

**FY99 Unified Funding Call: NRPP Resource Management  
Funding Proposal for JELA-N-005.011  
MODELLING RISK OF CHINESE TALLOW INVASION**

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**Project Title:** Modelling risk of Chinese tallow invasion in a heterogenous landscape: effects of natural and anthropogenic disturbances across a hydrologic gradient

**Abstract:** The Barataria Preserve of Jean Lafitte National Historical Park and Preserve is threatened by Chinese tallow tree (*Sapium sebiferum*), an aggressive invader in wetland forests and freshwater marshes. Its rapid establishment and displacement of native vegetation in disturbed areas threaten diversity and productivity of these wetland systems, and the expense of removal make preventive management the preferred defense. A study is needed to 1) assess the distribution of tallow within the 18,500 acre preserve, 2) develop a model to predict risk of invasion as a function of community characteristics and landscape heterogeneity, 3) determine the consequences of tallow invasion to communities at risk, and 4) develop a set of recommendations for tallow management .

**Proposal Includes:**

- ✓ Title and Abstract
- ✓ RMP Project Statement
- ✓ Servicewide Ranking Criteria

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**Submitted:**

For consideration to the National Park Service Southeast Region, Gulf Coast Cluster  
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## Project Statement

**Southeast Region**

JELA-N-005.011

Priority: 9

Last Update: 04/22/98

Initial Proposal: 1998

Title: MODELLING RISK OF CHINESE TALLOW INVASION

Sub-title: IPM

Funding Status: Funded: 4.00 Unfunded: 197.20

Servicewide Issues: N05 (NON-NAT PLANTS)  
N17 (BIODIVERSITY)

Cultural Resource Type:

N-RMAP Program codes: H00 (Pest and Hazard Management)  
H01 (Integrated Pest Management)

10-238 Package Number :

## Problem Statement

At the 18,500 acre Barataria Preserve, Chinese tallow tree (*Sapium sebiferum*) is an aggressive invader in wetland forests and freshwater marshes. Its rapid establishment and displacement of native vegetation in disturbed areas threaten diversity and productivity of these systems, and the expense of removal make preventive management the preferred defense. Linking natural and anthropogenic aspects of the landscape with the invasion process is a necessary step to understanding and preventing the spread of exotic species. A project is needed to: 1. assess the distribution of tallow within the park; 2. develop a model to predict risk of invasion as a function of community characteristics and landscape heterogeneity; 3. determine the consequences of tallow invasion to communities at risk; and 4. develop a set of recommendations for management of tallow in the park.

Landscapes that experience frequent natural disturbances and have a history of anthropogenic activity are particularly vulnerable to exotic species invasions, and reliable prediction of spatial spread is critical for developing effective controls. In heterogeneous systems, identification of factors that facilitate and inhibit establishment of invasive species is needed to construct predictive models and gain insight into landscape invasibility. In southern Louisiana, Chinese tallow tree is an aggressive invader in wetland forest and freshwater marshes. Its rapid establishment and displacement of native vegetation, particularly in disturbed areas, threaten diversity and productivity of these systems, and the expense of removal make preventive management that preferred defense. In the Barataria Preserve Unit of the park, swales (natural) and levees (artificial) function as invasion routes that provide tallow seed sources deep within large expanses of bottomland hardwood an freshwater marsh communities.

The pattern of invasion in bottomland hardwood forests likely reflect hydrologic and natural disturbance features such as canopy gaps, and the linear trend of ridge and swale geomorphology may facilitate exotic invasions because of high edge/interior ratios. Ridge and swale topography is common in these systems where the stream channel has moved across the floodplain over time. Swales represent the abandoned stream channels and are frequently inundated. Tallow is a flood-tolerant species that readily invades the linear swales which provide an avenue into the bottomland hardwood community occupying the ridges. As canopy gaps occur on the ridges, tallow invades and perhaps hampers bottomland hardwood regeneration. Its spread in the bottomland hardwood forests as well as the emergent and floatant freshwater marshes in the Preserve may also be facilitated by the extensive levee and spoilbanks along keyhole canals systems that penetrate these communities and often support monospecific stands of tallow. Age of these features however, may provide some insight into invasibility because older levees with intact vegetation prior to the introduction of tallow do not support this species. recent levee systems may promote invasion and thus require more intensive pest management. In addition, extensive tallow invasion surrounding the construction site of the park's Education Center indicates an urgent need for park planning and management prior to any future construction, mitigation, or restoration projects within the Preserve. A model that predicts invasion risk based on environmental characteristics and proximity to invasion foci would be a useful tool for developing control strategies and targeting areas at risk.

