2018 Project Abstract
For the Period Ending June 30, 2022

PROJECT TITLE: Conserving Minnesota's Forest Birds of Management Concern
PROJECT MANAGER: Alexis Grinde
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 03g as extended by M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 18

APPROPRIATION AMOUNT: $500,000
AMOUNT SPENT: $500,000
AMOUNT REMAINING: $0

Sound bite of Project Outcomes and Results
Golden-winged Warbler, Veery, and American Woodcock are species of conservation concern in Minnesota and have had significant population declines throughout their breeding ranges. We documented nest success and used radiotelemetry to study juvenile survival to identify habitat characteristics and management actions that maximize productivity and inform conservation efforts.

Overall Project Outcome and Results
Minnesota's forests provide critical breeding habitat for hundreds of resident and migrating bird species. Current land use practices and future modifications to Minnesota's forests are likely to substantially transform native forest bird communities. Golden-winged Warbler, Veery, and American Woodcock are species of conservation concern in Minnesota and have had significant population declines throughout their breeding ranges. For breeding birds, conservation efforts are most effective when management plans include recommendations aimed at maximizing breeding season (nesting to post-fledgling) productivity. However, the period of time directly after young birds leave the nest and before they disperse and/or migrate (i.e., the post-fledging period), remains an understudied life stage for most bird species. To address this knowledge gap, we documented nest success and used radiotelemetry to study juvenile survival and habitat use for Golden-winged Warbler, Veery, and American Woodcock in managed forests. Our results showed that nest success (one or more birds fledged per brood) was 47% for Golden-winged Warblers (*n*= 51), 39% for Veery (*n*= 43), and 67% for American Woodcock (*n*= 13). Documented nest failure for all species was due to predation and weather events. A total of 72 Golden-winged Warbler fledglings were tagged with a survival rate of 39%. Juvenile survival was highest for Veery fledglings (*n*= 35) at 83%. A total of 31 American Woodcock hatchlings were tagged during the study with a survival rate of 71%. Over 85% of mortality events occurred when birds were less than seven days post-fledge, indicating this as a high-risk time period for these species. Vegetation surveys were completed at all locations where birds were detected using handheld telemetry (Golden-winged Warblers (*n*= 620), Veery (*n*= 384), and American Woodcock (*n*= 281)). These data are being used to provide breeding cycle habitat recommendations for managing forested landscapes to maximize productivity and prioritize conservation efforts.

Project Results Use and Dissemination
The preliminary results of the research were presented at 13 conferences during the course of project; the study was featured on MPR; and four articles have been written about different aspects of the study. Data from this research was incorporated into a fact sheet "Managing for Birds of Conservation Interest in the Great Lakes Region", which features habitat and management recommendations for Golden-winged Warbler. Three peer-

reviewed publications are expected to be published in 2023. The final results will be incorporated into the Golden-winged Warbler habitat management recommendations.

Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2018 ENRTF Final Report (Main Document)

Today's Date: August 15, 2022

Final Report Date of Work Plan Approval: 06/05/2018

Project Completion Date: June 30, 2022

PROJECT TITLE: Conserving Minnesota's Forest Birds of Management Concern

Project Manager: Alexis Grinde

Organization: Natural Resources Research Institute, University of Minnesota Duluth

College/Department/Division: Forest and Land Initiative

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Location: Northern Minnesota

Total Project Budget: $500,000

Amount Spent: $500,000

Balance: $0

Legal Citation: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 03g as extended by M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 18

Appropriation Language: $500,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota for the Natural Resources Research Institute in Duluth to identify forest-management actions and guidelines to conserve birds in Minnesota's forests. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 18. ENVIRONMENT AND NATURAL RESOURCES TRUST FUND; EXTENSIONS. [to June 30, 2022]

I. PROJECT STATEMENT:

Minnesota's managed forests provide critical breeding habitat for hundreds of resident and migrating bird species. Therefore, forest management provides an important opportunity to conserve and cultivate critical

habitat for species of conservation concern. On-going and future changes to Minnesota's forests are likely to have substantial consequences on forest bird communities. Indeed, several species that breed in Minnesota's forests have been identified as Species in Greatest Conservation Need (SGCN) by MN DNR and as Stewardship Birds of Minnesota by Audubon Minnesota. Golden-winged Warbler, Veery, and American Woodcock are species of conservation concern in Minnesota that have had significant population declines throughout their breeding ranges and all have a large portion of their breeding populations in Minnesota's young forests.

- Golden-winged Warbler is one of the most critically threatened birds in North America with a global population estimated at only 400,000 individuals, and approximately 50% of the global population nesting in Minnesota.
- Veery populations have experienced a global decline of over 40% from 1970 to 2014; approximately 6% of its global breeding population occurs in Minnesota's forests.
- American Woodcock populations have declined by over 30% in North America in the past 50 years; approximately 10% of the global population breeds in Minnesota.

Densities of Golden-winged Warbler, Veery, and American Woodcock are highest in young, wet forests of Minnesota; this forest type is increasingly threatened due to urbanization, agricultural development, and maturation of early successional forests across the state. Historically, periodic natural disturbances would create habitat for these species—wildfires or flooding from beaver dams created a patchwork of shrubby openings amid a largely forested landscape. Currently, the major mechanism of disturbance is harvest, providing an important opportunity for habitat management of these species.

For breeding birds, conservation efforts are most effective when management plans include recommendations to maximize breeding season (nesting to post-fledgling) productivity. However, the period of time directly after young birds leave the nest and before they disperse and/or migrate (i.e., the post-fledging period) remains an understudied life stage. To address this knowledge gap, we will use radio telemetry to study movements, cover-type selection, and survival of fledglings to determine how they use forests during the critical post-fledgling period. Our project will identify characteristics of young forests and forest management actions that maximize breeding season productivity for these species of conservation concern. Our specific objectives are to:

1. Quantify nesting habitat, nest success, and juvenile survival for Golden-winged Warbler, Veery, and American Woodcock in managed forests.
2. Quantify habitat use of Golden-winged Warbler, Veery, and American Woodcock juveniles during the post-fledgling period within managed forest plots in Minnesota
3. Provide breeding cycle habitat management recommendations for managing landscapes to maximize Golden-winged Warbler, Veery, and American Woodcock productivity and conservation.

