Research Grants for Graduate Students

Departmental Evaluation Sheet

Please fill out an evaluation form for each RGGS application submitted by your department. The completed evaluation forms and RGGS proposals are due in the Graduate School by 4:30 PM, October 1, 2008, or February 4, 2009. Proposals should be evaluated according to the three primary criteria for the RGGS program:

1. The originality/creativity and significance of the student's proposed research.
2. The clarity and appropriateness of the student's research design and procedure.
3. The feasibility of the student's proposed research.

Also note that the RGGS research projects should be for work that is to be conducted. Proposals that describe projects where significant work has already been completed are ordinarily not funded. Please pay particular attention to the timeline of the proposal to see that it accurately reflects the status of the project. Please note that RGGS funds cannot be used to reimburse money spent prior to the award. If you have questions about the evaluation of proposals, please contact the Graduate School.

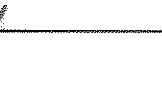
Student Name: _____

Project Title: Effects of white-tailed deer (Odocoileus virginianus) on early growth and survival of large-seeded...

This proposal was ranked ____ out of ____ proposals submitted by the department

In the space below, please provide your departmental evaluation of this proposal. If more than one proposal is submitted from your department, clearly explain the reasons for the relative ranking of this proposal. Attach additional sheet, if necessary.

Department: Biological Sciences

Signature of Chair: 

Print Form

RESEARCH GRANTS FOR GRADUATE STUDENTS
Application Cover Sheet

NAME	Student Number	Date:	Email Address
Home Town	**Mailing Address**		
Department Name		**Dept. Campus Box**	**Requested Amount**
Biological Sciences		1651	$500.00

Project Title

Effects of white-tailed deer (Odocoileus virginianus) on the early growth and survival of large-seeded bottomland hardwood tree species.

Nature of Project (check one)	Is this a resubmission? (Check one)
☑ Thesis	☐ Yes. If yes, previous app: _____
☐ Other Research Project	☑ No
Expected Date of Graduation:	**Student's Signature:**
May, 2011	

Compliances (Please check if your project involves any of the following):

☐ Animal Care ☐ Biosafety ☐ Hazardous Waste ☐ Human Subjects ☐ Radiological Safety

Project Summary (No more than 300 words)

Please see attached sheet (300 words would not fit in the box).

APPROVALS

Major Advisor (Printed Name)	Major Advisor Signature	Date
Dr. William Retzlaff		10/5/09
Department Chair (Printed Name)	Department Chair Signature	Date

FOR GRADUATE SCHOOL USE

GPA: _____ **Earned Hours:** _____ **Reviewed** _____
Approved: _____ **Not Recommended:** _____

RPAB Chair Signature: _____ **Date:** _____

Project Begin Date: _____ **Final Report Due:** _____

Effects of white-tailed deer (*Odocoileus virginianus*) on the early growth and survival of large-seeded bottomland hardwood tree species.

Summary

Bottomland hardwood (BLH) forests are regularly flooded forests located on the floodplains of streams and rivers in the central, southern, and southeastern United States. Due to their drastic loss since European settlement, restoring BLH forests has become a conservation priority. A potential limitation to natural regeneration and successful restoration of large-seeded BLH species is damage by white-tailed deer. Though the potential negative effects of white-tailed deer are well known, they have seldom been quantified, and the effects of deer damage on bottomland tree species has not been well studied. The objectives of my research are to test the effectiveness of metal deer guards in improving survival and growth of planted seedlings of large-seeded BLH tree species and to determine the relative effectiveness of guards of different heights. The study is located at a restoration site in the Two Rivers National Wildlife Refuge. In early summer 2009 I selected six of the groups of trees that were planted in fall 2008. Within each group, guards were then rearranged to give, for each of the four species, approximately equal numbers of trees with each height of guard (0.91 m, 1.22 m, and 1.52 m) as well as five control trees, with no guard. In November 2009, six additional groups of trees will be planted on the site. The plantings will comprise an equal mixture of five species, with 15 trees of each species per group. Growth, mortality and deer damage will also be tested among guard heights and also among species and against proximity to cover, with initial size and elevation as covariables. The results with assist land managers in planning restoration projects. Improved knowledge of the quantitative effects of white-tailed deer on regeneration and restoration will also help in the cost-benefit analysis of white-tailed deer management programs.