### **Description of Recommended Project or Activity**

#### **Study Objectives**

1. Describe the spatial distribution of tallow as a function of landscape heterogeneity
2. Develop a model that predicts risk of invasion for currently uninvaded areas
3. link landscape pattern with processes of invasion examined at a local scale
4. determine effects of tallow on diversity and ecosystem processes in communities at risk
5. develop a list of management recommendations to prevent tallow invasion

#### **Researchers**

Dr. Denslow, a noted forest ecologist at Louisiana State University, would be the principal investigator on this project. Loretta Battaglia, a post-doctoral advisee, would develop and oversee this project under the direction of Dr. Denslow. This project statement was developed with the researchers.

#### **Research**

Task 1: Assess distribution of tallow within the Barataria Preserve.

LSU will contract with Lockheed-Stennis for multispectral digital and photographic images of the preserve to be taken in an overflight times to coincide with leaf-out of *Sapium* in early March. Like many exotics, *Sapium* leafs earlier in the spring than native deciduous species. Previous unsuccessful attempts to identify tallow from aerial or satellite images have relied on existing images taken during the growing season when tallow is not easily distinguished from *Salix* (P. Hanley, pers. comm.). We will use data from known monodominant stands of tallow to determine its reflectance signature and to test this profile against known (test) stands of tallow in the

bottomland hardwood and cypress-tupelo communities as well as freshwater marsh. Digital multispectral data will be obtained at a resolution of 2-2.5 m (1:8000) and photographs at < 1 m resolution, allowing for both detailed photo-interpretation and use of ArcView GIS for analysis. This technique will be used to describe the distribution of tallow where it is invading intact bottomland hardwood and cypress-tupelo forests and freshwater marsh communities as well as in human-disturbed sites throughout the park.

Based on the tallow signature, each 2.5 m<sup>2</sup> polygon will be assigned a "1" or "0" corresponding to the presence or absence of adult trees. For each polygon containing tallow, a distance to nearest occupied polygon will be calculated. In the forest areas, all canopy gaps on the aerial images will be identified, and topographic maps of the study sites will be used to identify ridges and swales in the study areas. Vegetation structure taken from aerial photos will also be used to discern ridge and swale patterns and for the incorporation of topographic position into the model. In freshwater marshes, we will measure water depth, salinity and vegetation cover in areas where tallow is occurring as well as at random locations within the community matrix. We will use these data to model the risk of invasion in both community types.

**Task 2: Develop a model to predict risk of invasion as a function of community characteristics and landscape heterogeneity.**

Logistic regression will be used to investigate the relationship between the response probability, ie. presence of tallow, and the explanatory variables. Maximum likelihood will be used to estimate logistic regression parameters. The first step will be to test whether the difference in deviance between the null model of slope=0 is significantly different from the model including all covariates. If there is an overall significant difference, this suggests that incorporating at least one of the covariates improves predictive capacity of the model. If that occurs, we will initiate the iterative process of finding the most parsimonious subset of explanatory variable that provide a good fit. Inclusion of explanatory variable in the final model will be based upon results from likelihood ratio tests comparing a series of competing alternative nested models. Difference in deviance will be calculated for each pair of models evaluated and used to statistically compare fit of models. If there are no significant differences between the models, the choice should be the simpler one.

Because tallow migration cannot be reliably detected over time from past photographs, we will employ dendrochronological techniques to age individuals and to infer temporal invasion patterns. Ten hectares of plots will be established in the bottomland hardwood area which encompasses the range of heterogeneity encountered during the first phase of the study. These plots will be independent of the areas used to construct the initial model. Canopy, topographic, and distance to nearest neighbor data will be acquired for these plots as described above. Because previous canopy disturbances may have affected current tallow patterns but may no longer be detectable, we will supplement the current canopy data with that from previous aerial photographs. Light availability will be quantified in a subset of gaps and non-gaps using hemispherical photographs. All tallow stems will be cut, and cross-sectional disks will be taken back to the lab for dendrochronological assessment. All individuals will be aged and mapped; age and spatial information will be used to reconstruct the movement of tallow over time.

**Task 3: Determine the consequences of tallow invasion to communities at risk.**

Seeds of Chinese tallow will be planted at a variety of microsites in both forests and marsh communities to assess regeneration response under different environmental conditions. Germination, survivorship, and growth will be monitored weekly through two growing seasons. ALL individuals will be excavated at the conclusion of the experiment and before they become reproductive and used to examine biomass allocation patterns. All plots will be marked and plotted using GPS to assure relocation and total removal of all planted individuals.

Two removal experiments will be conducted to evaluate the effects of tallow on native vegetation. In plots established in the marsh communities, we will compare community composition in control plots to those in which tallow has been removed. This experiment is designed to assess impact of tallow on the species composition and ecosystem processes and determine whether tallow removal is a viable management strategy in this endangered community. In the second experiment, we will assess density effects of tallow on a native species, *Salix nigra*. Along one of the levees dominated by tallow, we will plant seedlings in plots along an experimental tallow density gradient. This experiment is designed to measure the effects of tallow density on hardwood regeneration.

