasive plant that is an ongoing problem in Minnesota. Two key species (European and glossy) were widely introduced as ornamentals in the late 1800's as shade-tolerant hedging with berries that attract birds, with persistent leaves, and that naturally suppresses weeds. These attributes, however, have allowed buckthorn to invade our forests. Buckthorn grows well in shade under tree canopies, outcompeting native plants for sunlight. Its berries provide food to birds, but harbor a laxative that encourages local seed dispersal. Buckthorn also exudes compounds that are allelopathic, meaning they suppress growth of other plants. Combined, buckthorn's biology lends an advantage over native plants, resulting in dense buckthorn thickets and degraded habitat. This poses a serious threat to intact forests ranging from wetlands to savannahs, and eradication is a critical challenge, particularly on private lands.

The **goal** of our project is to identify economic uses for buckthorn that **incentivize its removal on private as well as public lands** but also do not promote cultivation. Hand-pulling or cutting buckthorn, followed by application of herbicides to reduce stump-sprouting, is the principal removal method. This has led to massive efforts, largely volunteer, from those who understand the *ecological* value of killing buckthorn. We want to attach *economic* value to the buckthorn as it is removed, in order to make removal more worthwhile to private landowners. To do this statewide without encouraging cultivation requires defining flexible, even temporary market options of appropriate scale. This would be most efficient if done in tandem with product development, not post hoc. Our project and collective expertise have been assembled following this logic, and we are partnered with others deeply familiar with eradication issues.

The tactic we propose (a 'carrot' not a 'stick') has been used before for woody invasives but with different markets. One example is a project focused on removal of woody invasives around St. Paul, incentivizing eradication within a 75-mile radius by burning residues for energy at the District Energy cogeneration plant. We aim to build a complementary, not competitive, approach that would be less centralized and might better target private lands. As an example of this decentralized tactic, the State of Virginia published a landowner's manual in 2009 targeting value-added options when removing invasive Ailanthus, the 'tree of heaven.' For that project, whose co-investigators included an investigator on this proposal, Dr. Omar Espinoza, wood properties were characterized and options for harvesting in tandem with other species were assessed. This is similar to our proposal, but many aspects will not translate, particularly those related to solid wood products not possible from an understory shrub. **Therefore, we will focus on all buckthorn tissues (bark, etc.) and uses market valuation to identify thresholds in demand, above which there might be incentive to plant buckthorn.**

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Capture and characterize extractable components **Budget: $130,922**

We will target two components of buckthorn: solid residues and extractives. Composites can integrate chipped (flaked) or ground buckthorn into a solid product. Extractive compounds from buckthorn, which have some history in dyes and medicines, likely harbor other 'bioactive' qualities (eg, anti-fungal activity) that remain poorly defined. We will first characterize solids and extracts from all plant tissues, varying tree age and extraction to assess a range of options.

Outcomes (*Completion Dates*)

A. Separation & varied extraction of buckthorn (varied ages/locations) (*Jan. 31, 2014)*
B. Physical property characterization of bark, heart- and sapwood *(Jan. 31, 2015)*
C. Chemical characterization of water/organic extracts from all tissues *(June 30, 2015)*

Activity 2: Establish efficacy of target components **Budget: $168,285**
For solid material, either chipped or ground into flour (sawdust), we will determine potential to pelletize or hot-press into a solid product, as well as test heating potential as btu's from pellets, charcoal, etc. For extracts, biological activity will be tested against fungi, bacteria, and plants, targeting species relevant medically and that are pests in forests, fields, or building materials.

Outcomes (*Completion Dates*)

A. Determination of best-use solid product options for buckthorn *(June 30, 2015)*
B. Standarized verification of biocidal efficacy of water/organic extracts *(June 30, 2015)*
C. Identification of target bioactive compounds for purification *(Jan. 31, 2016)*

Activity 3: Identify realistic markets and aid in development **Budget: $67,559**
We will target economically-viable supply chains that offer incentive without promoting cultivation, particularly those that are attractive for private landowners and that offer flexibility given unpredictable, even dwindling supply. Substitution schemes are an example, using ground buckthorn in production of fiberboard as a temporary stand-in for aspen or other species.

Outcomes (*Completion Dates*)

A. Assessment of availability, concentration, and site operability *(June 30, 2014)*
B. Estimation of extraction, transport, and fixed/variable process costs *(June 30, 2016)*
C. Determination of expected market values, viability, and perceptions *(June 30, 2016)*

III. PROJECT STRATEGY

A. Project Team/Partners

Jonathan Schilling (Project Lead) is Associate Professor in the Bioproducts and Biosystems Engineering (BBE) department at the University of Minnesota (UMN), and is an expert in wood microbiology and extractives as biocides. **Christine Salomon** is Assistant Director and Assistant Professor at the Center for Drug Design at UMN. Her expertise is extraction and characterization of biologically active compounds for targeting commodity compounds. **Omar Espinoza** (Co-PI) is Chair of Forest Products Management Development Institute (FPMDI) and Assistant Professor in BBE at UMN. His has experience with Virginia's invasive 'tree of heaven' eradication efforts and an established connection to the MN forest products industry.

