

M.L. 2015 Project Abstract

For the Period Ending June 30, 2018

PROJECT TITLE: Preserving and Protecting Minnesota Native Orchid Species

PROJECT MANAGER: David Remucal, Ph.D.

AFFILIATION: University of Minnesota Landscape Arboretum

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FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: M.L. 2015, Chp. 76, Sec. 2, Subd. 08c

APPROPRIATION AMOUNT: \$167,000

AMOUNT SPENT: \$156,077

AMOUNT REMAINING: \$10,923

Overall Project Outcome and Results

Minnesota is home to 48 species of native orchids, 20% of which are on the state endangered species list. Even “common” orchids are generally regarded as rare. These plants are charismatic state treasures that evoke the imagination of Minnesota residents and people around the world. Orchid hunting – both photographing and poaching – has increased the threat to these plants while , in turn, increasing conservation efforts. Beyond poaching, orchids have a more complex relationship to their environment than many other plant species and are easily affected by local disturbances, especially those that change local groundwater levels and flows.

The Native Orchid Conservation Program (NOCP) at the Minnesota Landscape Arboretum (MLA) follows a vision unique to the U.S.: to conserve the genetics of all Minnesota orchid species and bring as many as possible to MLA to display. Building a seedbank for 15 of the state’s species was the initial objective and research to develop propagation techniques for all species is on-going. Some species have known growth-from-seed techniques; for most, however, that knowledge is unknown. As both conservation and propagation of seed efforts continue, the goal is to share information in order to encourage obtaining orchids for personal gardens through sustainable seed-produced orchids, rather than poached transplants (which have a high failure rate). Displaying these orchids is vital and will accomplish two goals: 1) show visitors the beauty of these treasured plants – plants they might otherwise never see due to the remote habitats they often occupy, and, 2) educate people about the importance of protecting these species and about their known successful propagation techniques.

While the NOCP and MLA are committed to long-term orchid conservation, success was achieved quickly within the project’s first phase, banking more species than expected. Through this process, it became clear that: there is untapped enthusiasm throughout Minnesota for orchid conservation, finding some species in the wild remains difficult, and there may be lower population numbers than expected for even the “common” species. We created a diverse genetic bank for nearly 1/3 of Minnesota’s species, covering much of the state, and have worked with nearly 2/3 of Minnesota’s species to research, establish, or further propagation. This advanced our work, allowing us to display some of our new orchids already, to the delight of MLA visitors. Our data will increase understanding of how these species are distributed across the state and provide locations of vital populations identified

for conservation. Ultimately, as we bank seed and establish propagation techniques for each species and pair this work with an increased understanding of how each species lives in its natural environments we will better equip ourselves and others to keep these treasures on Minnesota landscapes for years to come.

Project Results Use and Dissemination

Over the course of the granting period the public visibility of the Native Orchid Conservation Program increased steadily. With articles in magazines/newspapers, a story on MPR and social media posts, we engaged the public in multiple ways and the success bred interest across the state. The result was that we had people from around the state contacting us with offers to help, information about orchid populations in need, and requests to have us bank seeds on private landowners' lands. This reaction from around the state was unexpected this early in the program and demonstrates both a real need for this kind of program and general support among Minnesotans. As we continue to establish this program and develop our strategy to educate visitors and the public, this broad base of support will allow us to continue to reach the farthest corners of the state. This kind of reach will allow us to share our work and Minnesota's orchids with people who may not be able to visit the Arboretum and, interestingly, will also allow us to share our plant treasures with people around the world.



Environment and Natural Resources Trust Fund (ENRTF) M.L. 2015 Work Plan Final Report

Date of Report: 8/31/2018

Final Report

Date of Work Plan Approval: 6/15/2015

Project Completion Date: 6/30/2018

PROJECT TITLE: Preserving and Protecting Minnesota Native Orchid Species

Project Manager: David Remucal, Ph.D.

Organization: University of Minnesota Landscape Arboretum

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Location:

Statewide

Total ENRTF Project Budget:	ENRTF Appropriation:	\$167,000
	Amount Spent:	\$156,076
	Balance:	\$10,923

Legal Citation: M.L. 2015, Chp. 76, Sec. 2, Subd. 08c

Appropriation Language:

\$167,000 awarded the first year is from the trust fund to the Board of Regents of the University of Minnesota for the Minnesota Landscape Arboretum for propagation and cultivation research to enable long-term conservation of at least 15 selected species of the 48 native orchid species in Minnesota. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Preserving and Protecting Minnesota's Native Orchid Species

II. PROJECT STATEMENT:

The initial phase of this new program will involve two main activities: 1) collect and preserve seed and/or live plants from 15 native Minnesota orchid species, and 2) research the propagation and cultivation of each species. There is a total of 48 species in Minnesota and our eventual goal with this program is to bring all 48 orchid species to the Arboretum for conservation and research, however this proposal is to fund the initial 15 species. Traditional conservation efforts, *in-situ* conservation that focuses on maintaining the species in its current habitat, are important but because of increasing habitat degradation and loss, they cannot be the only conservation method applied. A Native Orchid Conservation Program like this may or may not be able to prevent the loss of populations of orchids, but it plays a very necessary and complimentary role alongside traditional conservation efforts. Through collection and research, we will be able to build a seed bank from which populations could be reconstituted in the event that wild populations are lost. This is a vital activity as there is unfortunately an increasingly likely possibility that the habitats of many wild populations will change substantially over the next 30 years and will no longer support these populations in the wild. This seedbank approach will make it possible for the Arboretum to act as a bulwark against irreversible species loss as well as insurance in case individual populations are lost.

Orchids often have many specialized growing requirements, making them more vulnerable to changes in the local environment than most other plant species. Laboratory research on basic orchid biology and observation of introduced populations is essential to comprehending how they are likely to respond to environmental changes. With this understanding it could be possible to develop new ways to detect early declines in Minnesota's ecosystems.

There are roughly 200 species of orchids native to the continental United States and Minnesota has nearly a quarter of those species.