II. OVERALL PROJECT STATUS UPDATES:

First Update January 1, 2019
Work completed as of December 15, 2018 has focused the following activities: 1.) Identification study sites, 2.) Obtaining necessary permits and certifications that are needed for the project, and 3.) Development of nest searching protocols and telemetry methods for tracking birds.

Second Update July 1, 2019
We are in the middle of the first field season for this project, work completed as of June 25, 2019 has focused on the following activities: 1.) Obtained all permits necessary for bird work, 2.) Built and deployed 12 automated

telemetry stations on the study plot, 3.) Nest searching for focal species, 4.) Telemetry on American Woodcock, Veery and Golden-winged Warblers.

Third Update January 1, 2020
We completed the first field season and are currently processing and analyzing the data and preparing for the upcoming field season.

Fourth Update July 1, 2020
We are in the middle of the second field season for this project. Due to COVID-19 travel restrictions and guidelines, we had to alter plans associated with the original study design. Specifically, we were planning to use a second study area for the 2020 season, however given the extenuating circumstances we were not able to do so. We are using the same study area as we did in the 2019 season, but have expanded our nest searching areas. The overall scope of work has not been impacted by COVID-19. We were able to obtain permission to start field work in late April and have completed the following activities: 1.) Nest searching for focal species, 2.) Telemetry on American Woodcock, Veery and Golden-winged Warblers.

Amendment Request as of 07/08/2020
We request to shift $25,000 in funds from the **Equipment/Tools/Supplies** budget category to the **Travel expenses in Minnesota** category. We request this change because we were able to obtain supplies and build our own automated telemetry stations, further the cost of the UAVs and receivers were lower than when the project budget was originally developed. Travel costs associated with field work were higher than we estimated in our original budget, additionally, COVID-19 related travel guidelines for the 2020 field season required changes in travel logistics that will likely significantly impacted travel costs. Specifically, the **Equipment/Tools/Supplies** budget category will be reduced to $78,090 and the **Travel expenses in Minnesota** category will increase to $35,000. This change is needed to complete the on-going field work but will not impact activity outcomes or the overall budgets for each activity.

Amendment Approved by LCCMR 7/16/2020

Fifth Update January 1, 2021
We completed the second field season for this project and are currently in the process of entering vegetation data and processing insect samples. We have completed preliminary analysis and are in the early stages of preparing our first manuscript. We have requested a project extension for the project until June 2022 due to the impacts COVID travel restrictions had on our project design. The extension would allow us to have an additional field season in a new study area and allow us to assess the consistency in species response to habitat characteristics in different managed forests.

Project extended to June 30, 2022 by LCCMR 7/1/21 as a result of M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 18, legislative extension criteria being met.

Sixth Update August 31, 2021
We completed the third and final field season for this project and focused on American Woodcock and Golden-winged Warbler habitat use to increase sample size for these species. We were able to deploy tags on three female American Woodcock in May 2021, one female died in in late May however the other two birds were tracked throughout the breeding season and we expect to continue to collect data until October 2021. The Golden-winged Warbler research was conducted in three study areas in Chippewa National Forest, we mapped a total of 31 breeding male territories, found 18 nests, tagged 27 juvenile birds, and documented 176 habitat use locations during the 2021 field season.

Seventh Update January 31, 2022:

The project is on track for completion on June 30, 2022. We were able to deploy two tags on male American Woodcock in September 2022 and have been collecting locations for the four birds with active satellite tags through fall migration and on the wintering grounds. We have also completed processing insect samples collected during the 2021 field season. We have completed preliminary analyses for Activity 1 and 2 and will be working to finalize results. We plan to deploy three remaining GPS tags in April / May 2022.

Amendment Request as of 04/20/2022
We request the re-budget of funds as follows: $4,000 from Travel to the Personnel category, and $3,465 within the Travel category from the original lodging budget to short-term lease. The short-term lease will be used to house field personnel during the 2022 field season. We request this change because we were able to find a short-term housing solution that is more centrally located and less expensive than the hotel we originally included in the budget. Specifically, the **Travel** budget category will be reduced to $31,000 and the **Personnel** category will increase to $390,910. This change is needed to complete the on-going field work but will not impact activity outcomes or the overall budgets for each activity.

Amendment approved by LCCMR 5/3/22

Final Update June 30, 2022
We were able to add a fourth field season for this project in spring and summer 2022. Based on the previous results we focused efforts on Golden-winged Warbler because of the need for additional information regarding habitat use, nest success, and juvenile survival. In 2022, we found 22 nests, banded 43 juvenile birds, and tagged 29 birds with transmitters. We are currently incorporating the 2022 data into our analyses and are in the process of writing three manuscripts that we intend to submit this winter. Overall, our results showed that nest success (one or more birds fledged per brood) was 47% for Golden-winged Warblers (*n*= 51), 39% for Veery (*n*= 43), and 67% for American Woodcock (*n*= 13). Documented nest failure for all species was due to predation and weather events. A total of 72 Golden-winged Warbler fledglings were tagged with a survival rate of 39%. Juvenile survival was highest for Veery fledglings (*n*= 35) at 83%. A total of 31 American Woodcock hatchlings were tagged during the study with a survival rate of 71%. Over 85% of mortality events occurred when birds were less than seven days post-fledge, indicating this as a high-risk time period for these species. Vegetation surveys were completed at all locations where birds were detected using handheld telemetry (Golden-winged Warblers (*n*= 620), Veery (*n*= 384), and American Woodcock (*n*= 281)). These data are being used to provide breeding cycle habitat recommendations for managing forested landscapes to maximize productivity and prioritize conservation efforts.

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Assess nesting habitat requirements for Golden-winged Warbler, Veery, and American Woodcock

Description:
We will utilize data collected from our long-term study areas in managed forests of northern Minnesota to identify study sites in young forest stands that have high densities of our focal species. We will search for nests using a combination of standard nest searching methods and by radio-monitoring females to find nests. Upon finding nests, we will record and monitor their progress using nest cameras and field observer nest checks at regular intervals. We will record observations of nestling behavior such as begging or sitting quietly and adult activities such as feeding nestlings, chipping, singing, or not present. We will document sources of mortality and nest failure (if possible); nests that fledge at least one young will be considered successful. We will use high resolution imagery to characterize forest structure and composition at multiple spatial scales around nest locations. These data will allow us to evaluate habitat and landscape factors associated with nest success and hatchling survival.