For this effort, we include non-ENRTF-funded partners **Julie Blackburn** and **Dan Shaw** from Minnesota Board of Water & Soil Resources (BWSR), who lead the Cooperative Weed Management Areas (CWMAs) in MN. Our partnership can guide collection, target dissemination of findings, and build collaboration for future funding efforts using the CWMA framework.

B. Timeline Requirements

This effort would span three years. Activity 1 will provide the building blocks for Activity 2, both providing core baseline data. Activity 3 will be active throughout the project period because it will both guide the characterization effort as well as the transition of the project into action.

C. Long-Term Strategy and Future Funding Needs

The strategies for this project are **1)** to building a core knowledge that positions us to translate our work into real-world applications, and **2)** to actively participate in this translational effort. In addition to funding sources for fundamental invasive species research (eg, Plant Conservation Alliance and US Fish and Wildlife), we are also aligned with initiatives such as the USDA Pulling Together Initiative (PTI), which uses CWMA's as a model system. By building on a baseline effort that has been guided by the CWMA program in Minnesota, and coupled with FPMDI, we feel strongly that we can align the project for continued success. This has the potential in Minnesota to offer value to local and rural economies as well as a template that might be utilized toward eradicating other invasive woody plants such as honeysuckles and Siberian elms.

2012-2013 Detailed Project Budget

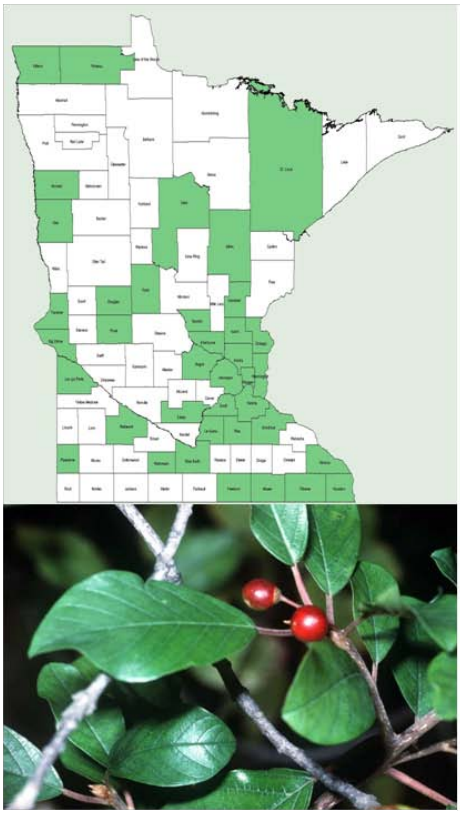
IV. TOTAL ENRTF REQUEST BUDGET (3 years)

BUDGET ITEM	AMOUNT	FTE
Personnel:		
Omar Espinoza (Co-PI, 1 month summer salary, year 1 **(June 2014)** 84% salary, 16% fringe + benefits)	$6,924	2%
1 Postdoctoral Research Associate (Center for Drug Design, Solomon advising, 2 years **(January 2014-December 2015)**, Activities 1,2, 80% salary, 20% fringe + benefits)	$103,776	100%
1 Postdoctoral Research Associate (BBE, Schilling advising, 2 years **(July 2013-June 2015)**, Activities 1,2, 80% salary, 20% fringe + benefits)	$104,068	100%
1 Graduate Research Assistant (BBE, Espinoza, 2 years **(July 2014-June 2016)**, Activities 2,3, 48% salary, 52% fringe + benefits)	$74,737	50%
Equipment/Tools/Supplies:		
Activity 1 supplies: Wet-chemistry characterization supplies (eg, acids, filters, pipette tips, pipets, sundries); Extraction solvents and supplies (eg, organic solvents); Analytical supplies (eg, chromatography columns, autosampler tubes)	$25,000	
Activity 1 equipment: Agilent High-performance liquid chromatograph 1200 series fraction collector and heat exchanger unit, installed. Schilling lab.	$15,261	
Activity 2 supplies: Solids application supplies (eg, resins, hot-press molds); microbial culturing supplies (eg, petri dishes, media, cultures)	$25,000	
Activity 3 supplies: Dedicated computer and software for GIS and product life cycle assessments;	$5,000	
Travel:		
In-state travel for buckthorn collection and meetings with BWSR and industries	$7,000	
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$366,766	