MINNESOTA – 48

Florida – >87
North Carolina – 69
New York – ~60
South Carolina – 55

Texas – 50

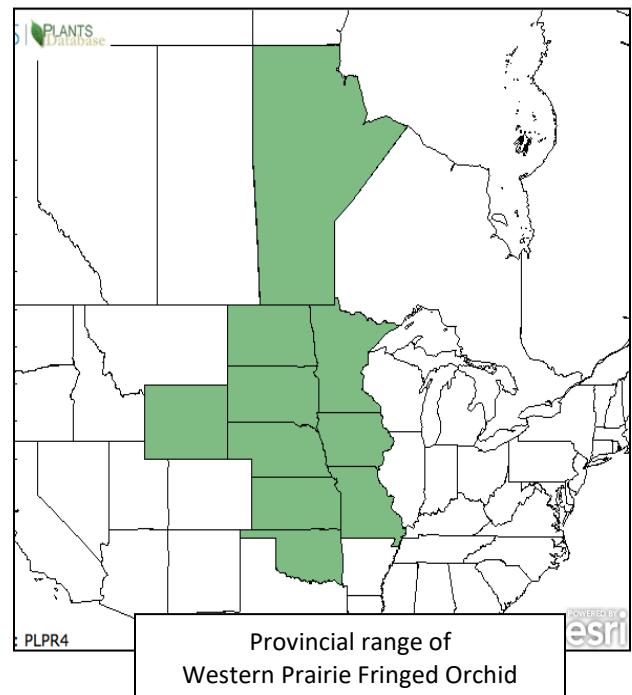
Georgia – 50
Washington – 41
Pennsylvania – ~40
Wisconsin – 40

Iowa – 32

California – 31
Alaska – 31
Colorado – ~25
Hawaii - 3

With ten of Minnesota's 48 native orchid species already listed on Minnesota's List of Endangered, Threatened, and Special Concern Species, it is imperative to invest in the long-term preservation of this group of plants that can be found in every ecosystem type in the state. Orchids can be found throughout in Minnesota in native forest, wetlands, and prairie.

The Western Prairie Fringed Orchid is found on mesic prairie in western MN (*habitat seen in map on right with photo below*). Because native prairie habitat in Minnesota has been decimated and fractured, this species, while widespread, is endangered. It is imperative that a program like this is developed prior to either to loss of any endangered orchid species from our state or to the critical attrition from unlisted species to the point that they too become endangered. **The goal of this program is to preserve Minnesota's native orchid diversity.** The Arboretum is deeply committed to preserving and protecting Minnesota's threatened and endangered plants and it currently houses a



collection of eight native orchid species, some of which have been acquired through rescue efforts throughout the state. **The long-term goal of this work is to bring all 48 orchid species – either as seeds or live plants – to the Arboretum for conservation and research. It is our vision to do this work for conservation purposes only, not for commercial breeding.**

We will also be able to increase the visibility and appreciation of our native orchids by sharing our research with the public through installations in Arboretum grounds as well as in its conservatory. This native orchid conservation program at the Arboretum will introduce nearly 500,000 visitors to these elusive plants and their important role in forewarning threats to Minnesota's ecosystems. The Arboretum is committed to making its information and resources accessible to all Minnesotans, and it is in that spirit that the Arboretum waives its entrance fees for visitors during the month of January – an ideal time to view native orchids in the Arboretum's conservatory. In addition, admission is free on Thursdays from November – March and then from April – October admission is free the third Thursdays of the month after 4:30.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of [1/15/2016]:

The Native Orchid Conservation Program had a very successful year. We collected seed from 24 native species to begin the important work of propagation research, while our original goal was to work with 15 species for banking and research for the first phase of our program as the opportunity to collect seed from more than 15 species presented itself we did so as to begin the process of this research. It is likely that for any one particular species the process of developing a successful propagation protocol will take years, so we are hoping to begin that research as soon as possible for each. Our hope is that by the end of the three years of the first phase of the program we will have information on how to successfully propagate at least 15 species – they just may not include all of the 15 species we are going to bank for this first phase, although the 15 species we are going to bank will be among the species we will be researching.

We have started banking species ahead of schedule and we are positioned to successfully fulfill the banking goals of 2016. Orchid populations are hard to find from year to year and our hope is that with continued engagement with botanists and naturalists around the state we will continue to be successful.



Western Prairie Fringed Orchid

Amendment Request (06/15/2016):

The Arboretum is requesting the following changes in the project budget.

1. Personnel (Wages and benefits)

Changes in personnel reflect both: University policy (intern hourly rate changing from \$10.50 an hour to \$12.00 an hour) and; job classification (David Remucal transitioning to a full time professional and administrative position from a temporary position).

2. Equipment/Tools/Supplies

Lab Supplies – This line item is increasing to account for costs related to external soil testing and lab work that needs to be conducted at highly specialized lab facilities at both Texas Tech and the Smithsonian in Washington, DC.

Water distillation/deionization system – It was determined that current contract with a water distillation provider (Smith Engineering) would offer the needed level of deionized water and a maintenance contract making it a more sustainable option for the Arboretum. These costs are being incurred, because with the addition of the orchid conservation work, the system is now being used year-round as opposed to the less frequent use before the start of this project.

3. Capital Expenditures

Lab Glassware Dishwasher – Making this determination to eliminate the purchase of a Lab Glassware Dishwasher allows the Arboretum to cover additional costs in personnel, lab supplies, and travel.

3. Travel Expenses in Minnesota

Food and Lodging – As the project has progressed, the research team lead by Dr. David Remucal has started collecting orchid roots in addition to seed collection. Roots need to be collected earlier in the year, which means extending the time needed for travel.

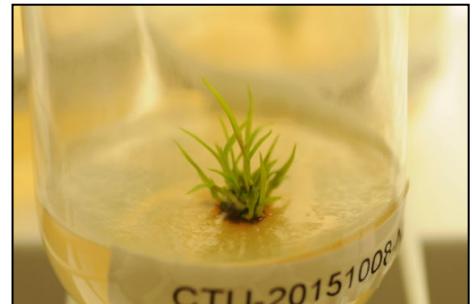
Mileage – The project team will be travelling 21 days instead of the 15 as originally proposed in order to collect roots in addition to seeds.

Amendment Approved by LCCMR 08/30/2016

Project Status as of [6/15/2016]:

The Native Orchid Conservation Program has seen a great deal of activity over the past six months, with propagation work being a major focus over the winter months. For example, the photo on the right shows small green leaves starting to form on 4-month old tuberous grass pink orchid seedlings. This work is being lead by Dr. David Remucal, who has recruited a very enthusiastic and dedicated team of 10 volunteers who together

contributed a total of 699 hours to plant conservation work at the Arboretum. This project has been very attractive to a diverse range of volunteers who are interested in environmental science, lab work, conservation and more. The photo on the left highlights Arboretum volunteers helping us to track plants on Arboretum grounds.



Project Status as of [1/15/2017]:

The Native Orchid Conservation Program has had another successful year. Staff gathered seed from several species this summer, bringing the total number of species that the program has been able to begin working with to roughly 32 (of 48 total native species) and the total population number collected and/or banked to roughly 27. In addition significant progress has been made in root collection, analysis and propagation over the past several months.