ENRTF BUDGET: $ 167,468

Outcome	Completion Date
1. Locate and monitor Golden-winged Warbler, Veery, and American Woodcock nests in the 2019 and 2020 breeding seasons.	August 2020
2. Evaluate factors associated with nest success and hatchling survival.	December 2020

First Update January 1, 2019
We have developed nest searching methods specific to each focal species. We have also obtained the Federal Bird Banding Permit (Permittee: Annie Bracey; Permit Number: 24165) required for capturing, banding, and attaching radio-transmitters on focal species.

Second Update July 1, 2019
We obtained Institutional Animal Care and Use Committee (IACUC) approval from the University of Minnesota (PI: Alexis Grinde; Protocol ID: 1902-36815A).

The 2019 study area is approximately 1 km x 1 km in size and is located north of Warba, MN and located on UPM Blandin land. In April 2019, we made and deployed 12 automated telemetry stations throughout the plot, these stations are "listening" for and recording signals from radio transmitters placed on focal species 24hr/day (Figure 1.1).

We started nest searching for American Woodcock in April, 2019. The majority of nest searching for American Woodcock was completed using a trained dog, Riley and systematically walking the study area (see https://www.duluthnewstribune.com/sports/outdoors/1358717-Hunting-for-answers-on-forest-bird-decline). A total of six American Woodcock nests were found and monitored this field season. A total of 17 Veery nests and six Golden-winged Warbler nests have been found and are currently being monitored and are starting to hatch. We anticipate several re-nesting events will be occurring into July.

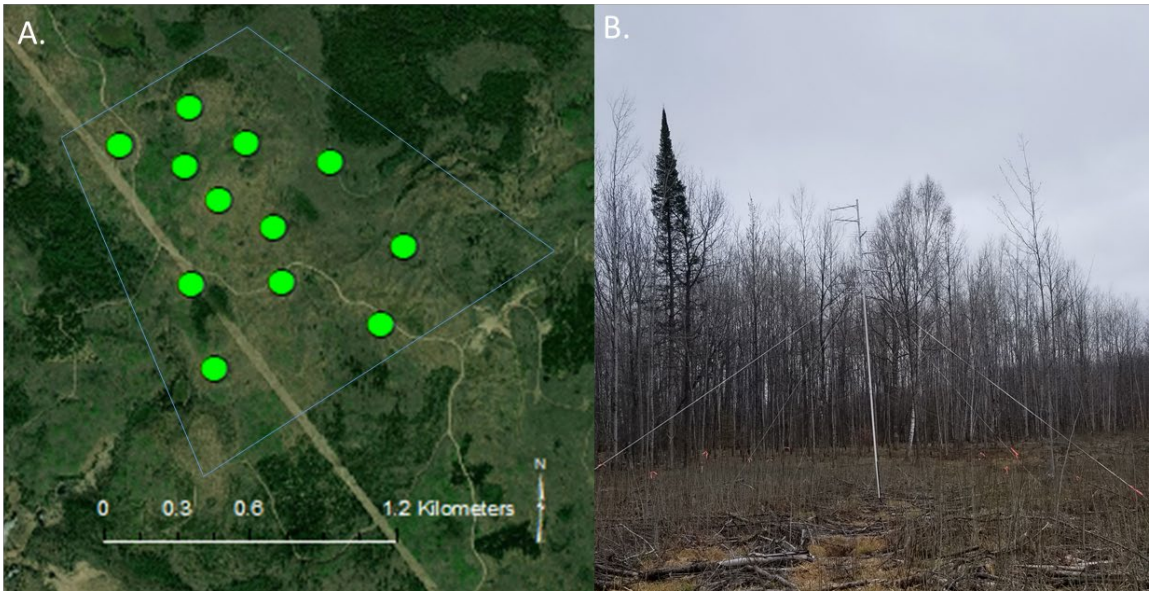


Figure 1.1. A.) 2019 study area outlined in blue, green dots represent automated telemetry station locations, B.) Automated telemetry station placed in recently harvested forest stand in the Blandin study area. This station is listening for and recording signals from radio transmitters placed on focal species 24hr/day.

Third Update January 1, 2020

The nest totals for the 2019 breeding season were as follows:

- American Woodcock. We found a total of six nests, five nests were successful and one failed during incubation likely due to weather.
- Golden-winged Warbler. We mapped a total of 13 territories based on the behavior of singing males. We found a total of six nests, three nests were successful and three failed during the nestling stage.
- Veery. We found a total of 18 nests, seven of the nests were successful and 11 failed at various stages of nesting.

We quantified habitat characteristics of the nest locations (*n*=37) for all of the species including primary cover type, age, structure, vegetation characteristics around the nests. We are currently summarizing these data to assess common factors associated with nest success for each species.

Fourth Update July 1, 2020

As of June 29, 2020 the nest totals are as follows:

- American Woodcock. We found three nests in 2020, note we had a late start to the field season due to COVID-19 travel and work restrictions. We found a total of nine nests in 2019 and 2020.
- Golden-winged Warbler. We found a total of five nests so far this year.
- Veery. We found a total of 15 nests at this point of the 2020 season.

Fifth Update January 1, 2021

The nest totals for the 2019 and 2020 breeding seasons were as follows:

- American Woodcock. We found a total of nine nests in total in the 2019 and 2020 field seasons, despite systematic nest searches across the study area, all nests were found in one stand that was approximately 25 year old aspen.
- Golden-winged Warbler. We found a total of 11 nests in the 2019-2020 field seasons. Seven nests were located in early-successional stands but only three of these nests successfully fledged young. Four nests were in stands that were over 12 years post-harvest, two of the nests were successful.
- Veery. We found a total of 43 nests in the 2019 and 2020 field seasons, 33 of the nests were found in forest stands that ranged in age from 12 to 35 years post-harvest. Approximately 40% of nests successfully fledged young.

We quantified habitat characteristics of the nest locations (*n*=63; Figure 1.2) for all of the species including primary cover type, age, structure, vegetation characteristics around the nests. We are currently conducting preliminary analyses to assess common factors associated with nest success for each species.