Background and Significance

Bottomland hardwood (BLH) forests are regularly flooded forests located on the floodplains of streams and rivers in the central, southern, and southeastern United States (Sharitz and Mitsch 1993). Due to their drastic loss since European settlement, restoring BLH forests has become a topic of great attention and activity (King and Keeland 1999, Stanturf *et al.* 2000). In addition to BLH forest clearing, the flooding regime has been altered by the construction of locks and dams on the Illinois and Mississippi Rivers, causing an increase in flooding frequency and intensity. The altered flooding regime has created conditions where the soil moisture content throughout the year may be higher in some areas, which could be a limiting factor in growth and establishment of some bottomland tree species (Nelson and Sparks 1994). Large-seeded species, such as oaks and hickories, have limited dispersal distances (Battaglia *et al.* 2007) so it is necessary for BLH forest restoration managers to actively establish these species (King and Keeland 1999).

Another potential limitation of natural regeneration and successful restoration of large-seeded BLH species is damage by deer. It has been shown that oaks are the preferred browsing species for deer, due to their low fiber levels and high nitrogen levels compared to maples (Barancekova *et al.* 2007). Browsing by high populations of white-tailed deer can change the dynamics of hardwood forests (Horsley *et al.* 2003) and can limit regeneration of favorable species like oaks (Riley and Jones 2003). White-tailed deer (*Odocoileus virginianus*) have been found to negatively affect the growth and survival of *Quercus buckleyi* saplings (Russell and Fowler 2004) as well as other bottomland species (Joys *et al.* 2004) by both browsing and bark-rubbing.

In the past, restoration success has been limited by impacts of white-tailed deer. At Two Rivers National Wildlife Refuge (TRNWR) in Calhoun County, Illinois, white-tailed deer have negatively affected survival and growth of planted seedlings by browsing and antler rubbing, which damages the bark (Ken Dalrymple, pers. comm.). The impacts of the white-tailed deer have become such a problem that site managers have experimented with different types of deer guards. Spiral plastic trunk guards break down from UV light and plastic drainage pipe collects sediment and may promote an environment favoring pathogenic fungi. White-tailed deer are able to remove both types of plastic guard. In recent restoration plantings, welded metal mesh fencing secured to the ground by a wooden post is being trialed. The optimum height and overall effectiveness of this type of tree deer guard has not yet been determined. The ideal tree guard would minimize damage from white-tailed deer antler rubbing while allowing the tree to grow without impeding optimal canopy development.

Though the potential negative effects of white-tailed deer are well known, they have seldom been quantified, and the effects of deer damage on bottomland tree species has not been well studied. The objectives of my research are to test the effectiveness of the guards on the growth and survival of planted seedlings of large-seeded BLH tree species and to determine the relative effectiveness of guards of different heights.

My research will contribute to the understanding of white-tailed deer impacts on the growth and survival of BLH forest species. The results will quantify the extent to which white-tailed deer negatively impact restoration projects in the Upper Mississippi Valley. With these results, agency managers and conservation groups will have better information to guide restoration projects. Improved knowledge of the quantitative effects of white-tailed deer on regeneration and restoration will also help in the cost-benefit analysis of white-tailed deer management programs.

Procedure/Methodology

Study Sites

The Two Rivers National Wildlife Refuge (TRNWR) is located near the confluence of the Mississippi and Illinois Rivers at Calhoun Point, in Calhoun County, Illinois. The majority of the land is subject to annual flooding from the Mississippi and Illinois Rivers.

In spring 2008, a site adjacent to Swan Lake, the Swan Lake Restoration Site, was planted with plus of Virginia wild rye (*Elymus virginicus*), switchgrass (*Panicum virgatum*), and prairie dropseed (*Sporobolus heterolepis*). However, due to summer 2008 flooding, Virginia wild rye is now the predominant herbaceous species in the field. In November 2008, RPM® seedlings of four large-seeded tree species, *Quercus bicolor* (swamp white oak), *Q. macrocarpa* (bur oak), *Q. palustris* (pin oak), and *Carya illinoinensis* (pecan), were planted in groups to resemble a wet savannah community that may have occurred on the site prior to European settlement (Nelson and Sparks 1994). Trees were planted on higher elevations in the field, with about 100 trees per group and a total of 14 groups. Each group has a relatively equal number of each species, with a 0.91 m (3 ft), 1.22 m (4 ft), or 1.52 m (5 ft) metal mesh deer guard surrounding each tree.

