2016 Annual Report Assessing Wildlife Response to NRCS Conservation Programs Targeting Early Succession Habitats

A Conservation Effects Assessment Project (CEAP)

Cooperative agreement # 68-7482-15-501

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NOTE: This is an annual report and therefore the results contained herein are not considered final. This project and its many components are ongoing. Final results and conclusions will be presented in a final report, graduate theses/dissertations, NRCS's Conservation Insight series, and peer-reviewed publications.

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Project Synopsis

The Golden-winged Warbler (*Vermivora chyrsoptera*) is one of the most critically threatened, non-federally listed vertebrates in eastern North America. The implementation of science-based best management practices that create or maintain Golden-winged Warbler breeding habitat is thought to be an important step to reversing the species decline. In 2012, NRCS and USFWS initiated a joint conservation program called *Working Lands for Wildlife* (WLFW). This program specifically targets the creation or enhancement of habitat for imperiled species, including the Appalachian population of the Golden-winged Warbler. Additionally, the American Bird Conservancy and its partners were awarded funding for a Regional Conservation Partnership Program (RCPP) project in Minnesota, Michigan, and Wisconsin to assist NRCS with landowner outreach, coordination, and technical assistance to benefit Golden-winged Warbler, American Woodcock (*Scalopax minor*), and associated species. To date, between the Appalachians and Great Lakes efforts, >6,650 acres and >14,000 acres of Golden-winged Warbler nesting habitat have been produced on public (MN and PA) and private lands (MN, WI, PA, NJ, and MD), respectively. Herein, we describe methods and some preliminary results for each of five projects concerning the habitat management initiatives that target Golden-winged Warbler habitat. These include 1) monitoring of biological response to habitat management across both regions (woodcock, songbird, and vegetation); 2) development of range-wide Priority Areas for Conservation (PACs) for Golden-winged Warblers; 3) development of an online tool to evaluate the effectiveness of actions taken to improve habitat conditions for Golden-winged Warblers; 4) evaluation of landowner response to NRCS conservation programs targeting early successional habitat; and 5) post-fledging survival and habitat selection in managed forest.

We conducted woodcock surveys (n=649) at sites that were recently managed to create habitat for Golden-winged Warblers. Woodcock were detected at 38% and 85% of locations across the Appalachian and Great Lakes regions, respectively. Woodcock density was higher on public lands within the Appalachians, but equal between the ownership types within the Great Lakes. We conducted point counts (n=823) for Golden-winged Warblers and associated songbirds. The results of occupancy modeling indicated 25% and 89% occupancy of sites by Golden-winged Warblers in the Appalachians and Great Lakes regions, respectively. Within the Appalachians, we found a strong effect of ownership domain on occupancy with public land sites hosting warbler occupancy rates of 40% in contrast to 12% on private lands. We found a similar (though weaker) trend in the Great Lakes. Analysis of vegetation associations highlight the importance of woody regeneration, with the range of values for the majority of managed sites falling within recommended values for GWWA nesting habitat outlined by the Golden-Winged Warbler Best Management Practice (BMP) guidelines for each region We used a four-step process to create a single spatial layer indicating locations potentially suitable for Golden-winged Warbler habitat management. These potential Golden-winged Warbler habitat areas (Priority

Areas for Conservation, PACs) incorporate both public and private lands that met the following criteria: i) > 60% non-coniferous forest cover at the "macro" landscape scale or were within a contiguous non-coniferous forest polygon that was > 1,000 acres ii) < 20% development, cropland, and coniferous forest cover at the macro landscape scale, and iii) not located within land cover classes that preclude forest management for Golden-winged Warblers. Our partnership has continued to make progress toward developing a data management tool that links avian, vegetation, and management treatment datasets. We are ready to initiate a phone survey of private landowners who own the sites monitored in 2015 and/or 2016. Specifically, we developed a 20-minute long telephone survey instrument using an iterative question design which will be conducted in early 2017. The subsequent analysis of survey data will explore how landowner participation in this voluntary conservation incentive program for early successional habitat affects landowners. Finally, we located 120 Golden-winged warbler nests and radio-tagged 117 fledglings across two managed forests in northern Pennsylvania. Golden-winged Warbler fledglings experienced most mortality early (Days 1-4) in the post-fledging period. By the end of the 30-day monitoring period, fledglings had moved on average >650m from their nests and had used a variety of cover types. Collectively, our partnership has continued to make excellent progress toward the 5 primary components of this project. We expect to complete portions of this project in 2017, and hope to continue on-the-ground monitoring efforts through work with NRCS and additional partners beyond 2017.