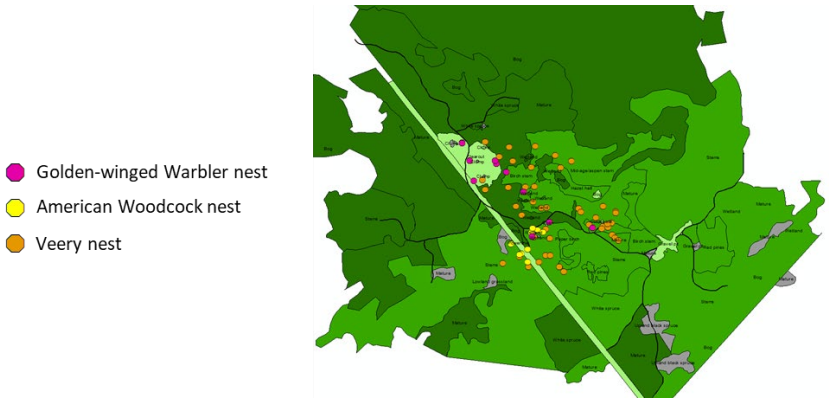


Figure 1.2. Nest locations for the 2019 and 2020 field seasons.

Sixth Update June 30, 2021

American Woodcock. Nest searches were conducted using trained hunting dogs, however due to the extreme heat in May 2021 we were not able to run the dogs on a regular basis. Instead, we shifted our focus to tagging breeding females and ultimately were able to tag three females in a study area near Hackensack, MN. One of the females was tracked for six days and was predated, likely while on a nest. The other two females have been tracked since May, one female nested near the Hackensack area and the other moved to an area near Agassiz National Wildlife Refuge.

Golden-winged Warbler. We mapped a total of 31 breeding male territories and found 18 nests locations during the 2021 field season. Nest success varied across three study areas from 80% to 38%; the average nest success was 52%. A total of nine nest predations occurred across the three study areas; Brown-headed Cowbirds, Blue Jay, and red squirrels were documented near nests.

Veery. We did not focus on Veery this field season, this decision was based on a variety of factors including hiring constraints associated with COVID-19. We had high sample sizes associated with Veery from the 2019 and 2020 field season and feel the data that was collected the previous two years will provide valuable insight into Veery habitat use during the breeding season.

Seventh Update January 31, 2022:

We have continued to track the female American Woodcock that were tagged with satellite tags in May. Both of the females that were tagged and tracked throughout the breeding season survived the hunting season and fall migration. The female that bred near Hackensack migrated straight south and was last detected near Kisatchie National Forest in Louisiana on November 13, 2021 (*n*= 44 locations). The female that bred near Thief Lake also migrated south through Iowa, stopped in Missouri, Arkansas, and was last detected near the Texas- Arkansas boarder on December 8, 2021 (*n*= 55 locations). Two males were fitted with transmitters in September near Hackensack, MN. One of the males moved northward from the banding site in Walker, Minnesota to an area near Baudette where he stayed for over a month. We think this bird was potentially prospecting for a new territory for nesting in the spring. headed south shortly and has been moving around the wintering grounds ranging from areas near Muskogee, Oklahoma, Shreveport, Louisiana, and was last detected near Livingston, Texas on February 6, 2022 (*n*= 26 points). The other male showed an unexpected migration movement by traveling east to Ohio before heading south and spent time in Alabama and was last detected near Martin, Tennessee on February 21, 2022 (*n*= 26 points). The tags are programmed to record data through May 2022. If the batteries last through spring migration, we hope to learn more about breeding site fidelity and migration patterns as they return to Minnesota in the spring (Figure 1.3).

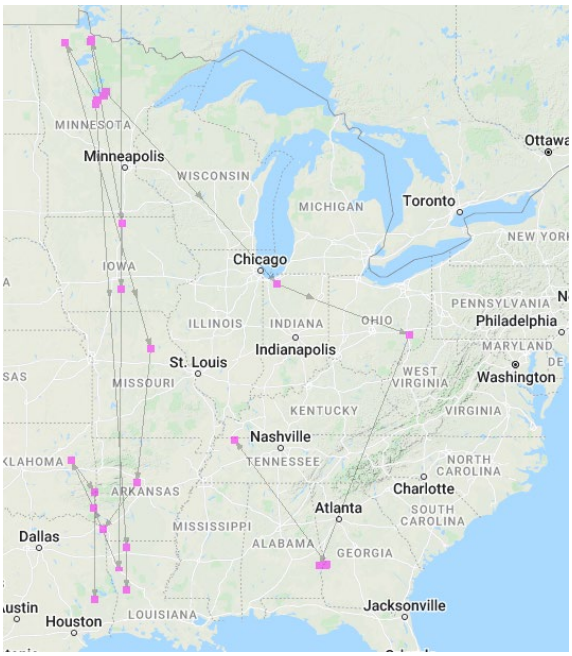


Figure 1.3. Locations of five American Woodcock tagged with GPS satellite tags.

Final Report Summary

American Woodcock. We were able to obtain locations two of the male birds tagged in fall 2021 over the spring and the start of the breeding season. The male that spent the winter in eastern Oklahoma and Texas was detected from April to June 2022 in Arkansas near the Ouchita National Forest, the last detection was June 26, 2022, which indicates the male did not return to Minnesota for the breeding season. The other tagged male was detected in northern Wisconsin on April 2, 2022 and on April 7, 2022 he returned to the exact area he was tagged in the fall. The bird stayed in the same general location throughout April, suggesting the bird was establishing breeding territory. We were able to tag one additional female in May 2022, the bird was captured on the nest in an area east of Leech Lake, at the time of the report we have 12 locations for the female, all locations are near the nest likely indicating a successful brood. The tag is set to continue collecting data through spring 2023.

Golden-winged Warbler. We mapped a total of 42 breeding male territories across six study sites in 2022 field season. A total of 22 nests were found and monitored, of the 22 nests found 10 of them (45%) successfully fledged one or more young. Reasons for nest failure included predation (*n*= 5), abandonment of the nest (*n*= 3), and flooded due to heavy rain (*n*= 4). Documented nest predation events included predation by Broad-winged Hawk, common garter snake, raccoon, and chipmunk.

ACTIVITY 2: Assess habitat use of juvenile Golden-winged Warbler, Veery, and American Woodcock

Description:
As nestlings approach the fledging stage (~7-8 days post-hatch), we will tag juveniles with radio-transmitters. Juveniles will be tracked daily using a combination of ground telemetry methods, unmanned aerial vehicles (UAVs), and automated telemetry stations to identify movements for approximately 20 days post-fledgling. Using these cutting-edge technologies we will be able to obtain space-use data of fledglings at multiple spatial and temporal scales. We will use standard telemetry techniques to obtain GPS locations of tagged birds, however because accuracy of these points is often limited in dense, regenerating forests we will also attach VHF radio receivers and antenna to UAVs to perform broad sweeps of the study areas. This technique will allow us to

obtain multiple locations of tagged birds in a study area daily, further the accuracy of location data may be improved by tracking birds above the canopy. Finally, we will deploy automated telemetry stations in a grid across the study area; strength of the signals of tagged individuals detected at each station will provide information about direction and rate of movements over time.