Publicity for the program has increased, with stories about the program in both print and media, including Minnesota Public Radio (<https://www.mprnews.org/story/2016/10/31/saving-minnesota-rare-orchids-mission-smithsonian>). We also anticipate being able to present orchids from this program to the public this upcoming year.

The increased profile of the Native Orchid Conservation Program has brought increased opportunities to partner regionally, nationally, and internationally. In addition to our young but established collaborations with Texas Tech University and the Smithsonian Environmental Research Center, we are developing research projects on orchid propagation and restoration with the Central Botanic Garden of Belarus, the Chicago Botanic Garden, North Dakota State University, Crown College in St. Bonifacius, The Ridges Sanctuary in Wisconsin, the NAOCC and the Cloquet Forestry Center in northern Minnesota.

Project Status as of [6/15/2017]:

Winter and early spring were again the focus of propagation and seed bank work. We have several more species showing early success in propagation and we are starting the next phase of propagation work by planting orchids in pots and even a trial bog garden display.

The program continues to attract regional attention as more requests for talks and information about the project manifest and as more private citizens around the state offer assistance or knowledge in collecting and even offer access to populations on their land.

Project Status as of [1/15/2018]:

Summer and fall brought successful collection as the orchid program completes the seed banking efforts of this project. The final list of species completed by this report and by the end of the field season in 2018 will be:

Corallorrhiza odontorhiza var *odontorhiza* (autumn coral-root)

Corallorrhiza trifida (early coral-root)

Cypripedium acaule (stemless lady's-slipper)

Cypripedium candidum (small white lady's-slipper)

Cypripedium reginae (showy lady's-slipper)

Goodyera pubescens (downy rattlesnake-plantain)

Goodyera repens (lesser rattlesnake-plantain)

Goodyera tesselata (tesselated rattlesnake-plantain)

Liparis loeselii (Loesel's twayblade)

Listera cordata (heart-leaved twayblade)

Malaxis unifolia (green adder's-mouth)

Platanthera huronensis (tall green bog-orchid)

Platanthera obtusata ssp. *obtusata* (bluntleaved rein-orchid)

Platanthera psycodes (small purple fringed orchid)

Spiranthes magnicamporum (Great Plains ladies'-tresses)

We continue to increase our propagation efforts, having successfully propagated nearly half of the native orchid species in the state, and are actively working on propagation techniques for a full 2/3 of orchid species. We also continue to increase our outreach efforts, reaching a wider variety of audiences each year.

Project Status as of [6/15/2018]: Winter and spring again focused on propagation work as well as planning for the upcoming season and the second phase of the project. As the project begins to look towards the long term goals more intently strategic planning for development of the seed bank for each species becomes more crucial.

Overall Project Outcomes and Results:

Minnesota is home to 48 species of native orchids, 20% of which are on the state endangered species list. Even “common” orchids are generally regarded as rare. These plants are charismatic state treasures that evoke the imagination of Minnesota residents and people around the world. Orchid hunting – both photographing and poaching – has increased the threat to these plants while, in turn, increasing conservation efforts. Beyond poaching, orchids have a more complex relationship to their environment than many other plant species and are easily affected by local disturbances, especially those that change local groundwater levels and flows.

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IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Collect and preserve seed and/or live plants from orchids throughout MN

Description: The first phase of this new initiative will involve collecting seeds and/or live plants from a total of fifteen native orchid species, representing nearly a third of the 48 known species in Minnesota. Samples will be collected from as many individual specimens as possible to obtain a representation of several populations that span a large area of each species’ range. A tentative list of initial target species will be assembled at the beginning of the first summer with finalization of the initial list by the end of 2015.

Roughly one collection trip for each of the four regions of the state (NW, SW, NE, SE) anticipated to be visited the first year will be undertaken at the beginning of the summer to collect live plants and again in mid to late summer for seed collection, with a similar schedule anticipated for each year of the program, depending on specific species and locations. In subsequent years, species lists and location determinations will be made during the winter in order to adequately prepare and obtain necessary permits. Permits for collection of listed species will be obtained from the Minnesota Department of Natural Resources. Other permits for non-listed orchids will be properly obtained under Minnesota Statutes 2010, Chapter 18H.18.

When live plants are collected, either an appropriate garden location at the Arboretum will be used to house them, or they will be grown in appropriately controlled environments. When populations or colonies are established on Arboretum grounds, regular demographic monitoring will be performed in conjunction with

monitoring of environmental factors such as soil moisture and temperature to analyze changes. As the program grows and species are brought to the Arboretum, it will be vital to engage the public –to educate them on the importance of native orchid conservation. Education efforts will happen in collaboration with the statewide Master Gardeners Program, which is now located at the Arboretum. Some of the current plant populations at the Arboretum come from rescue/salvage operations at construction sites. The Arboretum would be prepared for future opportunities permitted by the Minnesota Department of Natural Resources to rescue native orchid populations.

Summary Budget Information for Activity 1:

ENRTF Budget: \$ 76,623

Amount Spent: \$ 70,483

Balance: \$ 6,140

Outcome	Completion Date
1. Finalized list of phase one species, with collection begun from as many of these species as possible.	12/31/2015
2. Collection of samples from 7 species, with a goal of three populations per species	12/31/2016
3. Establish demographic database to manage data collected for populations within the Arboretum.	12/31/2016
4. Public will have access to labeled species and a printed and online version of a "Visitors Guide to Minnesota Orchids" on display at various locations on Arboretum grounds.	6/1/2017
5. Collection of remaining 8 species and populations to meet proposed goal of 15 species.	6/30/2018

Activity Status as of [1/15/2016]:

We have successfully begun banking 15 species, we will narrow this number to focus on 7 species in 2016, but given the difficulty in finding large enough populations for many species we may expand the bank more opportunistically than premeditatively. For example, orchid species can sometimes be found with other orchid species and bank opportunities should be taken advantage of when they happen.