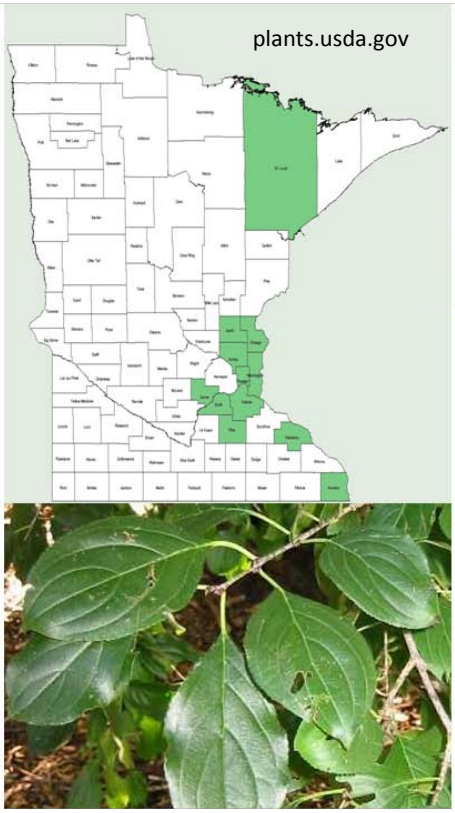
V. OTHER FUNDS		
SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Applied to Project During Project Period:	none	
Other State $ Being Applied to Project During Project Period:	none	
In-kind Services During Project Period: 1 month salary + fringe contributed by the PI and Co-PI's (2 investigators contributing 2 months each, total - Schilling contributing 3, total); use of existing chromatography supplies such as separation columns and guard columns	$62,830	
Remaining $ from Current ENRTF Appropriation (if applicable):	none	
Funding History: *Indicate funding secured prior to July 1, 2013, for activities directly relevant to this specific funding request. State specific source(s) of funds.*	none	

NOTE: Income generated from patents/royalties due to the proposed research would be shared with the ENRTF to the extent of their investment, although it is important to be clear that this is not the goal of our research plan.

European buckthorn (*Rhamnus cathartica*); distribution

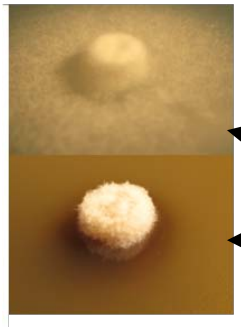


Glossy buckthorn (*Frangula alnus*); distribution



European buckthorn wood; ethanol extracts

PRELIMINARY TRIAL – Wood-decay fungi
Buckthorn extracts *suppress* fungal growth.



Trametes versicolor
Growth rate averages

Extract-free medium
(**2.4** millimeters/day) **FAST**

Buckthorn extracts
(**0.4** millimeters/day) **SLOW**

Gloeophyllum trabeum
Growth rate averages

Extract-free medium
(**5.8** millimeters/day) **FAST**

Buckthorn extracts
(**0.0** millimeters/day) **NONE**

Project Manager Qualifications/Organization Description

Project Manager:	Jonathan S. Schilling
2011-present	Associate Professor, UMN, Dept. Bioproducts & Biosystems Engineering
2006-2011	Assistant Professor, UMN, Dept. Bioproducts & Biosystems Engineering
2006	Ph.D. University of Maine, Wood Microbiology
2000	M.S. Longwood College, Environmental Studies
1995	B.A. Rhodes College, Biology

Dr. Schilling's group at UMN is well-positioned to succeed in this buckthorn project, focusing their research on **wood science, microbiology and forest ecology**. This team specializes in characterizing woody tissues and the attributes that affect decay by microbes. This has implications on wood product durability, tree health, and ecosystem-level processes in forests. To align with these areas, Dr. Schilling couples traditional characterization methods such as those of the American Society for Testing and Materials (ASTM) and American Wood Protection Association (AWPA) with microbial culturing and analyses, allowing exploration at an interface between biological organisms (trees and microbes). Supported by a research team of 9 members and in-house facilities for relevant culturing and analyses, Dr. Schilling is a good match for managing this project on buckthorn and the bioactive potential of extractives and solids.

Dr. Schilling brings experience managing multi-investigator projects and has successfully managed 7 grants and many contracts since 2006 as lead project manager. In total, these grants exceed $2M and have included cost-share and in-kind in the budgets. From these projects, 16 peer-reviewed scientific articles have been published along with 6 outreach publications. Dr. Schilling has given 54 presentations in that time, 18 of which were invited talks. He is a Resident Fellow in the Institute on the Environment (IonE) and adjunct faculty in the Department of Plant Pathology at UMN. Among these achievements since 2006, Dr. Schilling was awarded 3 'early career' grants totaling $1.3M, among them a prestigious, highly competitive Department of Energy (DOE) Early Career award in the Biological and Ecological Research (BER) program.

Dr. Schilling also has the ability to integrate this buckthorn project into the classroom and to disseminate the research to non-technical audiences. He teaches 2 courses annually at UMN: Biodegradation of Bioproducts (BBE 4/5302) and Bioremediation (ESPM 4/5608), both 3 credit courses targeting seniors and graduate students. Despite an appointment of 50% teaching and 50% research, he has dedicated significant time to outreach and service. This includes early detection case study publications, development of an online compendium for biodeterioration diagnostics (the 'Rot Bot'), and many service lectures, including those given at annual Pesticide Applicator and Kild Drying workshops. Because this project strategy includes transition of the project and translation of the science, this is an important aspect for the future of the effort.

This project would build a new and targeted collaboration with co-investigators Omar Espinoza (Ph.D. Virginia Tech) and Christine Salomon (Ph.D. Scripps Institution, UCSD), as well partners from the MN Board of Water and Soil Resources (BWSR). The **University of Minnesota** is an excellent home for this collaboration, providing the facilities and support needed to manage the research and to share the findings.