Juveniles will be tracked to monitor survival and record habitat use. We will record habitat variables at two scales: 1) macro scale; forest cover type the juvenile is using, and 2) the micro scale; within stand features (e.g. sapling height, vegetation density) around juvenile locations. In addition to recording habitat information where birds are located, we will also record habitat variables at paired random locations that were "available". Therefore on each day, every juvenile will have a "used" and paired "available" survey location. These data points will allow for analyses that show the extent to which fledglings select for specific cover types and habitat features that are associated with forest management. We will use high resolution imagery to characterize forest structure and composition at multiple spatial scales around "used" and "available" locations. This portion of the study will allow us to assess post-fledging survival across space and time. This information is imperative to maximize the productivity of breeding birds and to provide management recommendations for species of conservation concern.

ENRTF BUDGET: $ 249,969

Outcome	Completion Date
1. Tag juveniles with radio-transmitters as they approach the fledgling stage of development in the 2019 and 2020 breeding seasons.	August 2020
2. Track juveniles daily and record habitat use for 14-21 days during the 2019 and 2020 post-breeding season.	August 2020
3. Document and evaluate juveniles space use and movement in relation to available cover type and forest structure.	December 2020

First Update January 1, 2019
Five members of the Avian Conservation and Wildlife Ecology research lab at the Natural Resources Research Institute have passed the Federal Aviation Administration Unmanned Aircraft Exam and obtained their remote pilot certificate in November 2018. This certification is required to fly UAVs for the project. Other activities include developing and testing telemetry equipment to determine best practices and data processing for field methods.

Second Update July 1, 2019
As of June 27, 2019 we have put 11 transmitters on five broods of American Woodcock, seven transmitters on two broods of Golden-winged Warbler, and eight transmitters on four broods of Veery (Figure 2.1). The juveniles are being tracked using a combination of hand-held telemetry and via the automated telemetry stations.

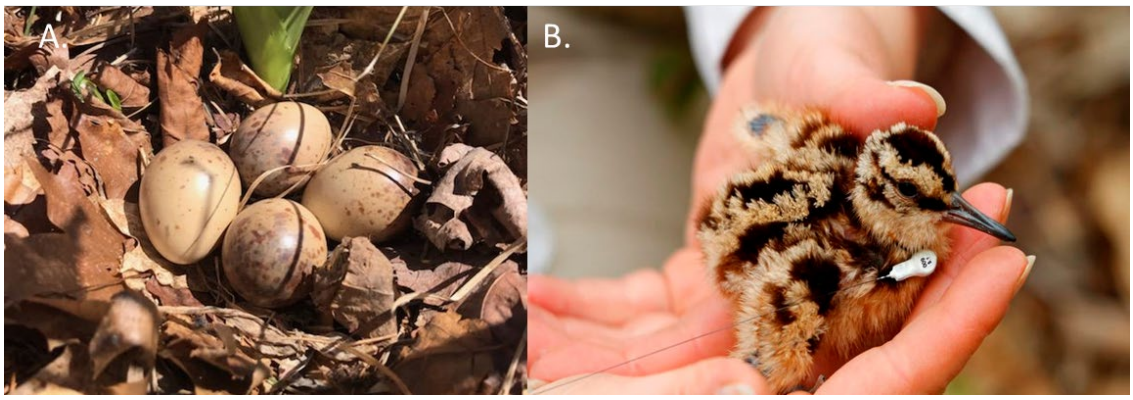


Figure 2.1. A.) American Woodcock nest, B.) American Woodcock chick with radio transmitter attached. Picture courtesy of Michael Furtman.

Vegetation sampling is being conducted at locations being used by juveniles and a paired random “non-used” location. Characteristics such as canopy cover, canopy composition, litter depth, stem counts, and ground cover are assessed and will be used to compare the differences in forest characteristics in the used and non-used locations. Additionally, we are collecting data on food availability, worms and soil invertebrates for American Woodcock, and insects for Veery and Golden-winged Warbler at the used and “non-used” locations.

Third Update January 1, 2020

Telemetry totals for the 2019 breeding season were as follows:

- **American Woodcock.** A total of 11 hatchlings from five broods were banded and fit with radio transmitters. There were five presumed mortalities and six "successful" individuals that were tracked for 45 days on average however two individuals were found alive at 66 and 78 days. We documented 138 hand-held telemetry locations for the juvenile woodcock.
- **Golden-winged Warbler.** Eleven nestlings from three broods were banded and fit with radio transmitters. There were six presumed mortalities, four "successful" individuals that were tracked for 20-30 days post-fledge, and one individual lost the transmitter. We documented 73 hand-held telemetry locations for juvenile Gold-winged Warblers.
- **Veery.** A total of 13 nestlings from six broods were banded and fit with radio transmitters. There was one presumed mortality and 11 "successful" individuals that were tracked for 14-20 days post-fledge. We documented 84 hand-held telemetry locations for juvenile Veery.

To characterize the available and used habitats in the study area we conducted 136 systematic vegetation surveys along with a total of 763 vegetation surveys that compared used and “non-used” paired locations that were randomly placed 30m from the telemetry locations. Preliminary results from the American Woodcock habitat data showed that average total stem count ($P < 0.01$), percent log cover ($P < 0.01$), and percent leaf litter ($P < 0.01$) were significantly higher at telemetry or “used” locations compared to the random locations and percent grass cover was significantly lower at used locations compared to random locations ($P < 0.01$; Figure 2.3). Insect samples were also taken at each telemetry location and are currently being processed and identified in the lab.

