

M.L. 2016, Chp. 186, Sec. 2, Subd. 08e

Project Abstract

For the Period Ending June 30, 2019

PROJECT TITLE: Controlling Reed Canary Grass to Regenerate Floodplain Forest

PROJECT MANAGER: Luis Ramirez

AFFILIATION: Audubon Minnesota

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FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: M.L. 2016, Chp. 186, Sec. 2, Subd. 08e

APPROPRIATION AMOUNT: \$ 218,000

AMOUNT SPENT: \$ 218,000

AMOUNT REMAINING: \$ 0

Sound bite of Project Outcomes and Results

Because of this work, we were able to identify best practices to control Reed Canary Grass in the floodplain forest. This information has been translated into a supporting decision tools that can be used by landowners and land managers.

Overall Project Outcome and Results

As a result of this work, the research team has identified that the most important considerations for long-term control of Reed Canary grass include:

- Treat Reed Canary Grass until it is controlled (this will take 2+ years)
- Controlling Reed Canary Grass before planting other species is key for survival
- Diversify site and plant as many species as practical
- Floods and site conditions may delay treatments and tree planting.

A decision making tool was developed to guide efforts to restore Reed Canary Grass to a native floodplain forest community. It includes guidance for treating the grass and restoring native species in both open field and forest gap settings. These recommendations are based on scientific field studies that tested a variety of approaches. Much of the research that forms the basis of these recommendations was conducted between July 2017-June 2019 at four sites in floodplain forest along tributaries of the Mississippi river between Red Wing, MN and the Iowa border (see case study from one site by Beebe 2019). These years were generally warm and wet experiencing longer duration and more frequent inundation than average conditions. Fall 2018 was warm and plants senesced late.

Project Results Use and Dissemination

The materials produced as part of the decision making tool to control Reed Canary Grass will be available electronically at the Audubon Minnesota webpage. Subsequently, computer files will be made available to state, federal and private land management agencies.



Environment and Natural Resources Trust Fund (ENRTF) M.L. 2016 Work Plan

Date of Report: 06/23/2021

Date of Next Status Update Report: June 30, 2019

Date of Work Plan Approval: 06/07/2016

Project Completion Date: 6/30/2019

Does this submission include an amendment request? yes

PROJECT TITLE: Controlling Reed Canary Grass to Regenerate Floodplain Forest

Project Manager: Luis Ramirez

Organization: Audubon Minnesota

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Location: Goodhue, Wabasha, Winona, Houston Counties

Total ENRTF Project Budget:

ENRTF Appropriation: \$218,000

Amount Spent:

\$216,071

Balance:

\$1,929

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 08e

Appropriation Language:

\$218,000 the second year is from the trust fund to the commissioner of natural resources for an agreement with the Minnesota state office of the National Audubon Society to determine the most effective regeneration methods for restoration of floodplain forests in southeast Minnesota impacted by invasive reed canary grass. This appropriation is available until June 30, 2019, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Controlling Reed Canary Grass to Regenerate Floodplain Forest

II. PROJECT STATEMENT: This project will help ensure the future of Mississippi River floodplain forests by developing the most effective methods for regenerating native trees in areas that are threatened by invasive reed canary grass. It will leverage Outdoor Heritage and private funding currently being used for reed canary grass control and tree planting within the floodplain. This project will evaluate different methods of reed canary grass control as well as different strategies for tree planting at sites within the Mississippi River floodplain with similar hydrological conditions and existing vegetation (primarily reed canary grass).

Floodplain forests protect water quality and provide critical habitat for wildlife. The Upper Mississippi River (Minneapolis to St. Louis) contains some of the most significant tracts of floodplain forest in the nation. However, the long-term existence of these forests is under threat from invasive reed canary grass, which aggressively out-competes tree seedlings.

Floodplain forests in the Upper Mississippi River are dominated by even-aged tree stands with low species diversity. It is expected that canopy trees will begin to die off in the next 50-70 years. Current knowledge suggests that as adult trees die they will be replaced by reed canary grass dominated wet meadows. Without active restoration, Minnesota may lose much of its floodplain forests, along with the many species of birds and other wildlife that depend upon these habitats for survival. This effort will greatly advance the science and understanding of reed canary control methods and tree survival within the Mississippi River floodplain, with direct application to Foresters and Wildlife Managers.

III. PROJECT STATUS UPDATES:

Amendment Request (08/10/2016)

Amendment request is needed to move travel budget items to Professional/Technical/Service Contracts. Travel costs will be incurred only by Univ. of MN and Univ. of WI – La Crosse students and will be reimbursed as part of the contracts with the Universities. As such, the Travel Budget category row is being removed and those travel costs are being added to the Professional/Technical/Service Contracts budget category. The amount of total travel going to University of MN increased from \$11,100 to \$15,000, and the proportion going to Univ. of WI – La Crosse decreased from \$11,200 to \$7,200 as a result of finalizing project sites and better estimates of overall travel needs. Total cost for travel did not change. Amendment Approved by LCCMR 8/30/2016.

Project Status as of December 31, 2016

The project is proceeding as planned with some minor changes due to extensive flooding during fall 2016. One of the project sites was relocated and reduced in size due to high water preventing site preparation work. The site decreased from 10 acres to 4 acres, and was relocated approximately ½ mile from the original site. With that change, all site preparation was completed at all of the study sites, including marking study plots, mulching plots, and applying herbicide following two different treatments. All sites are ready for tree planting during spring 2017. Pre-project surveys were completed to document existing vegetation prior to site preparation. The project is on schedule.

Project Status as of April 30, 2017

The project continues as planned. In mid-April, all of the bare root trees were planted at each of the four project sites (total of approximately 10,000 trees). Root Production Method (RPM) trees will be planted in late April and early May. In May and June, research staff and graduate students will begin measuring tree survival and growth, natural regeneration, and reed canary grass recurrence.

Project Status as of October 31, 2017

The project continues as planned. All bare root and RPM trees have been planted at all sites and study treatment plots. Research staff, graduate students, and a summer intern measured tree survival for both bare roots and RPM's, tree growth, deer browse impacts by tree species, and vegetation species and abundance within the study plots.

Amendment Request (05/29/2018)

Amendment request is needed to move a portion of the budget in Professional/Technical/Service Contract to University of Wisconsin-La Crosse for Activity 1 from Travel into Supplies and Equipment. Travel costs for UWL personnel have been less than anticipated, so we request to move \$4300 out of the UWL contract and into the Supplies budget. A portion of the additional supplies funding will be used to buy replacement field cameras for daily monitoring of water levels within experimental plots. Currently, cameras belonging to Dr. Thomsen at UWL are being used for this purpose, but they will be needed for another project this summer, so we need to purchase new cameras for this project.

Amendment Approved by LCCMR 6/28/2018

Project Status as of May 31, 2018

We decided to delay the direct seeding until Fall 2018, due to wet conditions during the fall, which made it impossible to prep the sites for seeding.

Due to unusual growing season conditions in fall 2017, we were unable to apply herbicide as planned. Instead, we plan to use the grass-specific herbicide Intensity in all treated plots, to provide some growing-season control of RCG. Treatments will occur in late May or early June, 2018 to maximize effectiveness. Furthermore, we plan to spot-spray several patches of Canada thistle with Transline in July. Finally, we plan to do Rodeo and Oust applications in Fall 2018.

All data for the 2017 growing season has been entered and preliminary analyses have been conducted. The graduate students presented at several conferences and meetings with land managers during the fall and winter, getting feedback about our first year results.

In January 2018, project graduate student Bill Kiser was offered a permanent, full-time position with the Fish and Wildlife Service. He will still, however, complete his MS thesis using project data in fall 2018. The salary remaining in the UWL subcontract will be used to provide salary for two part-time graduate student research assistants, who will assist with project sampling (Activity 1) and contribute to the development of the decision support tool (Activity 2). This does not change the budget, match, or outcomes of the project.

Project Status as of October 31, 2018

The final stage of tree maintenance is scheduled for the first week in November, 2018. The study sites will be treated with herbicide(s) to control reed canary grass. The research team has also been working to compile collected data from the projects two growing seasons. This data has begun to be used to create a decision support tool to assist land managers in determining the best possible methods for reforestation projects.

Project Status as of April 30, 2019

All data has been collected and currently been analyzed by researchers at the University of Minnesota and the University of Wisconsin-LaCrosse. Final analysis interpretations and decision support tools are under

development and expected to be available later this year. Intense flooding in the region may impact workloads and the logistics on other projects but we do not anticipate significant impact on this initiative.

Amendment request 04/30/2019

Amendment request is needed to change Nat Miller as project manager. Luis Ramirez has been hired as a Conservation Director for the Upper Mississippi River Flyway with the National Audubon Society and will supervise this project moving forward.

Overall Project Outcomes and Results: June 30, 2019

As a result of this work, the research team has identified that the most important considerations for long-term control of reed canary grass include.