The expected 15 species we will focus on for the initial phase of the native orchid program will be chosen from 16 species. Seeds have been collected from multiple individuals from one population for each of the following species:

Calopogon tuberosus var. tuberosus (tuberous grass-pink)
 Corallorrhiza odontorhiza var odontorhiza (autumn coral-root)
 Corallorrhiza trifida (early coral-root)
 Cypripedium acaule (stemless lady's-slipper)
 Cypripedium candidum (small white lady's-slipper)
 Cypripedium reginae (showy lady's-slipper)
 Galearis spectabilis (showy orchis)
 Goodyera pubescens (downy rattlesnake-plantain)
 Goodyera repens (lesser rattlesnake-plantain)
 Liparis liliifolia (lily-leaved twayblade)
 Malaxis unifolia (green adder's-mouth)
 Platanthera huronensis (tall green bog-orchid)
 Platanthera obtusata ssp. obtusata (bluntleaved rein-orchid)
 Platanthera praecox (western prairie fringed orchid)
 Pogonia ophioglossoides (rose pogonia)
 Spiranthes cernua (nodding ladies'-tresses)

The autumn coral-root can be very hard to find, and permitting for the western prairie fringed orchid can be difficult to obtain, so possible candidates for replacement in the first phase could be:

Goodyera tesselata (tessellated rattlesnake-plantain)
Liparis loeselii (Loesel's twayblade)
Listera cordata (heart-leaved twayblade)
Platanthera aquilonis (northern green bog-orchid)

Activity Status as of [6/15/2016]:

During this period, the research team went on two root collection trips. One to the Anoka Sand Plains and one to French Regional Park. The team collected root samples from several species which were fedexed to both Texas Tech and the Smithsonian for identification and propagation of the fungi.

To the right is an example of a “green adder’s-mouth” whose seed was successfully collected and brought to the Arboretum. As you can see, this plant is very small and easily blends into the environment, making discovery very challenging.



Activity Status as of [1/15/2017]:

A total of 5 overnight collection trips were made to several locations in Minnesota including: Bemidji, Grand Rapids, and Cloquet to collect seed and root samples for the Native Orchid Conservation Program. Overnight trips become increasingly important for this work as there are several locations where multiple species are present and therefore more time is required for collection.

In addition, there were 15 day trips. These trips resulted in collected seed from 24 species, completing the banks for 8 populations for several species. This included starting banks for 8 new species and starting a seedbank for new populations for nearly all of the species collected in 2015. It was reaffirmed for the project that collection of seed is highly dependent on finding locations suitable to carry larger populations of a target species and for most of the species in Minnesota where one species is found there are often other species present. Locations where we started or completed seed banks include a mixture of state, federal, county, and municipal public lands as well as private lands. State lands include Irons Springs Bog SNA, Wild River State Park, Carlos Avery WMA, and the Cloquet Forestry Center (University of Minnesota land). Federal lands include Chippewa National Forest. Being able to bank these state and federal lands is important as these are generally the most protected landscapes in the state and likely to have the largest, healthiest populations of orchids as well as greater chances of multiple species. That makes these locations important sources of genetic diversity as larger populations typically have greater available genetic diversity than do smaller satellite populations.

Most notably, because of publicity for the program through radio, print and presentations the project has begun to get proactive notifications of locations of orchid populations as well as volunteer collectors. This already has begun to accelerate reaching the program’s goals and is encouraging in that it shows that there is support for this kind of work with the general public in Minnesota. It is important to note that all of our collection, including that done by partners/volunteers, is done with appropriate permission or permits, of which we keep records. We will not accept seed without proper permission, and in fact have given talks about illegal collection issues.

Activity Status as of [6/15/2017]:

In addition to planning visits to several sites from the previous two years, additional sites have been added for banking, including Karnitz WMA, Ottawa WMA, Cuyuna Country SRA, Richard T Anderson Conservation Area, Big

Bog SRA, Mary Schmidt Crawford Woods SNA, and Plover Prairie Reserve (TNC). We have also added populations of orchids from several private land owners that have contacted us interested in our helping them preserve their species.

We have started to work with staff at two University of Minnesota Research Centers, Cloquet Forestry Center and Hubachek Wilderness Research Center, exploring the possibility of a combined seed banking and outplanting project across the three locations.

Activity Status as of [1/15/2018]:

A total of 7-overnight and roughly 20-day collection trips were made to multiple locations around the state as we continued to expand our collection efforts, both geographically and by species. We expanded collections south of the Twin Cities, around Ely, MN and near the St. Croix River as we developed better information for locations of banking populations. As our location information expands we are able to collect and protect an increasingly large number of protected lands able to bank seeds from nearly all of those lands previously mentioned as targets in addition to several additional locations, like Old Koschak Farm WMA, Itasca State Park and Hubachek Wilderness Research Center. Most importantly, as we increase our number of locations and species we gain valuable experience in efficiently searching and evaluating scouted locations.

Activity Status as of [6/15/2018]: Winter and spring again focused on propagation work as well as planning for the upcoming season and the second phase of the project. As the project begins to look towards the long term goals more intently strategic planning for development of the seed bank for each species becomes more crucial.

Final Report Summary:

The orchid banking program has successfully established seed banks for three populations for the following 15 species:

- Corallorrhiza odontorhiza* var *odontorhiza* (autumn coral-root)
- Corallorrhiza trifida* (early coral-root)
- Cypripedium acaule* (stemless lady's-slipper)
- Cypripedium candidum* (small white lady's-slipper)
- Cypripedium reginae* (showy lady's-slipper)
- Galearis spectabilis* (showy orchis)
- Goodyera pubescens* (downy rattlesnake-plantain)
- Goodyera repens* (lesser rattlesnake-plantain)
- Goodyera tesselata* (tesselated rattlesnake-plantain)
- Liparis loeselii* (Loesel's twayblade)
- Malaxis unifolia* (green adder's-mouth)
- Platanthera huronensis* (tall green bog-orchid)
- Platanthera obtusata* ssp. *obtusata* (bluntleaved rein-orchid)
- Platanthera psycodes* (small purple fringed orchid)
- Spiranthes magnicamporum* (Great Plains ladies'-tresses)

This species list is different than the proposed list presented two years ago, which is not surprising. For most biological research that involves field work with plants, opportunism and the unexpected are commonplace. For this study, we substituted alternative species when collections of proposed targeted were not obtainable and took advantage of key sites with multiple species as these locations can inform management and land protection decisions.

While the seed banking project has been successful, one important finding from the first phase of this project is the discovery that only some species of orchids have what would be considered large populations. Most species of orchids, even the common ones, are not present in large numbers even for what would be

considered “large” populations for them. Often a large population of a common orchid species could be 30 flowering individuals, which for most other species of “common” plants would be considered very small. These small populations complicate banking efforts as we have to balance the needs to maximize the bank for a population/species with the need to leave enough seed behind to not adversely affect a population’s ability to maintain itself. Banking such small populations often means collecting seed over several years’ time, therefore visiting populations multiple times in multiple years, which is logically tricky given the number of populations of orchids, the effort it takes to reach some populations and the variability in flowering from year to year. The larger lesson for our work and the work of others seeking to do this kind of seed banking with these species is that it is a large time and resource commitment to do this work.

The perhaps largest implication for management strategies for these species is that, because there are likely very few large populations of any one particular orchid species, any large populations should be protected. And small populations should not be discarded, if given infinite resources our recommendation would be to track all known locations of most orchids. While this is impossible, a more practical recommendation would be to record known locations for a prioritized list of orchid species beyond the members on the Minnesota’s List of Endangered, Threatened and Special Concern Species.