Task 4: Develop a set of recommendations for management of tallow.

Invasion of tallow poses a threat not only to communities in Jean Lafitte National Historical Park and Preserve, but also other parks throughout the southeast. We will conduct interviews with park and refuge managers throughout the region and incorporate this information with results from our predictive model, experiments, and a thorough literature review to develop a set of recommendations for park management of tallow.

#### Anticipated Products

1. Written report in digital and hardcopy formats to include
  - a. discussion of study methodologies
  - b. assessment of current spatial distribution of tallow
  - c. recommendations for management of tallow to be incorporated into the park's Integrated Pest Management Plan
2. Herbarium collections of park species to be kept on permanent loan at the LSU Herbarium
3. Hardcopy and digital data of the Barataria Preserve depicting areas at high risk for invasion which can be used to develop treatment priorities

#### BUDGET AND FTEs:

| -----FUNDED----- |           |          |          |                  |      |
|------------------|-----------|----------|----------|------------------|------|
|                  | Source    | Activity | FundType | Budget (\$1000s) |      |
| FTEs             |           |          |          |                  |      |
| 1999:            | PKBASE-NR | ADM      | One-time | 4.00             | 0.10 |
| Total:           |           |          |          | 4.00             | 0.10 |

| -----UNFUNDED----- |          |           |                  |      |
|--------------------|----------|-----------|------------------|------|
|                    | Activity | Fund Type | Budget (\$1000s) | FTEs |
| Year 1:            | RES      | One-time  | 82.40            | 1.20 |
| Year 2:            | RES      | One-time  | 57.40            | 1.10 |
| Year 3:            | RES      | One-time  | 57.40            | 1.10 |
| Total:             |          |           | 197.20           | 3.40 |

**(Optional) Alternative Actions/Solutions and Impacts**

If the park does not identify the environmental factors that influence Chinese tallow invasion and attempt to prevent new invasions, park managers will continue to rely on labor intensive chemical and mechanical methods to treat stands after establishment.

Compliance codes: EXCL (CATEGORICAL EXCLUSION)

Explanation: 516 DM2 APP. 2, 1.6

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**1. Significance of the resource or issue to the park**

The Park's enabling legislation contains specific language regarding the protection of certain values within the Barataria Preserve Unit, a 18,500 acre wetland complex. Two of the values enumerated in the legislation are vegetative cover and integrity of ecological and biological systems. Invasion by the non-native Chinese tallow tree threatens the ecological integrity of communities that span much of the hydrologic gradient represented in the Park.

Bottomland hardwood forests in the Barataria Preserve are among the southern-most such forests remaining in Louisiana. These communities provide habitat for many wildlife species including over 270 species of migrant and resident birds, and they are especially important to the thousands of neo-tropical migrant birds that utilize the Preserve every year before and after their long trans-gulf flight.

Freshwater marshes are another highly productive community within the Park that provide important habitat for a diversity of species. A unique and largely unstudied plant assemblage occurs in the floating marsh habitat where *Myrica cerifera*, a nitrogen fixing species, can alter local nutrient cycles which creates colonization microsites atypical of freshwater marshes. Rapid decomposition of tallow leaves can also alter the local nutrient profile.

**2. Severity of Resource Threat, Problem or Need(s):**

Chinese tallow tree invasions are currently affecting forested wetland and freshwater marsh communities in the Barataria Preserve, particularly disturbed sites. The park is planning several wetland restoration efforts in forested wetland communities in the preserve and would like to avoid, to the extent possible, promoting tallow invasion. It may be feasible to control hydrology, photoperiod, plantings, soil type, or other environmental factors to discourage tallow invasion of the restoration sites. However, relatively little is known about the species interactions and hydrologic and topographic conditions that may discourage tallow invasions. Majority of the research, as well as park resource management actions, have focused on control of existing trees as opposed to prevention of new tallow invasions. Although some attempts have been made to control its spread, no detailed tallow removal studies have been conducted in which reestablishment of native community diversity is measured. This type of information would be useful in designing wetland restoration projects.