- Treat reed canary grass until it is controlled (this will take 2+ years)
- Controlling reed canary grass before planting other species is key for survival
- Diversify your site and plant as many species as practical
- Floods and site conditions may delay treatments and tree planting.

A decision making tool was developed to guide efforts to restore reed canary grass to a native floodplain forest community. It includes guidance for treating the grass and restoring native species in both open field and forest gap settings. These recommendations are based on scientific field studies that tested a variety of approaches. Much of the research that forms the basis of these recommendations was conducted between July 2017-June 2019 at four sites in floodplain forest along tributaries of the Mississippi river between Red Wing, MN and the Iowa border (see case study from one site by Beebe 2019). These years were generally warm and wet experiencing longer duration and more frequent inundation than average conditions. Fall 2018 was warm and plants senesced late.

Amendment Request 06/23/2021

An amendment request is needed to reconcile the budget for the final report. The following changes should be made to Activity 1:

- Personnel and wages should be changed from \$46,800 to \$50,456
- The University of Minnesota contract should increase from \$104,400 to \$114,400
- The University of Wisconsin La Cross contract should decrease from \$51,100 to \$35,392
- Supplies should be increased from \$4,300 to \$6,352

Amendment approved by LCCMR 7/16/21

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Determine the most effective methods to control reed canary grass and regenerate trees.

Description: Competition from reed canary grass is one of the primary factors limiting forest regeneration in the floodplain. We will test the efficacy of reed canary grass control methods and examine the impact on tree regeneration. We will document pre-treatment reed canary grass levels and then test the efficacy of reed canary grass control using glyphosate herbicide versus a combination treatment of site scarification plus the herbicide Oust. Treatments will be replicated eight times in large plots within each of four 10 acre sites. Our replication will allow us to examine efficacy of treatments across a range of elevations, soils, and light availability within and among sites. Reed canary grass percent cover, height, and flowering culm production will be monitored for two full growing seasons. Our results will provide crucial evidence about how fluctuating water levels and variable site conditions within the floodplain influence restoration success, improving our ability to develop site-level prescriptions for future projects.

We will evaluate natural regeneration and artificial regeneration in both reed canary grass (RCG) treatments. Focal species for artificial regeneration include: silver maple (*Acer saccharinum*), cottonwood (*Populus deltoides*), sandbar willow (*Salix interior*), swamp white oak (*Quercus bicolor*). Within each replicate plot at all sites we will directly seed ~1/5 of the plot in a continuous strip (~30x150 ft) (4 sites x 2 RCG treatments x 8 replicates = 64 strips) in fall 2017 and spring 2018. In addition, we will plant our focal species as bare root and Root Production Method seedlings. Seedlings will be planted with 9 ft spacing in polycultures. We will monitor survival and growth (height, diameter) of planted juveniles. We will assess natural tree regeneration of these same species by monitoring abundance and growth of naturally established seedlings in ten additional 3 ft square plots per replicate (4 sites x 2 RCG treatments x 7 replicates x 10 plots = 640 plots).

Summary Budget Information for Activity 1:

ENRTF Budget: \$206,600
Amount Spent: \$206,600
Balance: \$1,929

Activity Completion Date:

Outcome	Completion Date
1. Data set on the effectiveness of two alternate site treatment strategies for controlling reed canary grass	January 2019
2. Data set on the extent of natural tree regeneration following reed canary grass control	January 2019
3. Data set on tree establishment, survival and growth by regeneration method and species following reed canary grass control	January 2019
4. Final research report documenting the effectiveness of various reed canary control methods, natural regeneration, and tree establishment, survival and growth	June 2019

Project Status as of December 31, 2016

The project is proceeding as planned, with the exception of a change to one of the project sites due to extensive flooding during fall 2016. Fall 2016 was extremely wet and the Mississippi River was unusually high. During mid-late September all of the project sites were underwater. Flows dropped during October, and three of the four sites became dry enough to complete site preparation work. One site, Collischan Bottoms near Red Wing, remained too wet to get equipment in for site preparation. A decision was made by the study team to relocate that site approximately ½ mile from the original site to an area that was dominated by reed canary grass and dry enough to get equipment on site. That site, however, was slightly less than 5 acres in size, while all of the remaining study sites remained at 10 acres. The study team considered dropping this site, but felt it would be acceptable and scientifically valid to reduce the size of this one study site but ensure the same treatment ratio could be applied to study plots. Consequently, this study site was reduced to 4.5 acres and 9 study plots.

With that change, all site preparation was completed at all of the study sites by early November. Plots were marked with color-coded PVC pipe in late summer (Collischan site was marked later), glyphosate herbicide was applied to appropriate study plots in October, a forestry mulcher was used to disturb soil at appropriate study plots in late October and early November, and the herbicide OUST was applied to mulched plots in mid-November. All sites are ready for tree planting during spring 2017. In addition, pre-project surveys were completed to document existing vegetation prior to site preparation. The project is on schedule.

Project Status as of April 30, 2017

Bare root trees of four species were planted at each study site in mid-late April 2017. Trees were hand planted by Conservation Corps MN with oversight and supervision by Audubon MN, University of MN, and University of WI – La Crosse staff. All rows were flagged prior to planting to provide a consistent pattern between study plots. Weather was wet and cool which is excellent for tree planting. Site conditions were good at most

locations, however, there were some study plots that were too wet to plant all of the trees designated for the plot.

RPM (large potted) trees will be planted the last week in April and first week in May 2017 at all of the study sites. Graduate students and assistants will begin monitoring natural regeneration, tree growth and survival, and recurrence of reed canary grass. A student intern position is posted by the University of MN and will be filled to assist with summer field work. The project remains on schedule.

Project Status as of October 31, 2017

All trees have been planted as proposed and all plots monitored for tree survival and growth, deer browse, and existing vegetation. RPM trees were also staked and protected from voles using tree tubes.

Bare root survival overall was pretty similar across all sites (88-90%), except at Root River, which had 80% survivorship. Bare root species either did better in glyphosate (Rodeo) plots, or had the same survivorship in both Rodeo and Oust plots. Cottonwoods had 86% survivorship in Rodeo, and 74% in Oust. Silver maple had 93% survivorship in Rodeo and 89% in Oust. Hackberry survivorship was 82% in Rodeo, and 80% in Oust. Swamp white oak had 96% survivorship in both treatments.

Cottonwoods and hackberry were the least likely to survive, with 80% and 81% overall survivorship respectively. Cottonwoods had the greatest survival (90%) at Collischan, and the lowest at Root River (66%). Hackberry's greatest mortality was at Root River and Whalen (74% and 76% survivorship), and their survivorship is greatest at Whitewater (92%). Silver maple had similar survivorship proportions at each site, and are at 91% survivorship overall. Swamp white oak are our number one survivors, at 96% overall. The oaks were 100% alive at Collischan, and they performed the poorest at Root River with 89% survivorship.

On average, across sites the proportion of RPMs alive was slightly greater in Rodeo plots. Cottonwoods had 4% greater survival, swamp white oaks, 5% greater, and silver maple 1%. For sites, Root River had the greatest survivorship, at 99%. Second place goes to Collischan at 93%, third to Whalen at 91%, and last place to Whitewater with 68%. Cottonwoods were the mostly likely to die, especially at Whitewater where only 23% are still alive. For comparison, 94% of silver maple are alive, and 87% of swamp white oak are alive at Whitewater. Silver maple were the most likely to still be alive, with overall 97% survivorship.

Deer browse in both RPMs and bare roots is concentrated on cottonwoods and silver maple. The amount of browsing seems strongly impacted by which site the tree is at, and more weakly related to treatment. The greatest herbivory occurred at Whitewater, Root River and Whalen each experienced moderate herbivory, and Collischan experienced the least herbivory.

Browse on bare roots doesn't seem to differ significantly by treatment, and they seem to be similarly browsed at each site. Deer prefer cottonwood and silver maple bare roots over swamp white oak and hackberry. Browse effects on RPMs from RCG treatment weak, but there were different patterns depending on site. At Whitewater the vast majority of RPMs were rated at 3, the most severe rating, even the swamp white oak, which the deer seem to not prefer at other sites.

Effects of herbicide treatment were also measured. Preliminary results indicate: 1) the number of reed canarygrass flowering culms are much less in experimental plots than controls; 2) species richness and percent cover of non-RCG plants are greater in experimental plots than control plots; 3) RCG height in experimental plots is less than in control plots; and (4) RCG litter depth in experimental plots is less than in control plots.

During late October or early November 2017 after leaf-off, plots will be treated with herbicide similar to fall 2016. During November 2017, swamp white oak and hackberry will be direct seeded in strips within each study

plot. During spring 2018, silver maple will be direct seeded within the same strips. Data similar to what was collected during summer/fall 2017 will be collected during summer/fall 2018.

The study is on track to be completed as scheduled.