While we have not yet produced a detailed brochure or online webpage for individual species, we have produced both brochures and webpage information, in addition to social media posts to inform about the program and orchids we have made available to the public for viewing. These have led to increased visibility for the research and conservation being done at the Arb. We are still determining with partners around the country how best to package and disseminate the growing propagation and cultivation information we are gathering as there must be some sensitivity to how this information can be consumed.

ACTIVITY 2: Propagation and cultivation research

Description: Develop an understanding of how to best grow each native orchid species. There are methods of growing orchids from seed that can be done in soils or laboratory environments that either include fungal associates or do not. It will be important to assess which methods produce the best, most reproducible results and which environmental factors are vital for seedlings and adults. In the first year, most germination methods will be asymbiotic techniques as these methods are more established for a wider variety of orchid species and will give us good baselines for comparing to symbiotic propagation methods.

There is research already underway for some of these native orchid species, and we are building collaborations with other researchers to promote effective sharing of our results and to avoid duplication of effort. For example, Dr. Jyotsna Sharma, a professor at Texas Tech University, who works on orchid mycorrhizal associations, will be able to help us identify the fungal associations for each species as well as assist us with their propagation and storage.

Summary Budget Information for Activity 2:

ENRTF Budget: \$ 90,377

Amount Spent: \$ 85,594

Balance: \$ 4,783

Outcome	Completion Date
1. Evaluation of varied methods of orchid seed germination and cultivation for each species. These evaluations to include both laboratory and soil methods.	12/31/2017
2. Arboretum convenes meeting of researchers and other interested groups such as the Orchid Society of Minnesota in field to share emerging results and best practices	Spring 2018

Activity Status as of [1/15/2016]:

We have collected enough seed from 24 native species (and one invasive species) in our initial propagation research. We have identified a protocol for an initial asymbiotic germination assay and have orchid seed from these species developing and will be evaluating this initial assay over the next year. As we identify successful

protocols for each species, we can move on to new species as well as further refine successful protocols to increase survivability and decrease germination times. As we identify mycorrhizal associates, we will be able to begin to add those to the germination trials.

Activity Status as of [6/15/2016]:

The following summarizes work in propagation over the past 6 months:

We have been developing propagation methods for the 24 species of orchid for which we collected seed last summer. We have already had good success with two species that haven't been targeted by commercial or enthusiast amateurs. Our trials are still in their early stages, but we expect more successes in the coming months.

We have started collecting roots for this current field season, and have made great progress on our fungal associate work with our collaborator at Texas Tech, having successfully isolated and studied 6 species in the past year with plans to add at least that many again the rest of this field season.



Showy Lady's Slipper protocorms – about 5 months old.

We are solidifying a groundbreaking inter-continental study of orchids and fungi with the Central Botanic Garden in Belarus and are already underway in that study.

We also have begun propagating orchids for restoration work for an orchid sanctuary.

Activity Status as of [1/15/2017]:

Photo at right shows: Delicate branching structure of isolated fungi from Minnesota checkered rattlesnake-plantain (*Goodyera tesselata*). Example of samples stored and propagated at Smithsonian Environmental Research Center for the Arboretum.



The project has only just begun germination of the seeds collected this summer, so there are not any results to report. Staff continues to work with the seeds and have noticed continued results.

The project still anticipates being able to introduce roughly 6 to 8 species to Arboretum grounds or greenhouses in 2017, including:

Cypripedium candidum (small white lady's slipper)

Cypripedium acaule (stemless lady's slipper)

Pogonia ophioglossoides (rose pogonia)

Calopogon tuberosus (tuberous grass pink)

Platanthera obtusata ssp. *obtusata* (bluntleaved rein-orchid)

Malaxis unifolia (green adder's mouth)

The project is hopeful that the pogonia, the grass pink, and the adder's mouth will flower their first years if they survive the transplanting process, however the primary focus will be on ensuring survival. An unforeseen benefit

of the orchid program is the ability to produce other plants that can be difficult to propagate in conventional means. For example, this year the project was able to grow from seed three of Minnesota's native carnivorous plant species, including the state-listed butterwort (*Pinguicula vulgaris*), for the Arboretum's special exhibit on carnivorous plants. Without the orchid program, it is unlikely that the Arboretum would have been able to grow seed from any of these species in time to use them for the exhibit.

Finally, the project experienced great success in collecting root samples for processing by both Texas Tech University and the Smithsonian Environmental Research Center. Partnerships with TTU and SERC have both developed and solidified during this initial phase of the Native Orchid Program at MLA. In both cases, these institutions provide expertise or facilities which we do not currently have or have available to us locally and the only costs we incur are costs for collection and shipping of material to our partners. Our partners are contributing their resources for identification (TTU) or storage (SERC). In the case of TTU, we hope to eventually put together and co-author an atlas of Minnesota's native orchids and fungal associates – a first-of-its-kind publication by any state for this unique and important plant-fungi association. In the case of the SERC, the North American Orchid Conservation Center has a mission to propagate and store the fungal associates of all North American orchids, similar to a seed bank in plants. They are isolating and storing living samples of the fungi found in the orchid roots which we send to them. We will be able to access these banks for future restoration work.

Activity Status as of [6/15/2017]:

Over the winter and spring, we again worked mainly to propagate and grow orchids in our lab and greenhouses. We successfully produced our first set of seedlings for use by a non-profit organization for restoration. Among the species for which we are refining propagation methods are the small-white lady's slipper (*Cypripedium candidum*), ram's head lady slipper (*Cypripedium arietinum*) and the western prairie fringed orchid (*Platanthera praecox*). Those three are listed species in Minnesota. We hope to be able to show at least two of these species in a new orchid display garden in 2018.

We have placed 10 species with which we have had success propagating from seed in pots. This has happened a year earlier than expected and a greater number of species than expected. We continue to find success in propagating species, with another 3-4 species likely to be available to put in pots next year. We had our first flower, which was a popular success for us both on our Facebook page and for visitors. We had many visitors come in specifically to take pictures of that orchid.

We have developed a small bog garden demonstration bed in which we are placing three orchid species, as well as one of our endangered non-orchid species. Through this we should be able to test both the hardiness of the orchid seedlings, and whether visitors might be tempted to take any of our new orchids when we display them.

Activity Status as of [1/15/2018]:

The orchid program continues to expand propagation efforts and is moving towards display and presentation of the banked and collected orchid species. There are now 16 species planted in pots, display gardens or being overwintered to do so in the spring. These include the listed small white lady's slipper and the ram's head lady slipper.