Introduction

The Golden-winged Warbler (*Vermivora chyrsoptera*) is one of the most critically threatened, non-federally listed vertebrates in eastern North America. This species has become rare and patchily-distributed across its Appalachian breeding range, and many populations in this region are in danger of extirpation unless effective conservation measures can be implemented. The Golden-winged warbler is somewhat more secure in portions of its Great Lakes distribution including Minnesota and northern Wisconsin, but even there it is considered a species of conservation need and/or a priority stewardship species. In 2010, the Golden-winged Warbler was petitioned to be listed under the Federal Endangered Species Act. The U.S. Fish and Wildlife Service reviewed the petition and determined that it had substantial merit. The implementation of previously developed science-based best management practices that create or maintain Golden-winged Warbler breeding habitat is thought to be an important step to reversing the species decline.

In 2012, NRCS and USFWS initiated a joint conservation program called *Working Lands for Wildlife* (WLFW). This program specifically targets the creation or enhancement of habitat for 7 imperiled wildlife species across the United States, including the Golden-winged Warbler within the Appalachian states. After three years, NRCS and its partners have conducted outreach, site visits, and created conservation plans for many private land owners within WLWF target areas in the Appalachian Mountains who desire Golden-winged Warbler habitat on their lands. To date, over 13,000 acres of habitat have been contracted/created on private lands in association with the WLFW-Golden-winged Warbler effort. Additionally, the American Bird Conservancy and its partners were awarded funding for a Regional Conservation Partnership Program (RCPP) project in Minnesota, Michigan, and Wisconsin to assist NRCS with landowner outreach, coordination, and technical assistance to benefit Golden-winged Warbler, American Woodcock (*Scalopax minor*), and associated species, mirroring the WLFW effort.

American Bird Conservancy and Indiana University of Pennsylvania-Research Institute (IUP-RI) have also work closely with several state and federal agencies to fill capacity needs in order to implement GWWA and AMWO guidelines on public lands in several states. For example, IUP-RI employed a forester who worked with the Pennsylvania Game Commission staff to identify and prepare areas for habitat management on State Game Lands. Additionally, American Bird Conservancy fills a similar position in Minnesota whereby a forester works with USFWS, MN-DNR, and County land managers to identify and prepare areas on public lands for habitat management. In 3 years, this partnership has resulted in over 4,900 acres of habitat being contracted on private lands in MN and WI. An additional 2,204 acres have been created on public lands in Minnesota since 2013. To date, between the Appalachians and Great Lakes efforts, >6,650 acres and >14,000 acres of Golden-winged Warbler nesting habitat have been created on public (MN and PA) and private lands (MN, WI, PA, NJ, and MD), respectively.

In 2015, we initiated work under a Conservation Effects Assessment Project (CEAP) to evaluate the effectiveness of WLFW and RCPP efforts intended to benefit Golden-winged Warbler. This projects has five primary components that couple aspects of evaluation and adaptive management. These components include: i) monitoring avian response among sites managed using NRCS- WLFW, RCPP; ii) using monitoring results to refine WLFW programmatic boundaries via the development of Priority Areas for Conservation (PACs); iii) developing a data management tool that links NRCS's implementation database with the avian and vegetation monitoring results for each NRCS contracted project under these two programs; vi) gaining an understanding of how participation in such voluntary incentive programs affects landowners; and v) quantifying post-fledging survival and habitat selection in managed forests. The components outlined here are those we believe to be ultimately essential to ensure long-term management of breeding season habitat for species like the Golden-winged Warbler, American Woodcock, and others on forest lands across the eastern US.

Part I. Monitoring and evaluating American Woodcock and songbird responses to habitat management associated with two NRCS conservation programs that target Golden-winged Warbler breeding habitat: *Working Lands For Wildlife* and *Regional Conservation Partnership Program*

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Background

The primary goal of our biological survey effort is to initiate a long-term inventory and monitoring program for Golden-winged Warbler, American Woodcock, and associated bird species across properties enrolled in NRCS conservation programs (*e.g*., WLFW, EQIP-Wildlife, etc.) and on lands managed by partner agencies. This year (2016) was the second year of this effort and we focused on a subset of states including Pennsylvania, Maryland, New Jersey, Wisconsin, and Minnesota. In 2017, we hope to incorporate sites within additional states such as Virginia, North Carolina, and potentially others as opportunities arise. This effort builds on a previous (2012-2014) project funded by NRCS-CEAP (Project ID#: 68-7482-12-502) that quantified and compared several Golden-winged Warbler demographic parameters (i.e., nest success, density) among NRCS conservation practices.