Project Status as of May 31, 2018

We decided to delay the direct seeding until Fall 2018, due to wet conditions during the fall, which made it impossible to prep the sites for seeding.

Due to unusual growing season conditions in fall 2017, we were unable to apply herbicide as planned. Instead, we plan to use the grass-specific herbicide Intensity in all treated plots, to provide some growing-season control of RCG. Treatments will occur in late May or early June, 2018 to maximize effectiveness. Furthermore, we plan to spot-spray several patches of Canada thistle with Transline in July. Finally, we plan to do Rodeo and Oust applications in Fall 2018.

All data for the 2017 growing season has been entered and preliminary analyses have been conducted, some of which we described in the October 2017 update (see above).

Although we have changed the timing on several elements, the study is on track to be completed as scheduled.

Project Status as of October 31, 2018

We have completed the second growing season of data collection on the project. We have documented a substantial rebound in RCG cover in our sites. We attribute this result to our inability to treat sites with herbicide in Fall 2017, and to the failure of several additional planned herbicide applications. However, we anticipate successful herbicide applications this fall.

Despite strong regrowth by RCG, tree survival ranges from 6-49% across our four sites for bare root stock, and from 25-73% across sites for larger planted trees (RPMs). The low survival of some stock types in some sites is a disappointment from one perspective. However, from another it is an excellent opportunity to gain insights about what drove the differences in tree survival across sites, which will in turn allow us to make recommendations to managers about what approaches will work best in different settings.

Both of the graduate students supported by the grant are currently analyzing their data and writing results up as MS theses, which will provide the starting point for peer-reviewed publications based on the project. We anticipate their graduation in December 2018 or May 2019.

Project Status as of April 30, 2019

All data has been collected and processed. At least one thesis will be submitted for publication this summer. In order to secure a stronger data set University of Minnesota staff will conduct a 3rd survey on August of 2019. Shortly after, a second scientific article will be developed and submitted for publication in 2020.

Final Report Summary: June 30, 2019

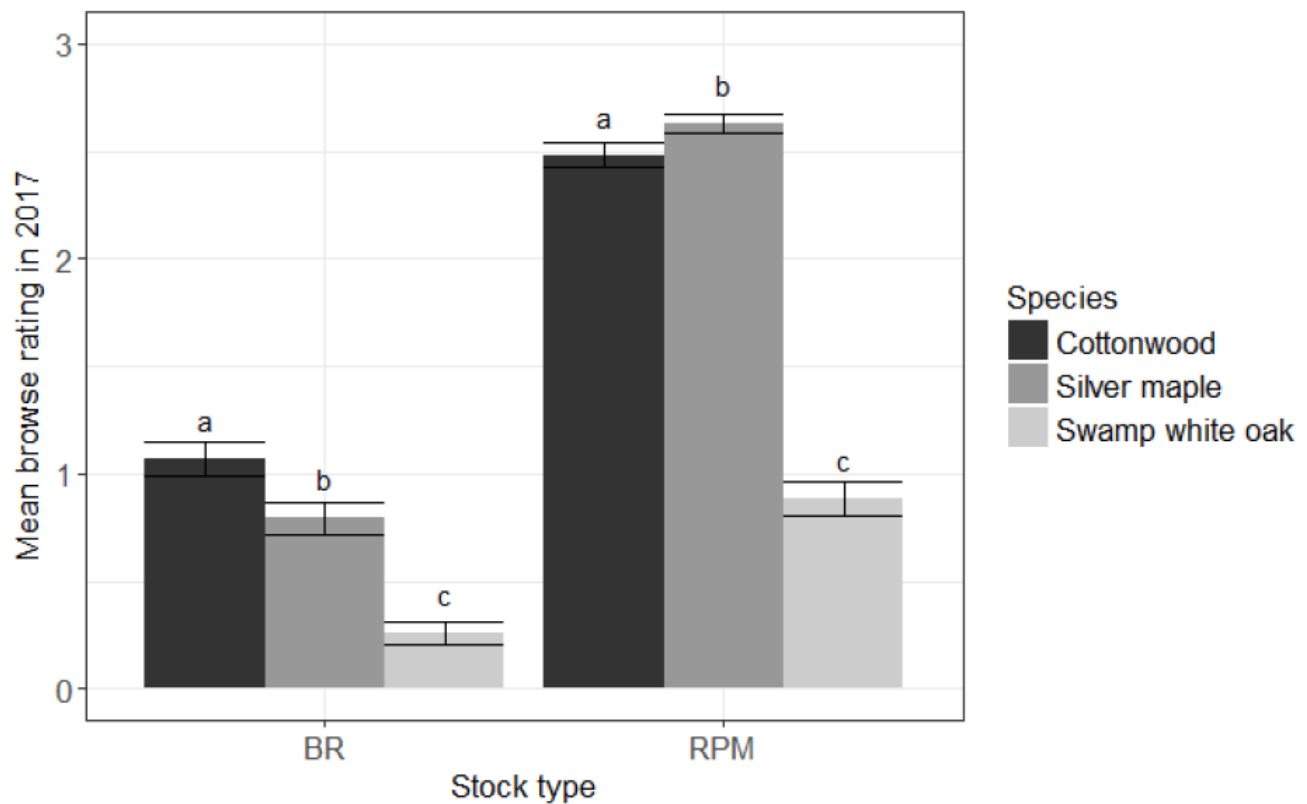
Tree survivorship across plots is as follows:

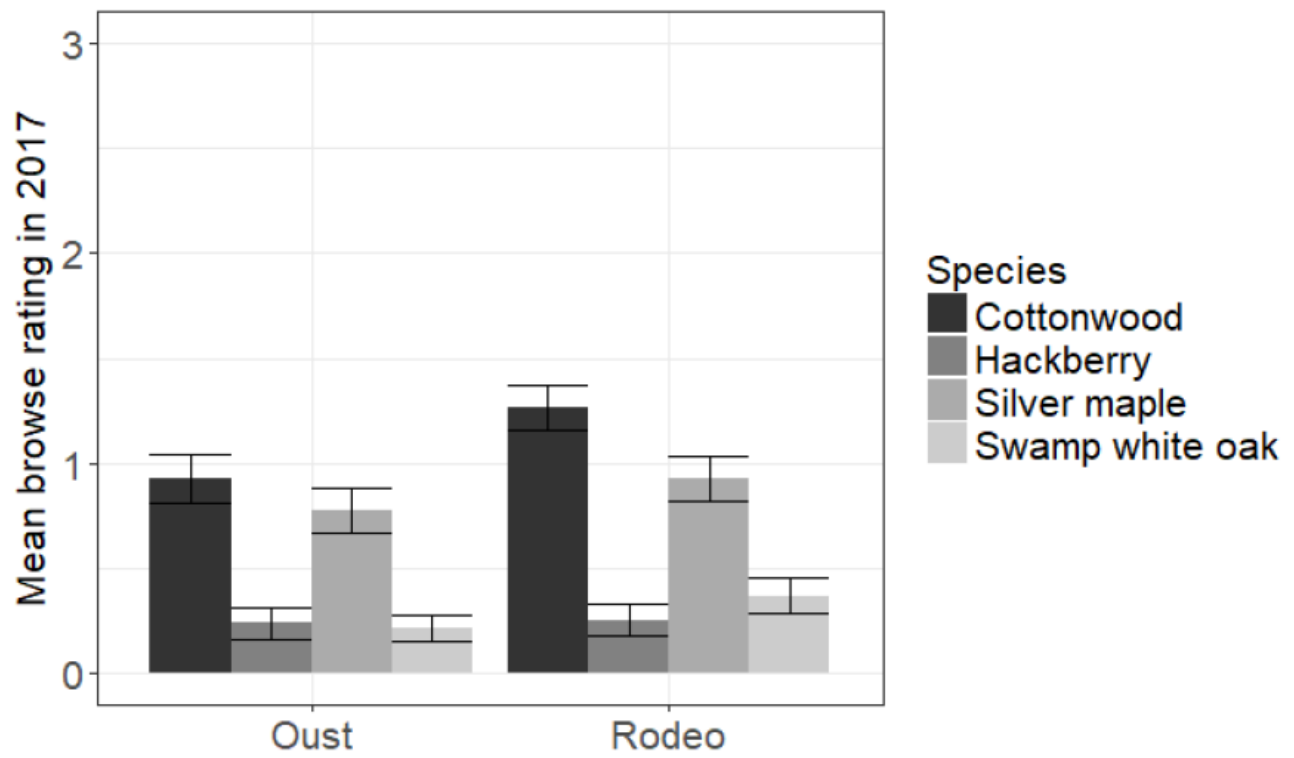
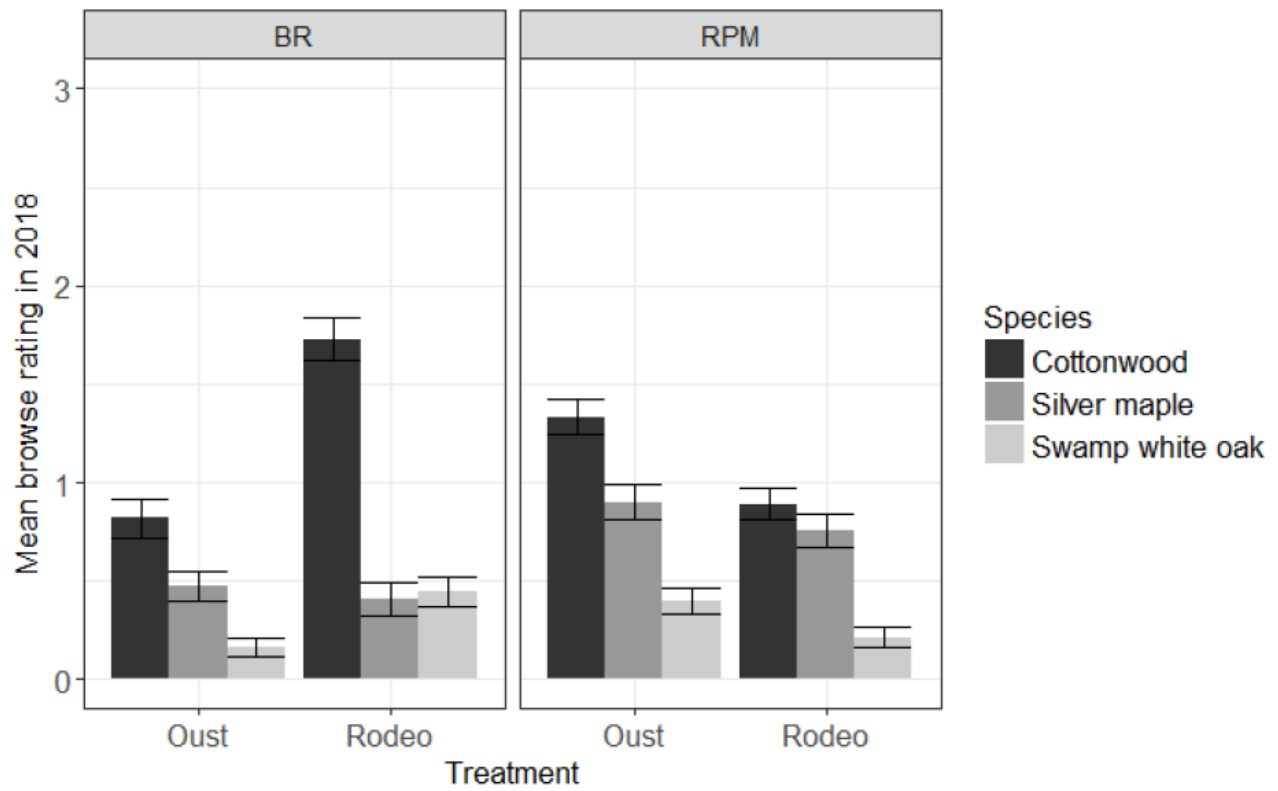
RPM Tree Survivorship		Bare Root Tree Survivorship	
Cottonwood	26.70%	Cottonwood	6.70%