The Swan Lake Restoration Site has a higher than average population of white-tailed deer during hunting season in the fall. Deer move from the Pohlman Slough Restoration Site, where hunting is permitted, to the Swan Lake Restoration Site, where hunting is not allowed. The white-tailed deer congregate on the west side of the Swan Lake Restoration Site, where cover is present and have been seen in groups of up to 70 (Ken Dalrymple, pers. comm.). Therefore, larger impact from white-tailed deer may be expected to occur on the planted tree groups closer to the west side of the field. Deer rubbing on the bark of the lower trunk by the antlers of small

male white-tailed deer typically occurs in early fall, while browsing of the twigs typically occurs over the winter and early spring.

RPM® Seedling Experiment 1

In early summer 2009 I selected six of the groups of trees that were planted in fall 2008. The species and current guard height of each tree was recorded. Within each group, guards were then rearranged to give, for each of the four species, relatively equal numbers of trees with each height of deer guard (0.91 m, 1.22 m, and 1.52 m) as well as five control trees, with no deer guard. The groups of trees did not have equal numbers of trees or numbers of each species within each group. If there were not enough trees present in a group to have six trees of each guard height, six trees were assigned a 1.52 m guard, then six trees were assigned a 1.22 m guard, etc. Guards have a circumference of 0.91 m (giving a diameter of about 1 ft or 0.3 m) and a mesh size of 5 x 10 cm (2 x 4 in) and are anchored to the ground using a 5 x 2.5 cm (2 x 1 in) pressure treated pine lumber stake, with the mesh fastened to the stake using three concrete form ties made of steel wire. The trees were tagged using numbered aluminum tree tags attached with a 20 cm diameter wire loop at the base of the trunk, and basal diameter (at 30 cm above ground) and height were measured. Diameter and height growth will be remeasured in late fall 2009 and fall 2010 to calculate diameter and height growth over the 2009 and 2010 growing seasons. In fall 2009, spring 2010 and fall 2010, mortality will be assessed for each species as the number of trees that have died since establishment of the experiment. Levels of deer damage will be quantified during fall 2009, spring 2010 and fall 2010 by measuring the height and circumference of rubbed areas on the trunk and counting browsed shoots per tree.

RPM® Seedling Experiment 2

In late fall 2009, six additional groups of trees will be planted on the Swan Lake Restoration Site. The plantings will comprise an equal mixture of five species: *Quercus bicolor*

(swamp white oak), *Q. lyrata* (overcup oak), *Q. macrocarpa* (bur oak), *Q. palustris* (pin oak), and *Carya illinoinensis* (pecan), with 15 trees of each species per group. There will be a total of 75 trees for each group (5 species x 3 guard heights x 5 replications). *Q. lyrata* will be used in addition to the four species planted fall 2008 because it is thought to be the most flood tolerant oak species and may be more successful than the other oaks in more flood-prone conditions. Three groups will be located close to the tree line on the west side of the field and three groups will be located about half way between the tree line and the road that forms the eastern boundary of the field. The six groups will be planted one to two meters lower in elevation than the 2008 plantings. The aim is to test both the effect of proximity to cover, where the white-tailed deer congregate in fall, and the effect of elevation. The 0.91 m guards will not be used because observations during summer 2009 showed that they can cause severe damage to the trunks of the top-heavy seedlings. Apart from this, the arrangement of guards will resemble the design used for experiment 1: five trees of each species with each height of guard (1.22 m and 1.52 m) as well as five control trees, with no deer guard. Guards will have the same specifications and method of anchoring as in experiment 1.

The trees will be tagged using numbered aluminum tree tags attached with a 20 cm diameter wire loop at the base of the trunk and their locations and elevations will be mapped using a total station. Initial basal diameter and height of each seedling will be measured immediately after planting. Diameter and height will be remeasured in fall 2010 to calculate diameter and height growth over the 2010 growing season. In spring 2010 and fall 2010, mortality will be assessed for each species as the number of trees that have died since planting. Levels of deer damage will be quantified in spring 2010 and fall 2010 by measuring the height and circumference of rubbed areas on the trunk and counting browsed shoots per tree.