**3. Problem definition and information base**

Degradation of forested wetland communities from establishment of Chinese tallow trees is a recognized and on-going problem in south Louisiana. Chinese tallow is a popular ornamental that seeds profusely, but provides little habitat value for native wildlife. The water-borne seeds wash into storm drains in urban neighborhoods and are then dispersed via bayous and canals where the seeds germinate and trees become established in natural areas. An integrated pest management approach to tallow invasion should involve prevention of seed production and

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distribution, prevention of establishment, and treatment of established trees. On-going park interpretive programs are used as an avenue to educate the public about the ecological impacts of planting of aggressive non-natives and existing resource management efforts focus on using mechanical and chemical methods to control established trees. This study would increase our understanding of factors that influence tallow establishment and therefore, allow park managers to make decisions that discourage new invasions. Understanding how to prevent, or at least discourage, tallow invasions is particularly important as the park begins several wetland restoration projects in forested wetlands. The experimental work proposed here would provide some baseline data on the impact of tallow density on natural community composition.

#### **4. Feasibility**

Obtaining a unique and reliable signature for tallow is a prerequisite to the model building/prediction phase of the project. Because tallow cannot be distinguished from *Salix* spp., the aerial images must be taken in the narrow time frame when only tallow leaves are expanded. Prior to bud burst, local tallow populations will be monitored several times each week. Flights will be scheduled on a standby basis. Despite early detection of tallow leaf-out and scheduling of flights, unfavorable and unpredictable weather conditions could delay flights indefinitely. If we are unable to distinguish a tallow signature, we will develop the model based on ground surveys in conjunction with GPS data.

#### **5. Problem Resolution**

Exotic species management is a continuing battle and rarely can an invasive species be eradicated completely and require no further management. However, by identifying factors that influence tallow establishment, the park may be able to prevent or discourage new invasions, particularly during wetland restoration efforts, and thus reduce future mechanical and chemical efforts to control established trees. This research would fill a critical information gap, bolster park interpretive efforts about exotic plants, and allow the park to use a more integrated approach to Chinese tallow control.

#### **6. Transferability**

Tallow trees are a recognized pest not only in southern Louisiana, but across the Gulf Coast, from Florida to central Texas, affecting everything from native prairie restoration in southwest Louisiana to oil-field site restoration efforts at the Big Thicket in Texas. There is considerable opportunity for the results of this project to benefit many land managers. The nearby US Fish and Wildlife Service's Bayou Sauvage National Wildlife Refuge has a tremendous problem with Chinese tallow invasions and the results of this research could be used to prevent and discourage tallow establishment as they begin a major capital construction project. There are many existing avenues to distribute the results of this project to interested land managers throughout coastal Louisiana, including the Barataria-Terrebonne National Estuary Program, the Gulf of Mexico Program, and the Restore Coastal Louisiana Coalition.

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**7. Cost Effectiveness**

Materials to be purchased include marking supplies, herbarium supplies, nutrient analysis supplies, computer and supplies, printing supplies and dendrochronology supplies. Labor to be paid during the first year includes 12 months salary for a post-doctoral fellow, 3 months salary for an undergraduate field assistant, and 1 month salary for Dr. Denslow. Second year labor costs include 12 months salary for a post-doctoral fellow and 3 months salary for an undergraduate field assistant. Third year labor costs include include 12 months salary for a post-doctoral fellow and 3 months salary for an undergraduate field assistant. Travel expenses to be paid include mileage and per diem costs. Housing expenses include lodging for 6 months per year. Direct costs include a subcontract with Lockheed-Stennis for flights and rectification of images. Meeting costs provide for attendance at one scientific meeting per year for the last two years of the project.

|        | Material/<br>Supplies | Labor                 | Travel | Housing | Direct<br>Costs | Meetings | Total    |
|--------|-----------------------|-----------------------|--------|---------|-----------------|----------|----------|
| Year 1 | \$5500                | \$46,550 <sup>1</sup> | \$1000 | \$3600  | \$8750          | -----    | \$65,400 |
| Year 2 | \$2000                | \$37,940 <sup>1</sup> | \$1000 | \$3600  | -----           | \$1000   | \$45,540 |
| Year 3 | \$2000                | \$37,940 <sup>1</sup> | \$1000 | \$3600  | -----           | \$1000   | \$45,540 |

<sup>1</sup> Includes 23% on Battaglia's and Denslow's salaries for fringe benefits.

Total=\$156,480 @ 26% overhead (LSU) =\$197,165

**8. Project Support**

Louisiana State University would contribute the salary for 33 months of Dr. Denslow's oversight of this project, valued at \$40,000 over the three year life of this project, as well as use of university's lab and herbarium facilities to analyze and store field data, valued at \$10,000. The park would contribute salary and benefits for the natural resource management specialist involvement in this project, valued at \$4000 over the life of the project. Total inkind contributions are valued at \$54,000 for this \$197,165 project.

This project will be included as part of a larger study on bottomland hardwood forest dynamics in Louisiana. Dr. Denslow is establishing a plot for long-term monitoring of forest dynamics in the Barataria Preserve. This project will specifically address the tallow problem in the park and will supplement the long-term monitoring project.