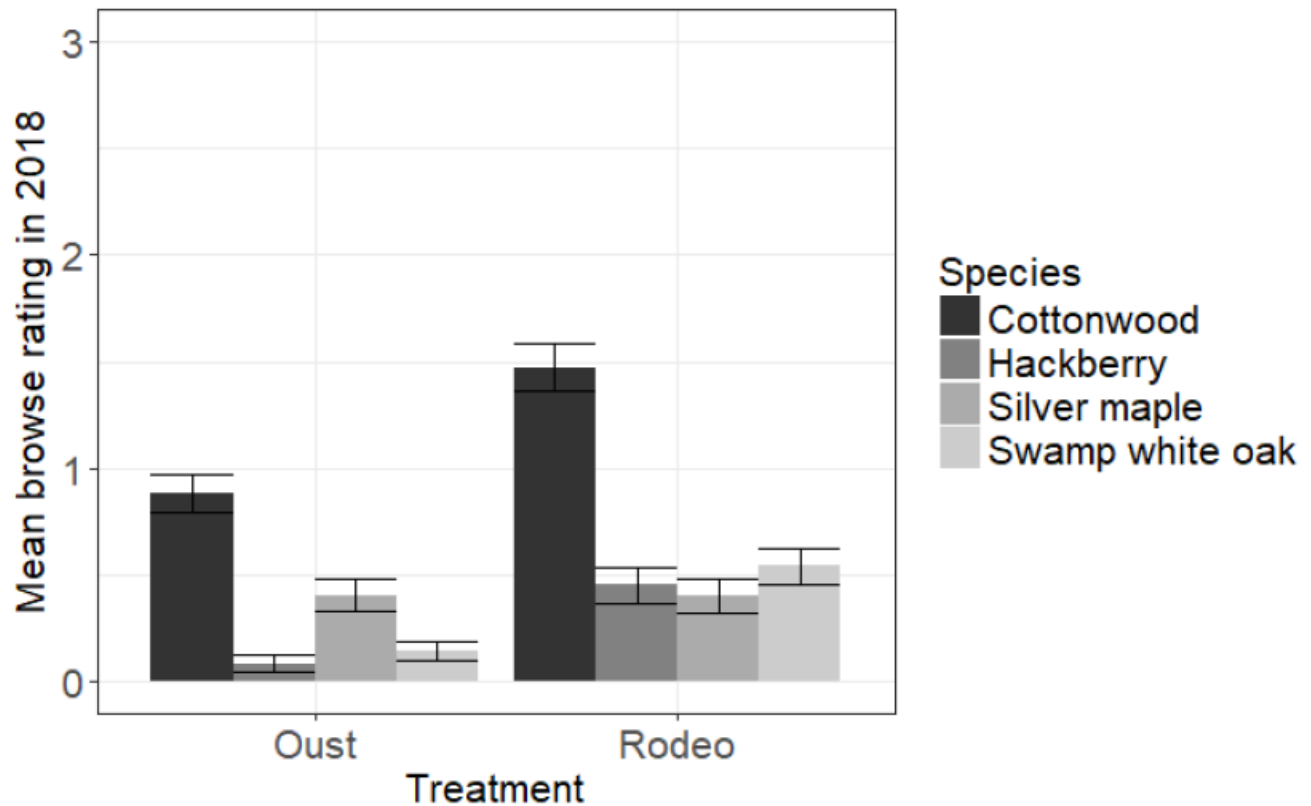
Silver Maple	58%
Swamp Oak	65.60%

Silver Maple	36.90%
Swamp Oak	26.20%
Hackberry	21.10%

Deer browse was assessed based on a scale of severity assigning a numerical value of 1-3 with increasing value corresponding to increased browse. Deer browse assessments were found to be most useful when including the interaction between species and treatment. Cottonwood had the greatest browse across treatments while silver maple was browsed only slightly less. Hackberry and swamp oak both had very low browse ratings across treatments. Final browse data for both years of project surveys are as follows:







Tree heights were assessed both years across stock types. No species mean height was significantly different any other species in a pairwise test. Bare root cottonwood grew the most averaging an increase of .4 m followed by RPM cottonwoods at .12 m. Silver maple RPMs and bare roots had the same average height growth at .1 m. Swamp oak RPMs grew an average of .12 m while bare roots grew .01m. Hackberry bare roots increased in height an average of .063 m.

For un-snapped trees from both stock types, there were two competing models for diameter; one with only stock type and another with interactions of the two treatments and stock types. Both included initial diameter. Overall RPMs had the greater average diameter compared to bare roots. Examining each stock type separately we found diameters for RPMs in the oust plots were significantly and greater than RPMs in the Rodeo plots (mean DBH of 1.26 cm and 1.22 cm respectively). The inverse was true for bare roots with diameters in Rodeo plots averaging .56 cm and .47 cm in Oust treatments. Change in diameter was greatest for RPMs with Rodeo plots experiencing a gain of .252 cm and Oust plots gaining .199 cm. Change in diameter was small for bare root stock in both treatment regimes, averaging .08 in Rodeo and .04 cm in Oust.

Reed canary grass performance was assessed across treatment sites. In 2017 significant differences in reed canary growth were noted between the month of survey and the treatment as well as when comparing the month of survey, site location and the treatment. In June of 2017 mean reed canary height was between two and 5 times taller in control plots compared to treatment plots. Reed canary grass height was similar in Rodeo and Oust plots with the exception of Oust having greater growth at a single site in July and another site in August. Reed canary grass heights increased in July and August within treatment plots as compared to control plots due to the grass re-growing from seed after control treatments, however significant overall differences in height still occurred between treatments and controls.