Activity Status as of [6/15/2018]: Propagation work continues and we have developed successful protocols for growing over a third of Minnesota's native orchid species. We have worked with NAOCC to bring a regional meeting of the group to Minnesota this fall. We were not successful in bringing the meeting to MLA this year as it will be in Door County, Wisconsin, but we will be an integral part of the meeting and we anticipate having the gathering at MLA in the future.

Final Report Summary: The orchid program's first phase of work was more successful than anticipated, and this success has pushed MLA to expand the program. We are currently propagating over a third of Minnesota's native species with work already underway for Phase 2 of this project on several more. There have been informal inquiries into assistance from our program to introduce orchids to other gardens, both within Minnesota and in other states as well as formal engagement with us to produce orchids from wild-collected seed for orchid reintroduction projects.

MLA is also part of a developing core group of orchid researchers/conservationists around the country that will be at the cutting edge of developing conservation techniques for the plants. This status for Minnesota as a leader in this research has been a direct result of the support that the ENRTF funding provides.

We have enough plants at various stages now that we are hoping to develop infrastructure to both display the plants effectively in raised boxes and to research how best to display these plants in these kinds of displays. Terrestrial orchids have not traditionally been able to be displayed in manipulated garden beds very effectively, and our early successes in propagation will push us to develop these techniques ahead of our anticipated time. This information could prove to be invaluable for botanic gardens around the country.

V. DISSEMINATION:

Description: Initially, live transplanted orchids will be kept in greenhouse or conservatory areas while we determine whether and how an appropriate garden location is available or can be constructed. While orchids are on display in the conservatory, the Arboretum will provide educational information on each species as well as specific opportunities for the public to engage with this effort. The Arboretum will also use its website (<http://www.arboretum.umn.edu/>) as a good location for dissemination of general information about the Native Orchid Conservation Program as well as, for example, which species in the collection are currently in bloom. In addition, working through the statewide Master Gardeners network, the Arboretum will be able to disseminate information on a very local level for master gardeners that are more interested in learning about and sharing information about native orchids with the local communities. This train-the-trainer work could happen during field work to each of the collection sites throughout the state during the summer months of the program.

Activity Status as of [1/15/2016]:

Dissemination activities have not begun as of 1/15/2016, however we have procured the donation of a display case that is specially designed to house and display orchids. This can be used to display both adult orchids as well as our developing seedlings for interpretive and educational purposes in The Arboretum's Oswald Visitor Center.



Activity Status as of [6/15/2016]:

Public education over the past six months has included:
For National Public Garden Day in May, Dr. David Remucal gave a talk about the Arboretum's Native Orchid Conservation Program and brought examples of the progress of our lab propagated seeds to show people throughout the day. We also got a few hundred Orchid-gami, which are paper orchid models, that we gave to visitors and helped them construct if they chose to sit down and chat for a while. This was a great opportunity for us to introduce the program to the public as well as answer questions people had about our state's native orchids.



Activity Status as of [1/15/2017]:

We have had several opportunities to publicize our orchid program and talk about the work that we have been able to do. In addition to giving talks to a few regional groups, including U of MN Extension Educators, we were interviewed by Minnesota Public Radio and the U of MN College of Food, Agricultural and Natural Resource Sciences for stories on the orchid program. The MPR story was picked up by regional newspapers (like the Madison, WI paper). Not only have these resulted in increased requests for speaking engagements around the state to hear about the

program, it has also resulted in increased contact by individuals around the state interested in helping with the project, or who have land that has orchids they are interested in having us bank, or even in one case potentially rescue from a road construction project.

Activity Status as of [6/15/2017]:

We have a pamphlet at the Arboretum with information about our Native Orchid Conservation Program. We have also increased the orchid program's presence on the Arboretum website and present currently flowering orchids. We will continue to use Facebook and social media to promote other flowering members of our collection. We also continue to increase the number of talks we give to gardening, scientific and social/naturalist groups as outreach and education on orchid conservation.

As part of our commitment to orchid conservation, the Arboretum sponsored an orchid-gami with the North American Orchid Conservation Center. Appropriately we were able to sponsor the model for the showy lady's slipper, Minnesota's state flower. As part of the sponsorship, the University of Minnesota Landscape Arboretum logo and websites is included on the diecast for the print model and so whenever that model is purchased by anyone, the Arboretum's connection to NAOCC will be publicized, as will our own orchid conservation efforts.

Activity Status as of [1/15/2018]:

MLA orchid program staff continues to give talks at invited locations. This fall, this expanded to include giving talks in front of University of Minnesota classes or audiences. The intention for working with these audiences is to inspire and recruit future generations of conservation professionals. This is especially important for programs like the Plant and Orchid Conservation Programs at the MLA as there are almost no advanced degree programs in conservation horticulture around the entire country.

Activity Status as of [6/15/2018]: Opportunities to educate the public about native orchid conservation continue to increase, with classes both at the Arboretum and at the University of Minnesota. Information about the program was also published in the Minnesota Conservation Volunteer publication of the Minnesota DNR, an important audience for us to reach as it reinforces our collaboration with various parts of the DNR. Information about the program continues to be added to the Arboretum's web page.

Final Report Summary: Over the course of the granting period the public visibility of the Native Orchid Conservation Program increased steadily. With articles in magazines/newspapers, a story on MPR and social media posts, we engaged the public in multiple ways and the success bred interest across the state. The result was that we had people from around the state contacting us with offers to help, information about orchid populations in need, and requests to have us bank seeds on private landowners' lands. This reaction from

around the state was unexpected this early in the program and demonstrates both a real need for this kind of program and general support among Minnesotans. As we continue to establish this program and develop our strategy to educate visitors and the public, this broad base of support will allow us to continue to reach the farthest corners of the state. This kind of reach will allow us to share our work and Minnesota's orchids with people who may not be able to visit the Arboretum and, interestingly, will also allow us to share our plant treasures with people around the world.