In order to assess effectiveness of guards, generalized linear modeling will be used to test for differences in growth, mortality and deer damage between unguarded trees and trees with different guard heights, taking into account initial tree size and elevation as covariables. Growth, mortality and deer damage will also be tested among species and against proximity to cover and elevation. Statistical analyses will be performed using SAS version 9.1 (SAS Inc. 2004).

Time Line

Fall 2009: Complete the topographic survey of the Swan Lake restoration site and produce a complete contour map of the field. Choose and survey locations for the six new experimental seedling plots at the Swan Lake restoration site. Record levels of deer damage in seedling experiment 1. Measure growth of existing seedlings over the 2009 growing season. Plant RPM® seedlings in six new experimental plots during mid November. Enter data and perform data analysis on growth and survival of seedlings thus far.

Spring 2010: Record levels of deer damage in seedling experiments 1 and 2. Present preliminary results at Illinois State Academy of Sciences conference.

Summer 2010: Record observations on deer damage to in seedling experiments 1 and 2 at Swan Lake restoration site.

Fall 2010: Present paper at the Ecological Society of America annual conference. Measure diameters, heights and levels of deer damage for RPM® seedlings. Enter data and perform data analysis. Commence writing thesis.

Spring 2011: Complete writing of thesis. Defend in May 2011.

Budget Justification

Item	Quantity	Cost per Item	Total Cost
RPM® tree seedlings of pecan	90	$9.95	$895.50
RPM® tree seedlings of bur oak	90	$9.95	$895.50
RPM® tree seedlings of pin oak	90	$9.95	$895.50
RPM® tree seedlings of overcup oak	90	$9.95	$895.50
RPM® tree seedlings of swamp white oak	90	$9.95	$895.50
100 ft. roll of 3 ft. welded metal 2x4 in. mesh fencing	15	$67.00	$1,005.00
100 ft. roll of 4 ft. welded metal 2x4 in. mesh fencing	14	$85.00	$1,190.00
100 ft. roll of 5 ft. welded metal 2x4 in. mesh fencing	11	$108.00	$1,188.00
2"x6"x10' pressure treated pine for stakes	46	$7.00	$322.00
8" Double looped wire bar ties (1,000/bundle)	8	$9.50	$76.00
Spring loaded auto bar tie twister	2	$28.50	$57.00
Galvanized utility wire 16 ga (250 ft./pack)	40	$7.00	$280.00
Round aluminum tree tags 1-1/4" (1,000/box)	1	$113.00	$113.00
Mileage $0.55 per mile (91 miles round trip; 10 trips)	910	$0.55	$500.50
TOTAL			**$9,209.00**

This is the total budget for the project. A total of $1,999.42 has already been funded by a grant from the National Great Rivers Research and Education Center summer internship program to Drs. Peter Minchin and Richard Essner, which also paid me a stipend of $4,000 over summer 2009. The U.S. Army Corps of Engineers has agreed to assist by purchasing the tree seedlings needed for the fall 2009 plantings. The requested funds from this RGGS ($500.00) would pay mileage for use of my own vehicle to visit the field site in Calhoun County, a round trip of 91 miles from Edwardsville. Additional external research funds already secured by Dr. Minchin, would pay for the remaining project expenses.

References

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Battaglia, L.L., Prichett, D.W., and Minchin, P.R. 2008. Evaluating Dispersal Limitation in Passive Bottomland Forest Restoration. *Restoration Ecology* 16: 417-424.

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RESEARCH GRANTS FOR GRADUATE STUDENTS (RGGS)
BUDGET REQUEST

	Requested Amount	Department Recommendation
COMMODITIES *(Supplies, etc.):*		
1.		
2.		
3.		
4.		
5.		
Commodities Sub-Total:	$0.00	
TRAVEL:		
1. Mileage 910 miles @ 0.55/mile	$500.00	
2.		
3.		
4.		
Travel Sub-Total:	$500.00	
CONTRACTUAL SERVICES *(Postage, photocopying, etc.)*		
1.		
2.		
3.		
4.		
Contractual Services Sub-Total:	$0.00	
EQUIPMENT:		
Equipment Sub-Total:	$0.00	
TOTAL REQUEST:	$500.00	