In May of 2018 there were no significant differences in in the height of reed canary grass height between control and treatment plots, with the exception of reed canary grass heights being taller in Rodeo Plots at one site as

compared to control sites. Height among plot types remained the same throughout the 2018 growing season with the exception of 1 site where reed canary was 20 cm taller in Rodeo plots compared to controls while reed canary grass was 20-30 cm shorter in Oust plots. The following graphs detail over all height performance:

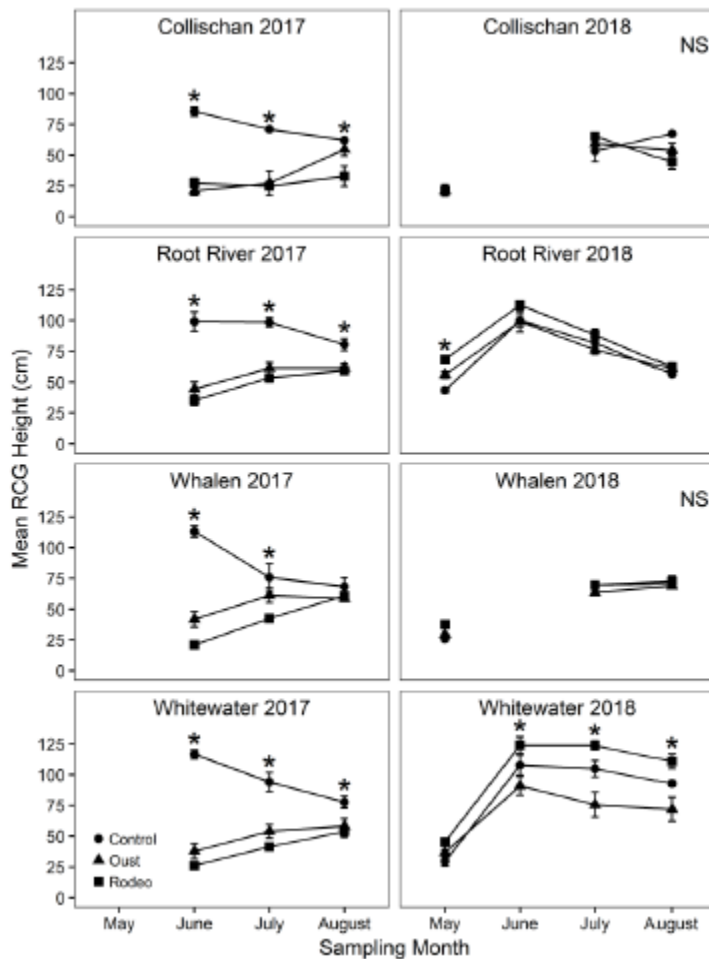


Figure 3. Mean reed canarygrass height by month and treatment at each site. Asterisks indicate within-month pair-wise significant difference ($P < 0.05$) among treatment types; sites with no significant difference among treatment types are indicated with 'NS.' Missing values for Collischan and Whalen in 2018 are due to flooding.

Reed canary grass flowering culm production in 2017 was between .6% and 25% that of control plots across all sites. Flowering culm production in Rodeo plots was 10% that of oust plots with the exception of 1 site which had nearly 0% flowering culms across treatments. In 2018 we were unable to survey multiple site locations due to flooding. Culm production at sites that could be accessed varied greatly between sites. Plots treated with Rodeo showed the greatest amounts of flowering culms.

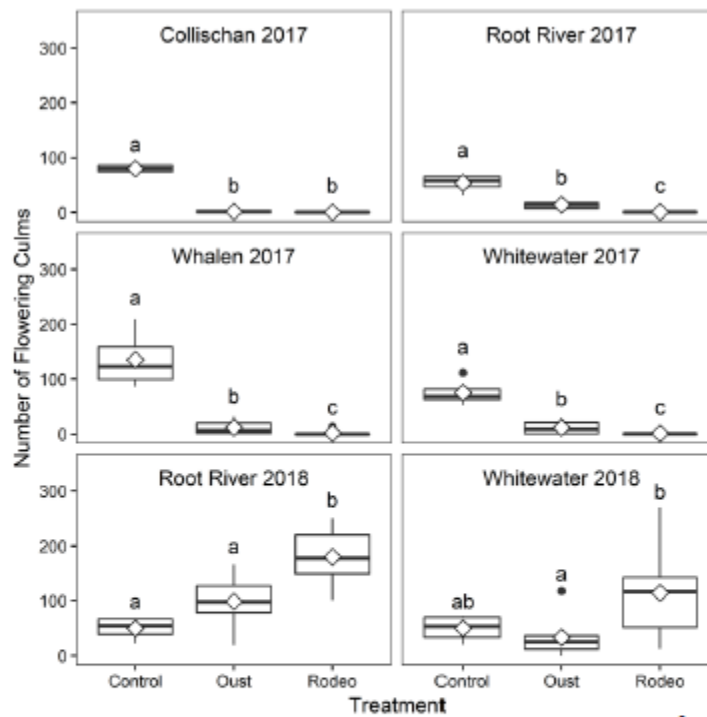


Figure 4. Boxplots of reed canarygrass flowering culm production per m^2 among treatments at each site. Boxes indicate interquartile range, whiskers indicate range of data occurring within 1.5-times the interquartile range, points outside of whiskers are considered outliers, horizontal lines within boxes indicate median, diamonds indicate mean, and letters above boxes indicate within-site post-hoc test statistical groups ($P < 0.05$). Flowering culms were counted within five 1-m^2 quadrats per plot and then averaged. We were unable to count flowering culms at Collischan and Whalen in 2018 due to flooding.

Reed canary grass percent cover increased throughout the growing season across treatment plots while holding near to 100% across controls.

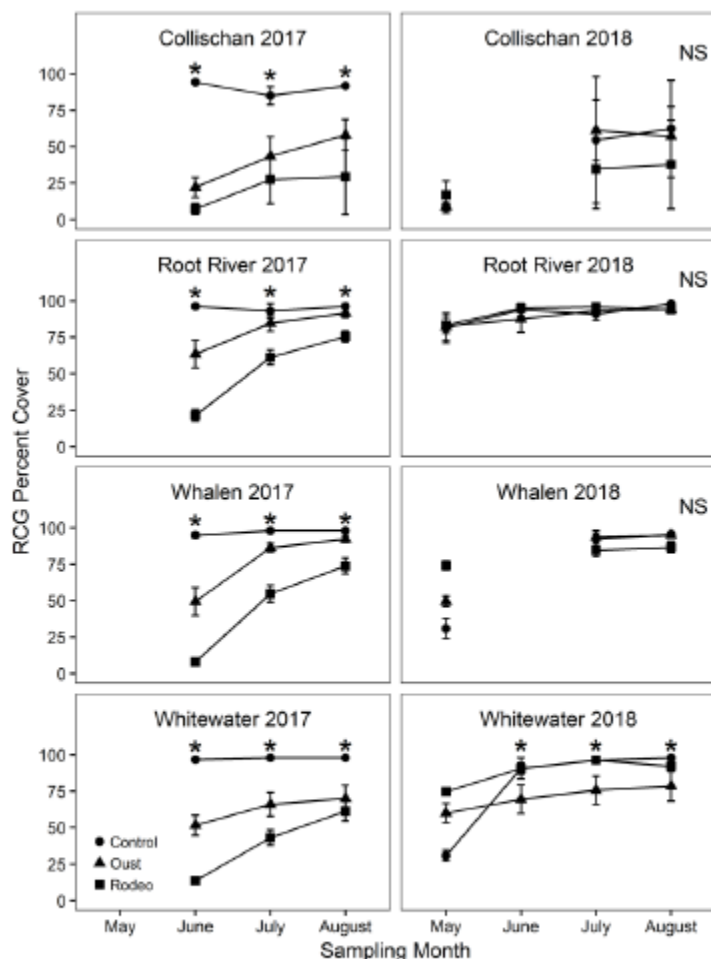


Figure 5. Mean reed canarygrass percent cover by month and treatment at each site. Asterisks indicate within-month pair-wise significant difference ($P < 0.05$) among treatment types; sites with no significant difference among treatment types are indicated with 'NS.' Missing values for Collischan and Whalen in 2018 are due to flooding.

In 2017 there were no significant differences in leaf litter levels between treatments aside from 1 site where Rodeo plots had a 10% lower value. In June leaf litter in Oust plots was significantly lower than Rodeo or control plots with great variability between sites. By comparison litter depths in Oust plots were approximately 56%-78% lower than that of Rodeo plots in June. By the seasons end litter depths were not significantly different across treatments.