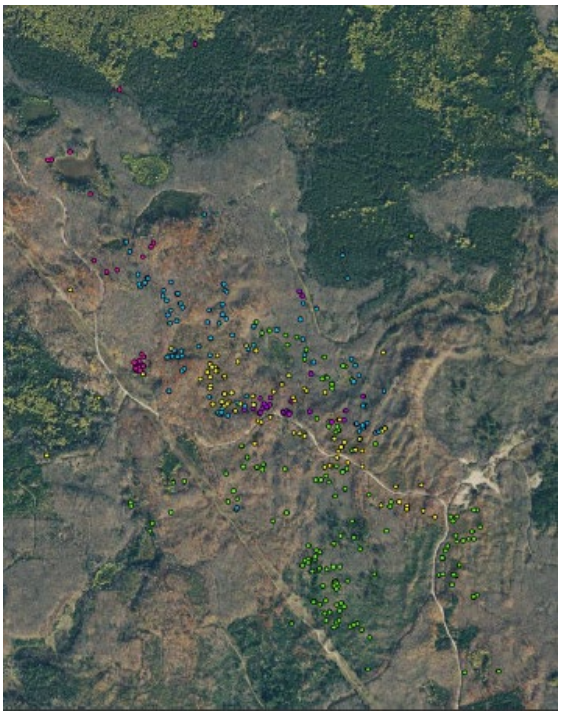


Figure 2.2. Hand-held telemetry locations for all focal species. American Woodcock: Green, Golden-winged Warblers: Yellow, Veery: Blue. Non-focal (mature forest breeding) species locations are also shown; Least Flycatcher: Pink; Nashville Warbler: Purple.

Figure 2.3. Preliminary results from paired t-tests of used and non-used locations for American Woodcock indicated that high stem densities, downed logs, and leaf litter are important features for juvenile woodcock.

Fourth Update July 1, 2020

As of June 29, 2020 we have collected the following data associated with Activity 2 in the 2020 field season:

- **American Woodcock.** We banded 18 individuals from seven broods and have 95 telemetry detections so far this season.
- **Golden-winged Warbler.** We have banded six individuals from two broods and have collected 32 telemetry points so far this year.
- **Veery.** We have banded 16 individuals from five broods and have collected 84 telemetry points for this species so far this season.

The juveniles are being tracked using a combination of hand-held telemetry and via the automated telemetry stations. Vegetation surveys and insect sampling are being conducted at telemetry "used" locations and paired "non-use" locations.

Fifth Update January 1, 2021

- **American Woodcock.** A total of 31 hatchlings were tagged and we collected 562 telemetry detections over the two field seasons. Predation was the primary cause of mortality and the overall hatchling survival rate was 71%.
- **Golden-winged Warbler.** A total of 16 fledglings were tagged and we collected a total of 199 telemetry locations. There were seven fledgling predations and the overall survival rate was 56.2%. The majority of mortality occurred when birds were less than five days post-fledge.
- **Veery.** A total of 35 fledglings were tagged and we collected a total of 384 telemetry locations over the two field seasons. There were six fledgling predations and the overall survival rate was 82.9%. All fledgling mortality occurred when birds were less than four days post-fledge.

Vegetation surveys and insect samples that were collected at "used" locations and paired "non-use" locations are being entered and processed.

Sixth Update June 30, 2021

- **American Woodcock.** A total of 58 habitat use locations were documented for American Woodcock in the 2021 field season. We expect the tags to remain active through the remainder of the post-breeding season.
- **Golden-winged Warbler.** A total of 37 fledglings were banded and 27 were tagged with radio transmitters. Fifteen juveniles died during the post-fledge period and the overall survival rate was 55.5%. The majority of mortality occurred when birds were less than five days post-fledge. A total of 176 were collected this field season. Vegetation surveys and insect samples were collected to document differences in habitat characteristics and food availability between the study areas.

Seventh Update January 31, 2022

We have completed processing insect samples that were collected at "used" locations and paired "non-use" locations. We have conducted preliminary analyses of habitat use for juvenile focal species.

Final Report Summary

- **American Woodcock.** A total of 18 habitat use locations were documented for American Woodcock in the 2022 field season. These data are currently being analyzed and will be included in the manuscript that is currently being prepared focusing on woodcock breeding movement and behavior.
- **Golden-winged Warbler.** A total of 43 fledglings were banded and 29 were tagged with radio transmitters. Nineteen juveniles died during the post-fledge period, three birds had unknown fates (e.g., tag failed, left the study area, predated and not detected), and only seven tagged birds survived to 25 day post-fledge (24% survival). Similar to the 2021 field season, the majority of mortality (89%) and occurred when birds were less than seven days post-fledge, the remaining two occurred day 16 and day 28 post-fledge. A total of 245 detections and vegetation points were collected this field season. These data will be combined with data from previous field seasons and are currently being analyzed to assess how differences in habitat characteristics and food availability impact overall productivity.

ACTIVITY 3: Activity 3: Develop forest management strategies to maximize Golden-winged Warbler, Veery, and American Woodcock productivity

Description:
Findings from Activities 1 and 2 will be integrated to establish habitat management guidelines that account for the interrelationships among nesting and juvenile habitat use and survival. Habitat guidelines will identify cost effective forest management strategies that improve, protect, and enhance young forest habitats to maximize breeding season productivity of focal species.

ENRTF BUDGET: $ 82,563

Outcome	Completion Date
1. Compilation and integration of nesting and juvenile habitat use.	February 2021
2. Development of habitat management guidelines to be used by land managers to maximize breeding season productivity of focal species.	June 2021

First Update January 1, 2019
Limited work has been completed associated with this activity other than researching and reviewing current habitat management guidelines.

Second Update July 1, 2019
Limited work has been completed associated with this activity.

Third Update January 1, 2020
Limited work has been completed associated with this activity.

Fourth Update July 1, 2020
Limited work has been completed associated with this activity.

Fifth Update January 1, 2021
Limited work has been completed associated with this activity.

Sixth Update June 30, 2021
Limited work has been completed associated with this activity but is the focus of this year's activities.

Seventh Update January 31, 2022:
Preliminary analyses have been completed and we are working with our forestry partners to ensure results will be translatable to management actions.

