BCIP Project Proposal

1. **Project title:** Biological control of Chinese tallow: Measuring changes in plant demography and local plant communities in Louisiana

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3. **Cooperators:** Wood Johnson, USDA Forest Service; William deGravelles, Nature Conservancy; and Julie Whitbeck, National Park Service.

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4. **Amount requested:** $50,400

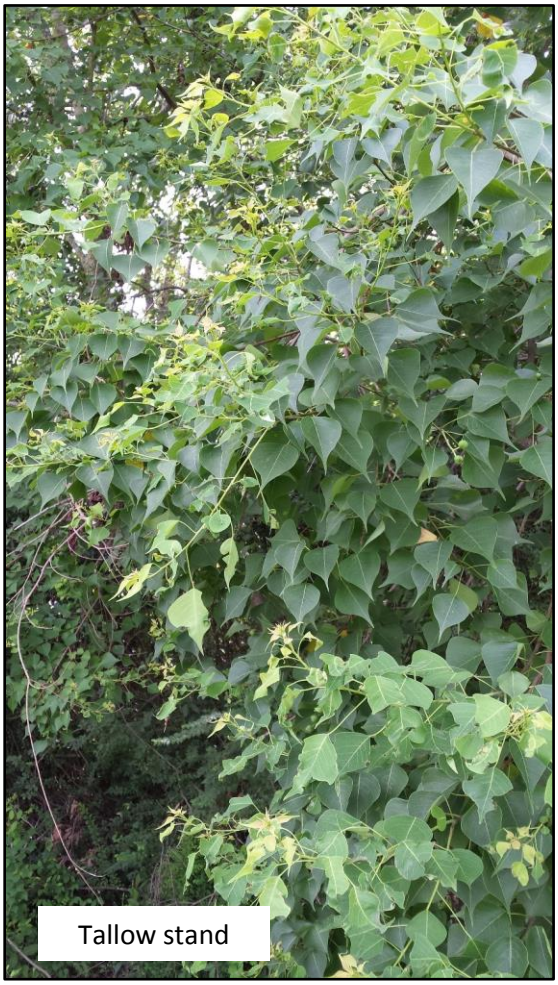
5. **Project goal:** To develop approaches to assess the impact of biological control of Chinese tallow in Louisiana. Because the flea beetle, *Bikasha collaris* (Baly) (Coleoptera: Chrysomelidae), could be released in the near future, it is critical to quantify the before and after infestation levels of Chinese tallow and presence of native plants. We expect this information to help in the development of effective management programs against invasive plants and support future restoration efforts. The supporting objectives are:

   - **Establish long-term monitoring plots of Chinese tallow**
   - **Quantify changes in Chinese tallow demographics before and after the release of *B. collaris***
   - **Measure the impact of local herbivores and plant pathogens on Chinese tallow saplings**

6. **Project Justification**

   Chinese tallow, *Triadica sebifera* (L.) Small (Euphorbiaceae) is a rapidly-growing, invasive tree in the United States (Bruce et al. 1997, Jubinsky and Anderson 1996). Native to southern China, Taiwan and northern Vietnam (Pattison 2008), this tree was first introduced to US in late 1700s (Bell 1966). In the United States, Chinese tallow has been reported in Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Tennessee, Alabama, Florida, Georgia, South Carolina, North Carolina and California (EDDMapS 2016, USDA-NRCS 2016). Of these states, it is listed as a noxious weed in Texas, Louisiana, Mississippi and Florida (USDA-NRCS 2016). The economic impact of Chinese tallow to the timer production in southern United States was quantified using data from the Forest Inventory and Analysis (FIA) of the USDA Forest Service (Wang et al. 2012). The authors found that lack of control of tallow could result in $300 million in losses over a 20 year period.

Chinese tallow invades both wetland and upland habitats including coastal prairies, riparian areas, flood plains, wetlands, lake margins of agricultural areas, forestlands, and natural areas (Bruce et al. 1997; Jubinsky and Anderson 1996). Rapid growth rates and a tolerance to a spectrum of environmental conditions have qualified this tree as one of the "ten worst alien plant invaders" in the US (Flack and Furlow 1996, Jubinsky and Anderson 1996, Wheeler and Ding 2014). Infestations displace native vegetation, therefore changing species composition and community structure in native habitats (Huang et al. 2011, Wheeler and Ding 2014). This large scale ecosystem modification greatly impacts the health of forests in southeastern US. Mechanical removal and physical control methods, such as prescribed burns, have proven to be counterproductive and impractical (Huang et al. 2011, Wheeler and Ding 2014). Moreover, chemical control with herbicides over a large scale is costly and poses risk to non-targets (Huang et al. 2011, Wheeler and Ding 2014). Due to the limitations of mechanical, physical and chemical control, biological control is considered as a potentially safe and cost effective option for control of Chinese tallow (Wheeler and Ding 2014). Several monophagous or oligophagous insects native to China have been identified as potential agents to control Chinese tallow, including the promising root feeding beetle *Bikasha collaris* (Baly) (Coleoptera: Chrysomelidae) (Huang et al. 2011).