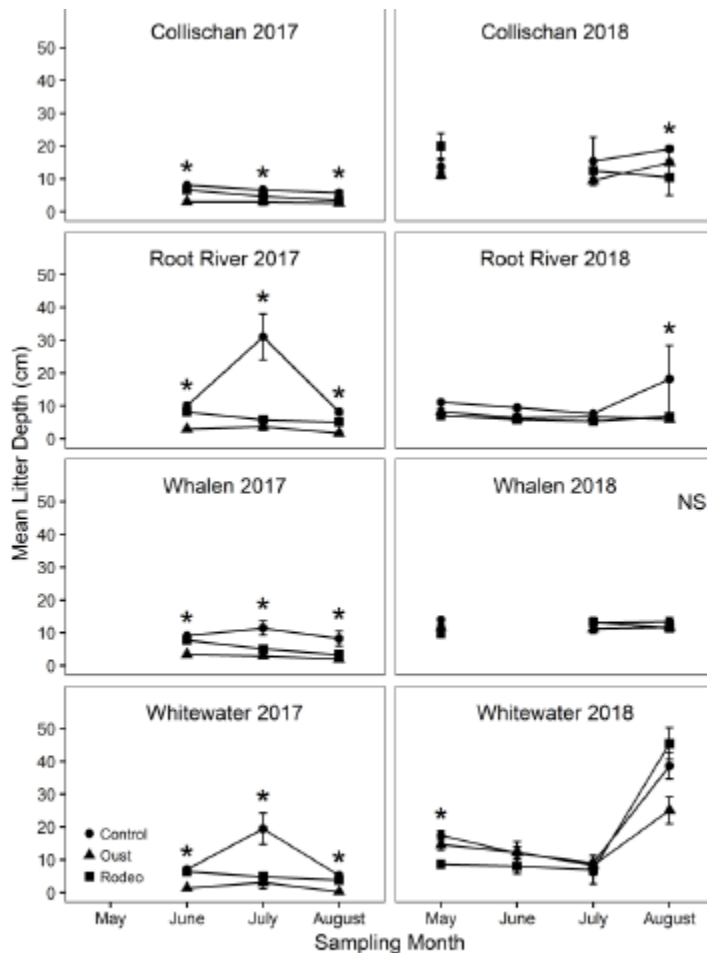


Figure 7. Mean litter depth by month and treatment at each site. Asterisks indicate within month pair wise significant difference ($P < 0.05$) among treatment types; sites with no significant difference among treatment types are indicated with 'NS.' Missing values for Collischan and Whalen in 2018 are due to flooding.

Volunteer plants were represented by 26 families and 55 species. A total of 87 volunteer tree species were found across plots (boxelder, green ash, cottonwood, hackberry and willow species). In 2017 non reed canary grass species richness in control plots was low with a maximum of 2 species per plot. Oust and Rodeo plots generally contained significantly more non reed canary grass species and generally did not vary significantly between sites.

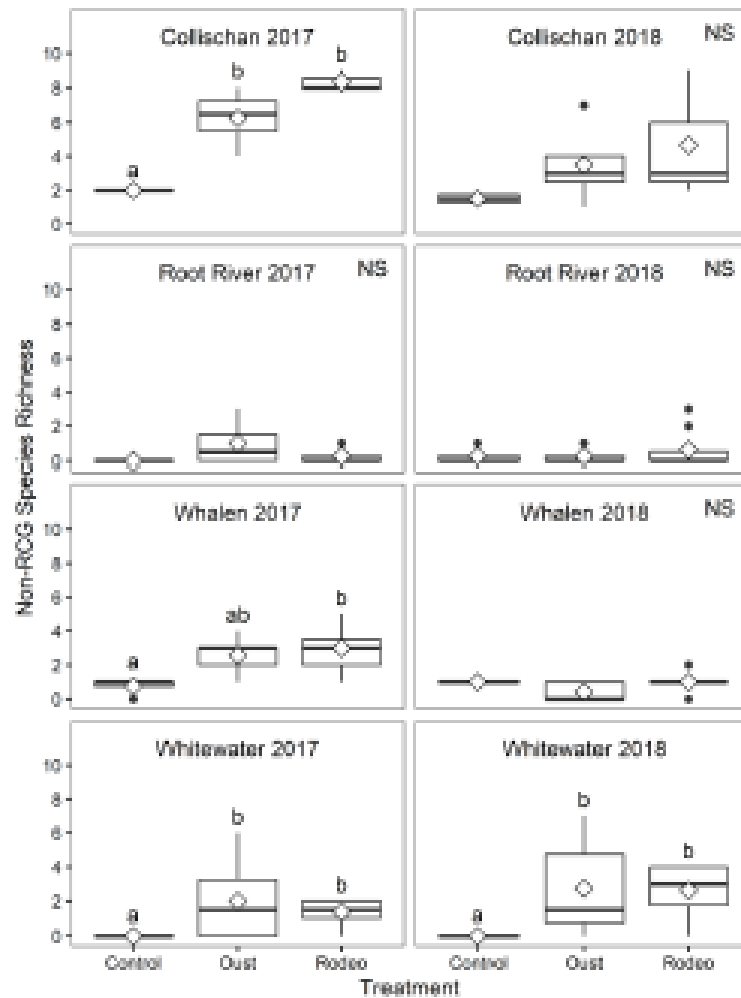


Figure 8. Boxplots of non-RCG species richness among treatments at each site. Boxes indicate interquartile range, whiskers indicate range of data occurring within 1.5-times the interquartile range, points outside of whiskers are considered outliers, horizontal lines within boxes indicate median, diamonds indicate mean, and letters above boxes indicate within-site post-hoc test statistical groups ($P < 0.05$). Species richness data were collected in August 2017 and 2018.

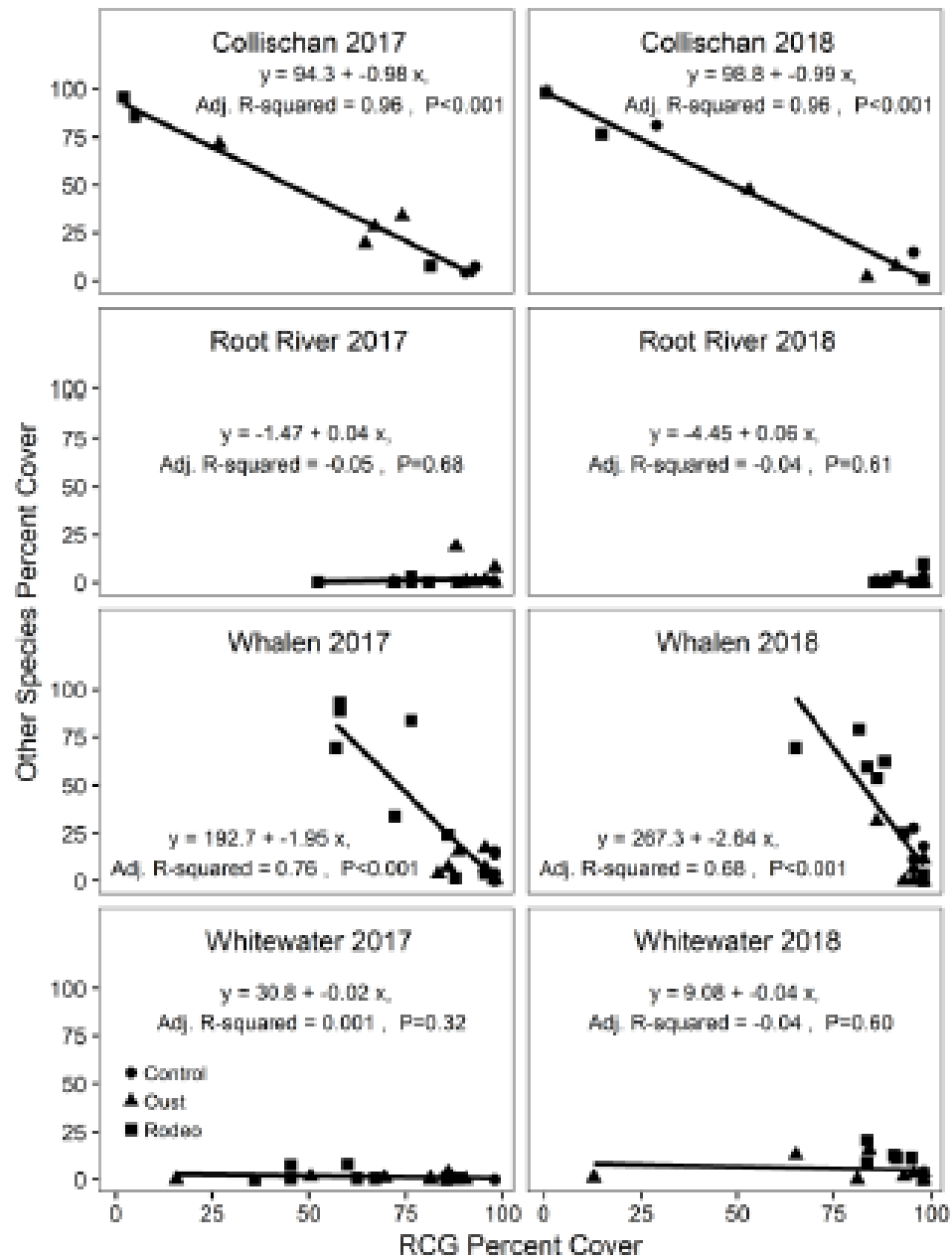


Figure 9. Regression analysis of Other species percent cover (y-axis) versus RCG percent cover (x-axis) by site and year. Only August percent cover data were considered for this analysis.