Final Report Summary
We are currently adding in the 2022 data into our analyses and will be finalizing all results fall 2022. Preliminary results indicate that the focal species responded to areas within stands that had more structural diversity compared to random or "non-used" sites. For example, in preliminary models, coarse woody debris was important for young woodcock chicks, particularly in May, because they use these structures for cover and camouflage before the vegetation has started to emerge. Veery relied on dense shrub layer for nesting and during the post-breeding time period. Similarly, Golden-winged Warblers nested in microhabitats that high stem density and fledgling survival was highest in areas with higher shrub density compared to non-used sites. Overall, this pattern indicates that forest management prescriptions and implementations that promote increased structural diversity, such as increased retention of coarse woody debris, feathered edges to soften

edge transition from harvested area to adjacent mature forest, will be beneficial to birds that breed in young forests. Further, this study quantified distance moved by birds during the post-fledging time period. For example, Golden-winged Warblers moved approximately 100 m from the nest the first seven days post-fledging and 500 m from the nest days 7-14 post-fledging. These data will provide important insight for landscape-level planning to ensure there are suitable forest types adjacent to harvested stands that will increase probability of juvenile survival. Shifting the focus from creating "suitable breeding habitats" to creating "high-quality breeding landscapes" will align ecological needs of birds throughout the breeding cycle with conservation efforts. We expect three peer-reviewed articles associated to be published in 2023.
Results and proposed modifications to current guidelines have been presented to a variety of local and national organizations and stakeholders including the Golden-winged Warbler working group, National Council for Air and Stream Improvement, Forestry for Minnesota Birds working group, and Minnesota Forest Habitat Collaborative.

IV. DISSEMINATION:

Scientific publications: We expect that this project will produce at least 3 peer reviewed journal articles focusing on post-breeding habitat use for these species.

Presentations: Results will be disseminated through local, regional, and national conferences.

Data: Publically available data will be hosted through the Natural Resources Research Institute website.

Project partners will use the results of this study to identify and improve forestry practices to benefit Minnesota's birds. Recommendations will be provided to public and private land managers to facilitate land use planning that maximizes Golden-winged Warbler, Veery, and American Woodcock breeding season productivity to help conserve these species of concern in Minnesota.

Description:

First Update January 1, 2019
Materials are not ready to disseminate.

Second Update July 1, 2019
Materials are not ready to disseminate.

Ryan Steiner presented an overview of the project to the Minnesota American Woodcock Banding Program at the Pineridge Grouse Camp in Remer, MN on May 10, 2019.

The American Woodcock portion of the project was featured in the Duluth News Tribune on June 8th, 2019 https://www.duluthnewstribune.com/sports/outdoors/1358717-Hunting-for-answers-on-forest-bird-decline and was also featured in the Natural Resources Research Institute June 2019 newsletter https://www.nrri.umn.edu/natural-resources-research-institute/news/woodcock-study.

Third Update January 1, 2020
Alexis Grinde presented an overview of the project "Early success of early-successional birds" as part of the National Council for Air and Stream Improvement, Inc. Birds in Working Forests webinar on October 15, 2019.

The preliminary results of this project will be presented at the SFEC's 2020 Forestry and Wildlife Research Review on January 9, 2020.

Fourth Update July 1, 2020
Several planned presentations were not given in the spring of 2020 because of the widespread cancelation of events due to the COVID-19 pandemic.

Fifth Update January 1, 2021
The research project was featured on Minnesota Public Radio on August 28, 2020: In northern Minnesota, tracking songbirds to help them thrive in a changing forest.

Preliminary results of this study have been shared at the following events:

- Grinde, Alexis. Forest birds and habitat management**:** What do we do? December 10, 2020. Minnesota Forest Management and Wildlife Summit.
- Steiner, Ryan. Juvenile survival and habitat use of American Woodcock, Golden-winged Warbler, and Veery in a managed forest. January 12, 2021. Forestry and Wildlife Research Review and MNSAF Annual Meeting.

Sixth Update June 30, 2021
We have been able to share the results of our study at virtual meetings this year including:

- Grinde, Alexis. Juvenile survival and habitat use of American Woodcock, Golden-winged Warbler, and Veery in a managed forest. March 29, 2021. NCASI Eastern Biodiversity Working Group Meeting.
- Grinde, Alexis. Young forests and breeding bird habitat. April 5, 2021. NCASI Northern Sounding Board Meeting.
- Dr. Grinde also led the development of the fact sheet "Managing for Birds of Conservation Interest in the Great Lakes Region" in collaboration with NCASI staff, which features habitat and management recommendations for Golden-winged Warbler.

Seventh Update January 31, 2022
The research project was featured in Duluth News Tribune Minnesota Public Radio on February 7, 2022: Study reveals woodcock wintering grounds.

We have given the following presentations:

- Grinde, Alexis. Forest Management and Birds in the Lake States: Improving Golden-winged Warbler Conservation and Habitat Restoration. NCASI. September 16, 2021.
- Bednar, Josh. Using Technology to Understand the Post-breeding Ecology of American Woodcock. Minnesota Ornithological Union Paper Session. December 4, 2021.
- Howland, Brett. Golden-winged Warbler breeding ecology and habitat use. Minnesota Chapter of The Wildlife Society. February 23, 2022.

Final Report Summary
We have given the following presentations:

- Grinde, Alexis. Forest Management and Birds in the Lake States: Improving Golden-winged Warbler Conservation and Habitat Restoration. NCASI. May 17, 2022.
- Bednar, Josh. Minnesota's Breeding Birds: trends and needs. May 22, 2022.
- Howland, Brett. Golden-winged Warbler breeding ecology and habitat use. Minnesota Chapter of The Wildlife Society. March 8, 2022.

Since the start of this project we have given a total of 12 presentations, been featured in three news articles, one MPR story, and helped to develop a fact sheet that has been disseminated to landowners and foresters across the Great Lakes region.

Peer-reviewed journal articles:
We are currently working on three peer-reviewed journal articles associated with this study. The first paper is a summary of nest success and post-breeding movements and habitat use for Veery, American Woodcock, and Golden-winged Warbler, the second focuses on American Woodcock habitat use and annual movements, and the third focuses on Golden-winged Warbler habitat-use and predation risk. We plan to submit all manuscripts in the fall of 2022. **Data:**Once published, data will be hosted through the Natural Resources Research Institute website.

V. PROJECT BUDGET SUMMARY:

A. Preliminary ENRTF Budget Overview: See attached budget spreadsheet

Explanation of Capital Expenditures Greater Than $5,000: n/a

Explanation of Use of Classified Staff: n/a

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 4.95 FTE

Enter Total Estimated Personnel Hours: 10,300	Divide by 2,080 = TOTAL FTE: 4.95

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

Enter Total Estimated Personnel Hours: 0	Divide by 2,080 = TOTAL FTE: 0

B. Other Funds:

SOURCE OF AND USE OF OTHER FUNDS	Amount Proposed	Amount Spent	Status and Timeframe
Other Non-State $ To Be Applied To Project During Project Period:			
	$ n/a	$ n/a	
Other State $ To Be Applied To Project During Project Period:			
	$ n/a	$ n/a	
Past and Current ENRTF Appropriation:			
	$ n/a	$ n/a	
Other Funding History:			
This project is building on 5 years of monitoring of breeding birds in large managed forest plots.	$ n/a	$ 125,000	Project began in 2012 and was completed in 2017.