Tallow stand

Bikasha collaris (Baly) (Coleoptera: Chrysomelidae) is a flea beetle that feeds on Chinese tallow in China (Zheng et al. 2004). Adult *B. collaris* have a reddish-yellow head and black elytra, whereas larvae begin as light yellow and darken throughout development (Huang et al. 2011). Adults feed preferentially on young Chinese tallow leaves, while mating and ovipositing frequently (Huang et al. 2011). The delicate, light yellow eggs hatch after approx. 9 days into larvae, which then feed below ground on roots and soil-covered stems for approx. 18 days (Huang et al. 2011). The total development time from egg to adult is approx. 35 days. Results from host range tests evaluating 68 species in 20 families indicated that *B. collaris* was host-specific to the genus *Triadica*, with a distinct preference for *T. sebifera* (Chinese tallow; Huang et al. 2011). In August 2016, the Technical Advisory Group


Bikasha collaris adult

for Biological Control agents recommended *B. collaris* for release on Chinese tallow in the US (USDA 2016).

The establishment of long-term monitoring plots allows for pre- and post-release assessment of plant performance in a field setting (Rayamajhi et al. 2008). Pre-release assessment allows biological control practitioners to collect baseline information about plant performance for comparison to post-release conditions. Baseline information can help tease out possible confounding biotic and abiotic factors, such as native herbivory or variation in host plant quality, unrelated to agent performance (Morin et al. 2009). By measuring the post-release impact of *B. collaris* on Chinese tallow, practitioners can acquire quantitative data on the effect of the agent on plant demographics and biomass allometry. This program allows for the rigorous long-term monitoring of the impact of *B. collaris* on Chinese tallow in the southeastern US, with emphasis on pre- and post- release assessment.

7. Approach

Objective 1: Establish long-term monitoring plots of Chinese tallow

To secure the access of research plots over several years, we will use 'Memorandum of Agreements' with land owners. Long-term monitoring is important for classical biological control programs because it allows researchers the collection of several variables related to weed performance and plant community restoration. We have identified several stakeholders in Louisiana with Chinese tallow infestations including the USDA-Forest Service, The Nature Conservancy, and US Department of Interior (see Letters of Support). These infestations are located in natural and managed forests in central and south Louisiana. Based on informal conversations we have secured their commitment to dedicate areas of their properties for at least 5 years. We will use four study sites in central and south Louisiana.

Objective 2: Quantify changes in Chinese tallow demographics before and after the release of *B. collaris*

To determine the effect of the biological control agent on Chinese tallow vital rates, we will use matrix projection models (Crone et al. 2011). The parameters of these models will come from data of plant demographics and biomass allometry. We expect the first releases of *B. collaris* could start in spring of 2018.

Plant demographics: The demographic study will gather plant census data from field populations to estimate initial recruitment, growth, and mortality. Individual plants within each plot will be tagged during 2017 with a unique number. At all sites, 100-120 trees will be measured for diameter at breast height (DBH) and when possible overall height. We will include replicates of all tree size classes in the census including seedlings (< 1 cm DBH), saplings (1-5 cm DBH), and reproductive trees (> 5 cm DBH). Each site will be visited annually and the fate of all trees and their growth will be recorded by measuring DBH.

Seedling recruitment and mortality will be assessed intensively within each plot with $4m^2$ subplots that will measure monthly seed rain into plots, the soil seed bank, seedling recruitment, growth rate, and mortality. Seed rain will be measured using a seed trap at each subplot which consists of plastic pots (531 cm^2 area) attached to metal poles at approximately 123 cm above the soil surface (Tipping et al. 2012) where seeds and litter fall will be removed, counted, and tested for viability. The soil seed bank will be monitored using soil cores which will be spread on a bed of sand in individual pots and watered from below in a greenhouse. Seedlings will be counted, removed, and the surface soil gently stirred to rearrange soil microtopography in order to encourage additional germination. Samples will be stirred three times before being discarded.