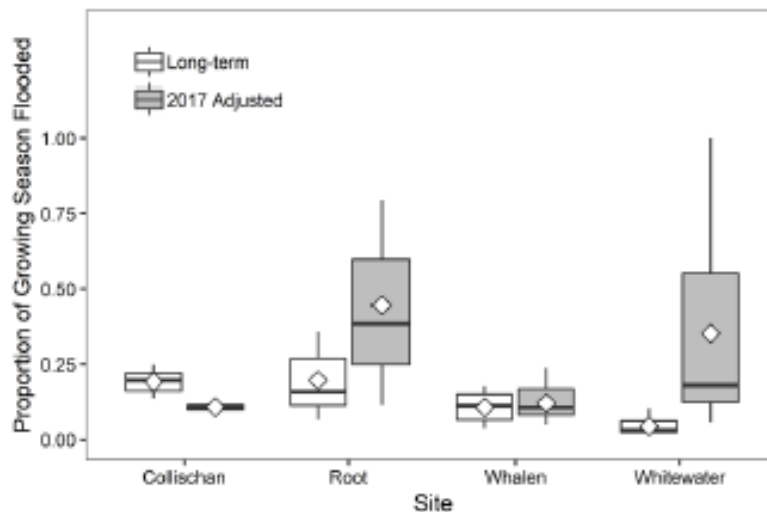


Figure 10. Boxplots of growing season 2017 adjusted flood and long-term (≥ 6 years, 2004 – 2017) flood data by site. Boxes indicate interquartile range, whiskers indicate range of data occurring within 1.5-times the interquartile range, points outside of whiskers are considered outliers, horizontal lines within boxes indicate median, and diamonds indicate mean. Growing season flooding for each plot was estimated by linear interpolation of Mississippi River (Collischan and Whalen), Whitewater River (Whitewater site), and Root River (Root River site) river gauge data and digital elevation model data. 2017 flooding was calculated using April 1 – July 31, 2017 gauge data.

ACTIVITY 2: Provide foresters and wildlife managers with information on the most effective methods to control reed canary grass and regenerate trees.

Description: We will use results from Activity 1 as well as data gathered from other sources to develop a decision support tool (likely online) to inform preparation of site-level management prescriptions using the most effective methods for regenerating forest given site conditions and financial resources. Users would input data on variables identified as important in this study, as well as operational constraints such as funding. Based on the combination of factors, the tool will recommend particular species, planting techniques and RCG control techniques that would lead to highest survival and best growth of a new cohort of trees. We would also contribute results of our project as a case study in the North Central Region Bottomland Hardwood Management Guide (http://www.ncrs.fs.fed.us/fmg/nfmg/bl_hardwood/index.html).

Summary Budget Information for Activity 2:

ENRTF Budget: \$ 11,400
Amount Spent: \$ 11,400
Balance: \$ 0

Activity Completion Date:

Outcome	Completion Date
1. Decision support tool that documents the most effective methods for controlling reed canary grass and regenerating floodplain forest for writing site-level prescriptions.	January 2019
2. Decision support tool is distributed to professional foresters and wildlife managers	June 2019

Project Status as of December 31, 2016

There has been no action on Activity 2. This will be completed during the later stages of the study.

Project Status as of April 30, 2017

There has been no action on Activity 2. This will be completed during the later stages of the study.

Project Status as of October 31, 2017

There has been no action on Activity 2. This will be completed during the later stages of the study.

Project Status as of May 31, 2018

The research group will meet to discuss initial steps for Activity 2 during summer 2018.

Project Status as of October 31, 2018

The research group met in September 2018 to start developing the decision tool we will produce based on the results of our experiment. We have begun developing a question-driven form, which would provide landowners information about management options, based on the type of site they are working in, species composition, their budget, and other considerations. Another meeting is scheduled for November.

Project Status as of April 30, 2019

The research group was able to make some additional progress in developing the decision making tool. Next steps have been identified and responsibilities assigned in order to have a final product by the end of the cycle.

Final Report Summary: June 30, 2019

Multiple Graduate Thesis papers were developed as a result of the project and can be found at the following links:

- 1) <http://hdl.handle.net/11299/202900>

DeLaundreau, Maria. (2019). Controlling Reed Canary Grass (*Phalaris Arundinacea*) And Restoring Floodplain Forest In The Upper Mississippi River Valley. Retrieved from the University of Minnesota Digital Conservancy, <http://hdl.handle.net/11299/202900>.

- 2) <http://digital.library.wisc.edu/1793/79361>

Kiser, William (2019) Suppression of Reed Canary Grass for Large-Scale Floodplain Forest Restoration Across Four Sites In South East Minnesota, USA. Retrieved from the University of Minnesota Digital Library, <http://digital.library.wisc.edu/1793/79361>

The materials produced as part of the decision making tool to control Reed Canary Grass will be available electronically at the Audubon Minnesota webpage. Subsequently, computer files will be made available to state, federal and private land management agencies.

A silvicultural case study has been added to the University of Minnesota's Great Lakes Silvicultural Library and can be accessed at the following URL:

<https://silvlib.cfans.umn.edu/content/reforesting-sites-dominated-reed-canary-grass-phalaris-arundinacea-usfws>

Beebe, A. 2019. Reforesting Sites Dominated by Reed Canary Grass, *Phalaris arundinacea* (USFWS). Great Lakes Silviculture Library. University of Minnesota. Cloquet, MN.

V. DISSEMINATION:

Description: Project results and reports will be disseminated through a wide variety of outlets. As described in Activity 2 above, a decision support tool will be distributed to professional foresters, wildlife managers, and other professionals. This tool, including background and instructions, will likely be web-based with access information provided through professional societies, universities, state and federal agencies, conservation non-profits, and other applicable organizations.

Applicable scientific research reports will be submitted to professional journals for publication.

Results will also be presented via formal presentations to professional societies, at conferences, and to interested conservation and forestry related groups. News releases and other “highlights” will be provided to conservation media outlets.

Project Status as of December 31, 2016

There has been no dissemination of information. This will be completed at the end of the study.

Project Status as of April 30, 2017

There has been no media coverage of the project to date. Audubon MN is developing a webpage link to information on this and other projects involving ENRTF and OHF sources. Formal dissemination of research study results will occur at the completion of the study.

Project Status as of October 31, 2017

There was significant media coverage of the project in May when the RPM trees were planted. This coverage included WI public radio, and several news media outlets in La Crosse, WI. Audubon has developed a webpage that provided more information on this and other projects: <http://mn.audubon.org/water-birds-and-people/lccmr-study-sites>

Project Status as of May 31, 2018

Both graduate students presented about the project at a meeting of Mississippi River researchers in January, 2018 and at the Wisconsin Wetlands Association Wetland Science Conference in February, 2018.

Student William Kiser presented his research at the Driftless Symposium hosted by Trout Unlimited and at the Upper Midwest Environmental Science Center in February, 2018. He also presented about the project at the Mississippi River Research Consortium meeting in April 2018.

PI Meredith Thomsen also presented at the Mississippi River Research Consortium meeting in April 2018.

Project Status as of October 31, 2018

As the decision support tool has begun development, there has been a series of meetings for direct engagement with landowners. These will continue and expand to a boarder audience once the tool is more fully complete.

Project Status as of April 30, 2019

One publication will be submitted this summer and a second on 2020. Discussions have been established to explore the possibility of posting the outcomes of this project on the University of Minnesota silviculture site.

Final Report Summary: June 30, 2019

Multiple graduate students have reported the study findings in various professional workshops and meetings. Findings from the study will be utilized in upcoming management with the Whitewater WMA (MN DNR).

Multiple Graduate Thesis papers were developed as a result of the project and can be found at the following links:

- 3) <http://hdl.handle.net/11299/202900>

DeLaundreau, Maria. (2019). Controlling Reed Canarygrass (*Phalaris Arundinacea*) And Restoring Floodplain Forest In The Upper Mississippi River Valley. Retrieved from the University of Minnesota Digital Conservancy, <http://hdl.handle.net/11299/202900>.

- 4) <http://digital.library.wisc.edu/1793/79361>

Kiser, William (2019) Suppression of Reed Canary Grass for Large-Scale Floodplain Forest Restoration Across Four Sites In South East Minnesota, USA. Retrieved from the University of Minnesota Digital Library, <http://digital.library.wisc.edu/1793/79361>

The materials produced as part of the decision making tool to control Reed Canary Grass will be available electronically at the Audubon Minnesota webpage. Subsequently, computer files will be made available to state, federal and private land management agencies.