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	\$ Amount	Overview Explanation
Personnel:	\$132,276	Salary for .40 FTE Curator for Endangered Plants. Salary for .14 FTE Seasonal Horticulture staff member specializing in work with endangered plants and propagation. One student intern for 400 hours over 10 weeks of summer. Costs are different than originally budgeted for two reasons: 1) there are now lower fringe rate expenses; and 2) offsetting that are changes in base salary for the Curator and interns from when this grant was awarded. The base pay rate was different than it is now, due largely to a minimum base rate being established this year by the University for those positions.
Equipment/Tools/Supplies:	\$11,011	Lab supplies, chemicals, glassware, growth media, greenhouse supplies. Also includes external soil testing lab work, postage for sample analyses, and lease/maintenance of a deionization water system.
Capital Expenditures over \$5,000:	\$0	
Capital Expenditures over \$5,000:	\$0	
Travel Expenses in MN:	\$23,713	Collection trips throughout MN over three years. Includes mileage, hotels, meals, vehicle insurance, leases a U of M vehicle appropriate for fieldwork, and vehicle repairs to U of M Fleet shop.
TOTAL ENRTF BUDGET:	\$167,000	

Explanation of Use of Classified Staff:

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

- 1) Lab glassware dishwasher –As mentioned in the amendment requests above, because of the significant changes in salary as dictated by new University policy, we are requesting to remove this from the budget altogether.
- 2) Water distillation/deionization system –Because we are requesting an amendment to the budget for this system to be leased system instead of purchased, it is removed from the Capital Expenditures category and added to the Equipment and Supplies category.

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 2.19 FTE

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: 0

B. Other Funds:

Source of Funds	\$ Amount Proposed	\$ Amount Spent	Use of Other Funds
Non-state			
Minnesota Landscape Arboretum Foundation	\$13,531	\$5,396	Arboretum personnel will be provided in-kind including: Director of Operations (.05 FTE) for supervision of Curator of Endangered Plants (\$8,911), Arboretum Curator (100 hours) for production and placement of plant labels (\$4,620). In addition the Arboretum is actively fundraising from private philanthropic sources to support this work. As explained above, there will also be funding to match the FTE increase of the Horticultural staff member associated with this project and the Arboretum will match funding for the lease, maintenance and fueling of the vehicle used by the program.
Helen Clay Frick Foundation	\$25,000	\$25,000	
State			
	\$	\$	
TOTAL OTHER FUNDS:	\$38,531	\$30,396	

VII. PROJECT STRATEGY:

A. Project Partners:

The Arboretum does not have organizational partners that will be receiving ENRTF funds. However, in order to accomplish this effort the Arboretum will work with the following organizations and individuals:

Minnesota Department of Natural Resources - The Arboretum's most key partner in this work is the Minnesota Department of Natural Resources. Dr. Remucal has already begun to conduct field work with DNR staff collecting seeds from Western Jacob's Ladder, as you can see in the photo at right.

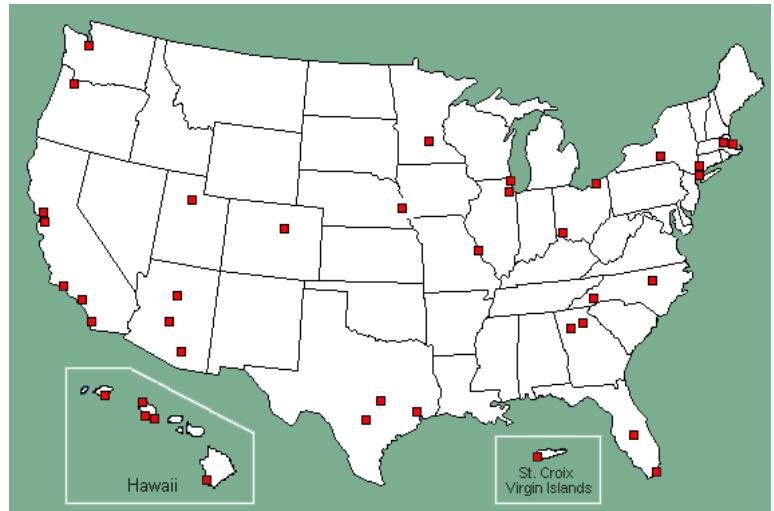


Center for Plant Conservation - The Arboretum is participating organization of the Center for Plant Conservation and plays a major leadership role in monitoring and protecting endangered plants in Minnesota, Wisconsin, Iowa, North Dakota and South Dakota.

National Researchers - Dr. Remucal has already discussed this project with Dr. Jyotsna Sharma Assistant Professor of Plant Ecology & Conservation at Texas Tech University, and she is interested in sharing information and building this field of practice.

Smithsonian - Dr. Remucal will work to build ties and potentially collaborate with the North American Orchid Conservation Center at the Smithsonian.

B. Project Impact and Long-term Strategy:



The Arboretum's Native Orchid Conservation Program is part of a long-term strategy to establish the Arboretum as a premier center for plant conservation and plant conservation research.

The Minnesota Landscape Arboretum is uniquely positioned to carry-out this effort. Botanic gardens:

- Keep records (accessions) on their collections;
- Manage accessions (grow and contain);
- Have greenhouse and garden space for display and experiments ;
- Possess in-house horticultural expertise; and
- Ultimately have a public mission to connect people to plants.

The Arboretum's first step in this effort was to establish itself as a participating institution with the Center for Plant Conservation (CPC) – see map above for locations of CPC participating institution locations. As an official CPC organization, the Arboretum is now charged with actively managing long-term propagule storage for several endangered species. In 2014-2015 this work included collecting seeds and/or live plants from the following species, which include one orchid [UPDATE: as of 2018, this list has expanded and MLA is now managing the range-wide conservation of 2 more orchids, as a direct result of the work supported by this funding]:

- *Besseya bullii* (kittentails)
- *Chrysosplenium iowense* (Iowa golden saxifrage)
- *Erythronium propullans* (dwarf trout lily)
- *Oxytropis campestris* var. *chartacea* (Fassett's locoweed)
- ***Platanthera praecalaria* (western prairie fringed orchid)**
- *Polemonium occidentale* ssp. *lacustre* (western Jacob's ladder)
- *Rhodiola integrifolia* ssp. *leedyi* (Leedy's roseroot)
- *Cypripedium candidum* (small white lady's slipper) – added in 2018
- *Cypripedium arietinum* (ram's head lady's slipper) – added in 2018

To conduct plant conservation on this level requires a long-term commitment. To successfully conduct seed storage the institution must be committed to the on-going collection of seeds as well as to the regular monitoring of the seeds in storage, as not all seeds can be stored indefinitely. Also in the case where live specimens of species are collected and grown in a controlled environment and then replanted at the Arboretum, there is an interest in seeing whether or not these plants could then survive in their native habitats over time, which requires continued propagation and monitoring.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	\$ Amount
Helen Clay Frick Foundation - general plant conservation	2014 – 2015	\$15,000
Helen Clay Frick Foundation – general plant conservation	2013 – 2014	\$20,000
Helen Clay Frick Foundation – seed bank / plant conservation	2011 – 2012	\$7,000

VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS:

N.A.