Biomass allometry: Plant biomass allocation will be quantified in 2017 at two sites to determine how tallow partitions its resources. Plants (n = 30) will be cut at the soil level and tree height will be measured. Each tree will be then separated into trunk, branch, twigs, leaves, flowers, and fruit components and weighed to obtain fresh weight biomass. Trees will be selected haphazardly to represent the range of sizes present within the population. To measure dry weight biomass, sub-samples of each component will be dried in an oven at 60° C for 5 days.

Predictive regression coefficients will be developed to relate DBH to biomass components. Demographic and allometry data will be integrated to project the total dry weight and allocation of trees pre- and post-biological control release. These data will also be used to develop matrix models and population projections using the life table data recruitment, growth, and mortality of each tree stage (Caswell 2001). Overall the results will be used to monitor the impacts of biological control over time (Shea and Kelly 1998, McEvoy and Coombs 1999, Rayamajhi et al. 2008).

Objective 3: Measure the impact of local herbivores and plant pathogens on Chinese tallow saplings

To determine baseline damage of local insect herbivores and plant pathogens, we will monitor Chinese tallow plots adjacent to those in Objective 2. Monitoring will include the characterization of species and the quantification of plant damage over time.

Characterization of natural enemies: Arthropods associated with Chinese tallow will be collected bimonthly from different niches including folivores, leaminers, leaf scrapers (mites), root feeders, and stem borers. Arthropods will be collected from the study sites mentioned in Objective 1. Because of the importance of proper host records, efforts will be made to collect immature insects observed feeding on tallow. Immatures will be reared in walk-in rearing rooms (25-26°C, 60-70% RH and 14:10 h (L:D)) at the Department of Entomology at LSU in Baton Rouge. Plants showing disease symptoms will be collected and transported to the laboratory for an identification of potential pathogens. Identification of insects, mites and plant

pathogens will be conducted using morphological methods. The outcome of this objective will be an inventory of the natural enemies found in different locations.

Damage by C. tradicae

Plant damage by natural enemies: Based on the herbivores and plant pathogens found during the survey, we will narrow the number of species to monitor for impact. Monitoring plots (4 × 4 m) will be established inside tallow infestations adjacent to those used for the plant demography study. Damage by key natural enemies will be monitored monthly during a two-year period based on their mode of feeding. For example, leaf area removed for folivores, proportion of galled stems, and proportion of leaf damage by pathogens, among others. Because of the wide distribution and impact the leaf mining month *Caloptilia triadicae* (Lepidoptera: Gracillariidae) on Chinese tallow (Fox et al. 2012, Duncan et al. 2016), we will monitor its population dynamics and damage at several locations. Damage by *C. triadicae* is recognized by the presence of leafmines and leaf rolls (Davis et al. 2013, Duncan et al. 2016). We will quantify the proportion of mined leaves per tree in each plot. Temperature and precipitation will be collected from nearby weather stations and used as in insect phenological models.

8. Expected Products and Outcomes

This project will provide baseline information on Chinese tallow demography in Louisiana before and after biological control is initiated. In addition, the impact of a new biological control agent will be quantified in order to determine the effectiveness of the program. This outcome will help improve biological control efforts against Chinese tallow in other areas, and serve as a model for other biological control programs.

8.1 Establishment of long term monitoring plots. Secure at least four long-term monitoring plots (at least five years) with Memorandum of Agreements with landowners.

8.2 Baseline information on demographics and plant demography. Estimates of above ground biomass including trunk, branches, leaves, flowers and fruit; recruitment, growth and mortality of tallow trees. A scientific paper will be prepared.

8.3 Current levels of tallow damage. An inventory of local insect herbivores and plant pathogens attacking Chinese tallow. Measurements of plant damage produced by the most common enemies. A scientific paper will be prepared.

2. Budget

	FY 1	FY2	Total
Item			
Grad student salary	10,000	10,000	20,000
Travel	4,000	4,000	8,000
Supplies	4,000	4,000	8,000
Overhead costs	7,200	7,200	14,400
Grand Total	**25,200**	**25,200**	**$50,400**

Budget notes

- Masters student: Monies will cover part of the student salary.
- Travel: Driving budget to research sites in Central and South Louisiana.
- Supplies: sampling equipment, cages, rearing equipment, identification fees, greenhouse space, tags, meter tapes, flagging, scales, clippers, loppers, chain saws

- **Matching contributions by the LSU AgCenter will include approximately two months salary of the PI, 46% fringe, and indirect (40% MTDC) for a total of $53,144.**

3. Timetable

Task	2017				2018			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Tallow demography study	**********				**********			
Tallow damage survey	**********				**********			
Data analyses and preparation of reports					**********			

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