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Beebe, A. 2019. Reforesting Sites Dominated by Reed Canary Grass, *Phalaris arundinacea* (USFWS). Great Lakes Silviculture Library. University of Minnesota. Cloquet, MN.

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview: See attached budget spreadsheet

Explanation of Use of Classified Staff: N/A – we are not a state agency.

Explanation of Capital Expenditures Greater Than \$5,000: N/A

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 0.69

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: 3.0 (two 50% FTE's funded for 2.5 years each, and one undergraduate research intern for 3 months each of two years)

B. Other Funds:

Source of Funds	\$ Amount Proposed	\$ Amount Spent	Use of Other Funds
Non-state			
University of Wisconsin La Crosse – waiver of overhead charges for graduate student and faculty in-kind contributions	\$16,500	\$24,666	Waiving overhead charges of \$9,000 for graduate student benefits (\$3,600/year for 2.5 years) and \$7,500 in indirect contributions from faculty (\$2,500/year for 3 years).
US Fish and Wildlife Service	\$50,000	\$20,000	Will contribute 30% of University of WI – La Crosse graduate student salary to research study
State			
Outdoor Heritage funding, cash	\$30,000	\$48,249	\$30,000 in Outdoor Heritage Funding will be used to implement floodplain forest restoration projects at research study sites. This is part of a \$300,000 appropriation for floodplain forest restoration along the Mississippi River beginning in July 2014 and ending June 30, 2017
Outdoor Heritage funding, cash	\$50,000	\$2,896	\$50,000 in Outdoor Heritage Funding will be used to implement floodplain forest enhancement projects at research study sites. This is part of a \$412,000 appropriation being recommended by LSOHC for funding beginning in July 2016
University of Minnesota , in-kind	\$65,000	\$22,750	Indirect contributions from faculty (2% time for 3 years, 66% salary and 44% fringe) and unrecovered indirect costs at 52% of direct cost base \$107,700.
TOTAL OTHER FUNDS:	\$211,500	\$118,561	

VII. PROJECT STRATEGY:

A. Project Partners: This project is a collaborative effort between Audubon Minnesota, the University of Minnesota, and the University of Wisconsin La Crosse. Primary team members include: Andy Beebe, Sue Swanson, and Tim Schlagenhaft (Audubon Minnesota); Dr. Rebecca Montgomery (University of Minnesota); Dr. Meredith Thomsen (UW La Crosse). Dr. Montgomery is a forest ecologist with experience in research and assessment of floodplain forest ecosystems, and Dr. Thomsen is a leader in reed canary grass control and effects on regeneration along the Upper Mississippi River. Dr. Thomsen's expertise in reed canary grass research specific to the Mississippi River is the reason some funding would go out of state.

The University of Minnesota, via contract with Audubon, Minnesota would receive \$122,700 (\$107,700 for research staff [e.g. graduate student and undergraduate research intern] salaries, fringe, and \$15,000 for travel), and the University of Wisconsin - La Crosse via contract with Audubon would receive \$43,300 (\$36,100 for graduate student salary and fringe and \$2,900 for travel), \$ 9,500 will be spent on supplies, and Audubon Minnesota will spend \$46,800 to manage the overall project, implement restoration and enhancement projects at the study sites, and assist with monitoring and research activities.

This team will also work closely with foresters and biologists from the US Fish and Wildlife Service, U.S. Army Corps of Engineers, and Minnesota DNR who will help with developing site prescriptions and project implementation, as well as dissemination of the final products and decision support tool. Funding from the Outdoor Heritage fund through a grant with Audubon will be used to implement projects on public lands.

B. Project Impact and Long-term Strategy: This effort is part of Audubon's long-term strategy to sustain and restore floodplain forest for birds and other wildlife along the Upper Mississippi River. Audubon hired a full time Forest Ecologist in January, 2015 to expand our work in this area. We secured \$300,000 in Outdoor Heritage funding (July 2014-June 2017) and \$20,000 in private funding and have been implementing restoration projects. However, we do not have funding to study the most effective restoration techniques. This is a critical question facing foresters and wildlife managers across the Upper Mississippi River. LCCMR funding will be used to conduct the studies needed to determine the most effective methods to control reed canary grass and regenerate trees, and to get this information in the hands of resource managers as a practical decision making tool for writing site-level management prescriptions. This will ensure future funds are spent on the most effective restoration projects.

Approximately \$30,000 of a current LSOHC grant for \$300,000 will be available to implement projects at the sites selected for study if the LCCMR proposal is funded. An additional \$412,000 is being recommended for funding by LSOHC to continue implementing forest restoration projects from 2016-2019, \$50,000 of this grant will be used to implement projects at the research study sites. This LCCMR proposal will provide the information and decision support tools for river managers to most effectively implement forest restoration projects using funding from other sources into the future.

C. Spending History:

Funding Source	M.L. 2008 or FY09	M.L. 2009 or FY10	M.L. 2010 or FY11	M.L. 2011 or FY12-13	M.L. 2013 or FY14
Outdoor Heritage Funding					300,000

(add or remove rows and columns as needed)

VIII. ACQUISITION/RESTORATION LIST: This work will be conducted on approximately 10 acre study plots located within larger project areas. Outdoor Heritage funding will be used to do the actual enhancement work (treating reed canary grass, tree planting) within the larger project areas, and LCCMR funding will be used to conduct the research and monitoring at study plots within those areas. Project areas are near La Crescent, Winona, and Red Wing, MN. They were selected based upon existing vegetation (dominated by reed canary grass), soil type, and hydrology. The Research Addendum describes in more detail how project sites and locations for study plots were selected.

IX. VISUAL ELEMENT or MAP(S): see project area map

X. ACQUISITION/RESTORATION REQUIREMENTS WORKSHEET: All activities within the project areas and study plots will occur on permanently protected land, primarily within the Upper Mississippi River National Wildlife and Fish Refuge, Minnesota state forests, and Minnesota state Wildlife Management Areas.

Enhancement activities will be conducted following state and federal guidelines to ensure ecological integrity and pollinator enhancement. All enhancement activities will follow the recommendations of MN DNR Foresters or USFWS Biologists.

Conservation Corps Minnesota will be given the opportunity to bid on projects involving tree planting.

XI. RESEARCH ADDENDUM: Was provided by December 11, 2015 deadline

XII. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted no later than December 31, 2016; April 30, 2017; October 31, 2017; April 30, 2018; October 31, 2018, and April 30, 2019. A final report and associated products will be submitted between June 30 and August 15, 2019.

Environment and Natural Resources Trust Fund**M.L. 2016 Project Budget****Project Title:** Controlling Reed Canary Grass to Regenerate Floodplain Forest**Legal Citation:** M.L.2016, Chapter 186, Section 2, Subd.8(e)**Project Manager:** Tim Schlagenhaft**Organization:** Audubon Minnesota**M.L. 2016 ENRTF Appropriation:** \$ 218,000**Project Length and Completion Date:** June 30, 2019**Date of Report:** June 23, 2021

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET		Revised Budget 6/23/2021	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM		Determine most effective methods to control reed canary grass and regenerate trees			Provide foresters and wildlife managers with information on the most effective methods to control reed canary grass and regenerate trees				
Personnel (Wages and Benefits)		\$50,456	\$50,456	\$0				\$50,456	\$0
Tim Schlagenhaft, Project Manager: \$22,400 (66.5% salary, 33.5% benefits); 9% FTE each year for three years.									
Andrew Beebe, Forest Ecologist: \$19,200 (66.5% salary, 33.5% benefits); 10% FTE each year for three years.									
Sue Swanson, Administrative Assistant: \$5,200 (66.5% salary, 33.5% benefits); 4% FTE each year for three years.									
Professional/Technical/Service Contracts									
University of Minnesota contract to fund one graduate student, staff scientist, or post doctoral research associate and one undergraduate research intern to conduct research. Graduate student will be a 50% FTE for 2.5 years (55% salary, 45% fringe benefits) for a total cost of \$97,700 (45% of total project cost). Undergraduate research intern will assist with data collection for 3 months each of two years for a total cost of \$10,000 (\$5,000/year and 5% of the total budget).		\$114,400	\$114,400	\$0	\$8,300	\$8,300	\$0	\$122,700	\$0
University of Wisconsin La Crosse contract to fund one graduate student to conduct research. Position salary will be funded 80% by US Fish and Wildlife Service and 20% from grant. Position will work 50% FTE for 2.5 years (76% salary, 24% fringe benefits) on the research project for a total cost of \$36,100 (17% of total project cost).		\$35,392	\$33,463	\$1,929	\$3,100	\$3,100	\$0	\$38,492	\$1,929
Supplies									
Supplies including flagging, pvc pipe, hand tools, work gloves, data collection supplies, seedling tags, etc.		\$6,352	\$6,352	\$0				\$6,352	\$0
COLUMN TOTAL		\$206,600	\$204,671	\$1,929	\$11,400	\$11,400	\$0	\$218,000	\$1,929