VI. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role

B. Partners NOT receiving ENRTF funding

Name	Title	Affiliation	Role
Sawyer Scherer	Forest Ecologist	UPM Blandin Company	Coordinating with study site selection

VII. LONG-TERM- IMPLEMENTATION AND FUNDING: The project is an extension of a long-term study (20 year) that has documented the impacts of forest management on Minnesota's breeding birds. This project will provide the data to assess habitat use of three species of conservation concern to better understand habitat associations across their entire breeding cycle. The results from this study will determine how forest harvests should be designed to maximize benefits for these species and identify habitat attributes that optimize nesting and brood-rearing success for these species. Identification and implementation of science-based best management practices that create or maintain Golden-winged Warbler, Veery, and American Woodcock breeding habitat is an important step towards sustaining and enhancing populations of these species in the state, plus reversing the widespread population declines observed throughout their breeding ranges. Findings and data generated from this project will also serve as a foundational resource to prioritize and assess future threats to Minnesota's birds.

VIII. REPORTING REQUIREMENTS:

- **The project is for 4 years, will begin on July 1, 2018 and end on June 30, 2022.**
- **Periodic project status update reports will be submitted January 1 and July 1 of each year.**
- **A final report and associated products will be submitted between June 30 and August 15, 2022.**

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

A. Budget Spreadsheet
B. Visual Component or Map
C. Parcel List Spreadsheet
D. Acquisition, Easements, and Restoration Requirements
E. Research Addendum

Attachment A:
Environment and Natural Resources Trust Fund
M.L. 2018 Final Budget Spreadsheet

Project Title: Conserving Minnesota's Forest Birds of Management Concern
Legal Citation: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 03g Final
Project Manager: Alexis Grinde
Organization: Natural Resources Research Institute, University of Minnesota Duluth
College/Department/Division: Forest and Land Initiative
M.L. 2018 ENRTF Appropriation: $500,000
Project Length and Completion Date: 4 years, June 30, 2022
Date of Report: August 15, 2022

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	REVISED BUDGET (5/3/2022)	AMOUNT SPENT	TOTAL BALANCE
BUDGET ITEM			
Personnel (Wages and Benefits)	$390,910	$390,910	$0
Alexis Grinde, Principal Investigator (66.5% salary, 33.5% benefits); 21% effort each year for 3 years. $67,340			
Research Scientists, (2), Fieldwork, Data Collection and Analysis (66.5% salary, 33.5% benefits); 44% effort each year for 3 years. $196,880			
Field technicians (4), Nest searches, Telemetry and Vegetation Sampling (92.3% salary, 7.7% benefits); 90% cumulative effort 3 months per year for 3 years. $77,565			
Bird banders (2) (92.3% salary, 7.7% benefits); 100% cumulative effort each year in Y1 and Y2. $15,125			
Undergraduate Research Assistant, Assist field technicians and data entry (100% salary); 45% effort each year in Y1 and Y2. $34,000			
Equipment/Tools/Supplies: $78,090			
3 VHF Radio Receivers telemetry receivers (incl. antennas) @ $2500 ea used to track birds. $7500	$7,500	$7,500	$0
3 unmanned aerial vehicles (UAVs) will be used to mount the receivers and track fledglings over large distances @ $3000 ea. $9000	$9,000	$9,000	$0
30 nest cameras to track nestling survival, hatch date, and predation events @ $150. $4,500	$4,500	$4,500	$0
240 transmitters ($150 ea.) to attach to birds to track their movements . $36,000	$36,000	$36,000	$0
4 GPS units to map precise locations of fledglings ($197 ea.). $790.	$790	$790	$0
6 automated telemetry stations to track long-range movements in remote locations $20,300	$20,300	$20,300	$0
Travel expenses in Minnesota	$31,000	$31,000	$0
Short-term lease of lodging locations (estimate $3,465).			
Travel for fieldwork, including mileage (75%) and lodging (25%) for researchers and banders. Mileage will be reimbursed at $0.535/mile (University of MN rate). Travel is largely associated with large-scale (state-wide) deployment and maintenance of the Motus receivers during the spring and fall migration. Lodging is estimated between ($90-$130 per night). $18,465.			$0
COLUMN TOTAL	**$500,000**	**$500,000**	$0

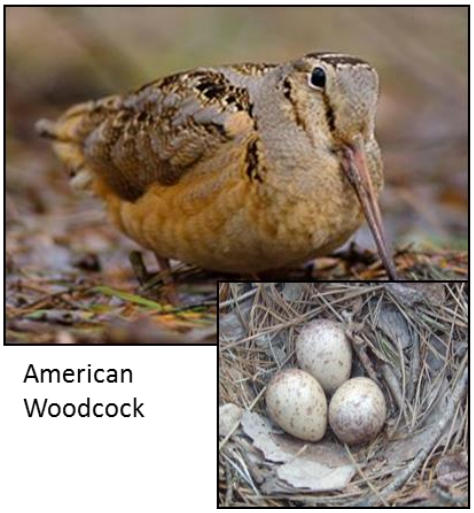
Natural Resources Research Institute
University of Minnesota Duluth
Driven to Discover

Conserving Minnesota's Forest Birds of Management Concern
Project Manager: Alexis Grinde
Legal Citation: M.L. 2018, Chp. 214, Art. 4, Sec. 02, Subd. 03g as extended by M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 18

Conserving Minnesota's Forest Birds of Management Concern

Golden-winged Warbler

Veery



American Woodcock

Problem: Golden-winged Warbler, Veery, and American Woodcock have had significant population declines and have a large portion of their breeding populations in Minnesota's young forests.

Solution: Determine how these species use forests during the post-fledging period and identify characteristics of young forests and forest management actions that maximize breeding season productivity.

Project Outcomes: Structural features such as coarse wood material, shrub density, and canopy diversity are important for nesting and survival of young birds. Utilizing forestry techniques that increase availability of these structures in young forests may help to increase annual survival.

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