IX. VISUAL COMPONENT or MAP(S): See attached.

X. RESEARCH ADDENDUM:

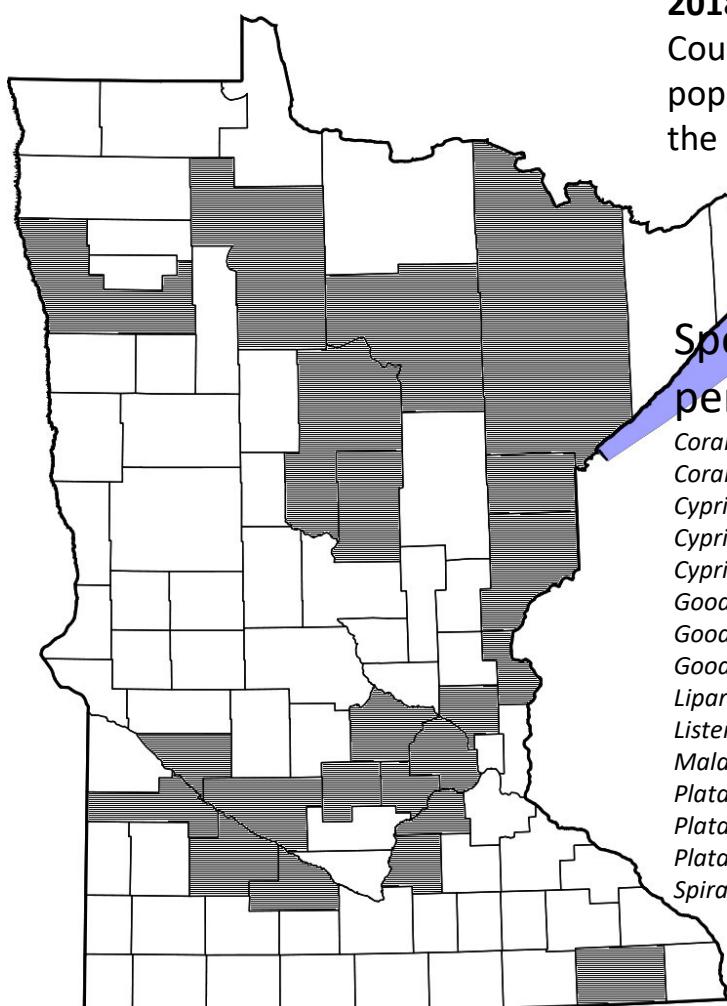
N.A.

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted no later than 1/15/2016, 6/15/2016, 1/15/2017, 6/15/2017, 1/15/2018 and 6/15/2018. A final report and associated products will be submitted between June 30 and August 15, 2018.

Environment and Natural Resources Trust Fund								
Final M.L. 2015 Project Budget								
Project Title: Preserving and Protecting Minnesota Native Orchid Species								
Legal Citation: M.L. 2015, Chp. 76, Sec. 2, Subd. 08c								
Project Manager: David Remucal, Ph.D.								
Organization: University of Minnesota Landscape Arboretum								
M.L. 2015 ENRTF Appropriation: \$ 167,000								
Project Length and Completion Date: 3 Years, December 31, 2018								
Date of Report: 8/31/2018								
ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	Collect and preserve seed and/or live plants from native orchids throughout MN			Propagation and cultivation research of native orchid species				
Personnel (Wages and Benefits) David Remucal, Ph.D., Project Manager: \$92,477 (.40 FTE @ \$25.24 per hour (FY2017 28.73) and fringe of 33.7%)	\$52,910	\$51,177	\$1,733	\$79,366	\$76,766	\$2,600	\$132,276	\$4,333
Ricky Garza, Seasonal Horticulture staff member:\$23,874 (.14 FTE = 291 hours per year @ 27.5% fringe) One student intern: \$15,925 (interns @ \$10.50 / hour (\$12.00/hour for FY2017 and beyond) for 10 weeks for 3 years @ 7.9 % fringe)								
Equipment/Tools/Supplies Lab supplies: Chemicals, glassware, growth media, greenhouse supplies, sterilization equipment. Includes external soil testing lab work and postage for sending samples to Texas Tech and the Smithsonian. (Correcting budgeted amount in Final Report to match approved amended budget in workplan)				\$7,411	\$5,828	\$1,583	\$7,411	\$1,583
Water deionization system- Asymbiotic orchid propagation requires very precise control of nutrients and substrates. Distilled water must be used in most steps to ensure that known quantities of chemical compounds are being used. Often in propagation in this manner well or tap water is fatal to plants. Cost is for lease and maintenance of the system..				\$3,600	\$3,000	\$600	\$3,600	\$600
Capital Expenditures Over \$5,000								
Travel expenses in Minnesota Food and lodging during seed and/or live plant collection trips in Greater Minnesota more than 200 miles round trip for 2 people - \$133/day x 21/days per yr x 3 years. Reimbursed based on University of Minnesota plan. (13840 reported spent in previous report was a typographical error, the correct number was 13040)	\$16,758	\$13,040	\$3,718				\$16,758	\$3,718
Mileage reimbursement for seed and/or live plant collection trips - .575 per mile x 21 round trips per yr x 3 years. Reimbursed based on University of Minnesota plan. (Correcting budgeted amount in Final Report to match approved amended budget in workplan)	\$6,955	\$6,266	\$689				\$6,955	\$689
COLUMN TOTAL	\$76,623	\$70,483	\$6,140	\$90,377	\$85,594	\$4,783	\$167,000	\$10,923

Preserving and Protecting Minnesota's Native Orchid Species



2018 Banked Orchid Populations

Counties (shaded) from which orchid populations have been banked through the 2017 field season for the project

Species banked by end of project period

- Corallorrhiza odontorhiza var odontorhiza* (autumn coral-root)
- Corallorrhiza trifida* (early coral-root)
- Cypripedium acaule* (stemless lady's-slipper)
- Cypripedium candidum* (small white lady's-slipper) *
- Cypripedium reginae* (showy lady's-slipper)
- Goodyera pubescens* (downy rattlesnake-plantain)
- Goodyera repens* (lesser rattlesnake-plantain)
- Goodyera tesselata* (tesselated rattlesnake-plantain)
- Liparis loeselii* (Loesel's twayblade)
- Listera cordata* (heart-leaved twayblade)
- Malaxis unifolia* (green adder's-mouth)
- Platanthera huronensis* (tall green bog-orchid)
- Platanthera obtusata* ssp. *obtusata* (bluntleaved rein-orchid)
- Platanthera psycodes* (small purple fringed orchid)
- Spiranthes magnicamporum* (Great Plains ladies'-tresses)

Asterisks (*) indicate state-listed species



Tuberous grass-pink seedlings on sterile media at MLA (D. Hansen, photo)



Showy lady's-slipper seedlings on sterile media at MLA (D. Hansen, photo)