Standardized monitoring protocols are used across all states included in this project such that basic demographic data (*e.g.*, singing male densities) and relevant habitat features (*e.g*., residual trees, shrub/sapling cover, and herbaceous cover) can be consistently collected and compared across all managed sites on participating public lands or private lands enrolled in NRCS programs. Monitoring within areas where habitat management has occurred using standard protocols will provide NRCS staff, public land managers, and their partners with an empirical evaluation of how focal species are benefiting from public and private land management efforts. Ultimately, information derived from this project combined with conservation practice-specific Golden-winged Warbler demographic parameters collected during the CEAP-GWWA Phase I will inform future conservation planning and potential modifications to existing conservation practice guidelines that target Golden-winged Warbler and American Woodcock. These data will provide the first broad-scale attempt to quantify avian response to recent NRCS-funded private lands conservation programs and similar efforts on public lands in the eastern U.S.

Objectives

1. Quantify Golden-winged Warbler occupancy and density in areas enrolled in NRCS programs and on public lands in key focal states (*e.g*., PA, NJ, MD, WI, and MN) and other states in future years.

2. Quantify American Woodcock presence and abundance in areas enrolled in NRCS programs, public lands in key focal states (*e.g.*, PA, NJ, MD, WI, and MN) and other states in future years as opportunities arise.

3. Relate avian survey data to site-level vegetation and landscape attributes, and to use these findings to inform potential modifications to NRCS ranking criteria or other aspects of program delivery.

4. Use conservation practice-specific demographic parameters for Golden-winged Warblers collected during the CEAP_GWWA Phase I (2012-2014), and avian survey results to model Golden-winged Warbler breeding population response to habitat management via NRCS programs.

Methods and Results

Part 1. American Woodcock Response to Habitat Management

We conducted American Woodcock singing ground surveys and passerine point count surveys at sites that were recently managed to create habitat for Golden-winged Warblers and American Woodcock. In 2016, we had 14 technicians assist with avian and vegetation surveys. These technicians were strategically placed throughout our monitoring areas (PA, MD, NJ, and MN) in a manner that maximized the number of sites that could be surveyed within a single breeding season. American Woodcock singing ground surveys were conducted within the dates and time period permitted under the USFWS American Woodcock Singing Ground Survey protocol. The challenge with monitoring the singing activity of American Woodcock is that the allowable dates for any given region are restricted to a 20-day window. Moreover, the survey period each evening is only 38 minutes in duration. As such, sites were only surveyed once, annually, for American Woodcock in order to maximize the number of sites surveyed. Surveys were conducted within an occupancy framework such that the rate of imperfect detection could be incorporated into habitat models.

From 15 April to 5 May, 2016, woodcock monitoring was conducted on 420 sites (treated 2013-14) across the Appalachians (PA, MD, NJ). All habitats monitored were those managed through habitat prescriptions as described in the Best Management Practices (BMP) for Golden-winged Warbler habitat in the Appalachian region. This region included western Maryland (Allegany and Garrett Counties), Pennsylvania's Appalachian Plateau, and western New Jersey (Sussex and Warren Counties). Of the sites monitored in 2016 for woodcock, 226 (54%) were on private lands and 194 (46%) on public lands. Surveys were conducted on warm nights (>4.4° C) with fair weather conditions and began ~15 minutes post-sunset and continued for no more than 38 minutes/night. American Woodcock were detected (n=274 individual woodcock detections) across 158 sites (naïve occupancy = 38%) during the survey period (Figure 1). Distance-removal models suggested that the density of woodcock was greater on public lands (0.52 males/ha) than on private lands (0.47 males/ha; null model > 2.0 ΔAICc ownership model, Fig. 2). Moreover, woodcock density varied as a function of woody stems with sites supporting higher densities of 1-2m woody regeneration hosting higher woodcock densities (Fig. 3). Finally, the geographic distribution of American Woodcock across the Appalachian region was relatively even with woodcock being detected in most counties represented by surveys (Fig. 4).

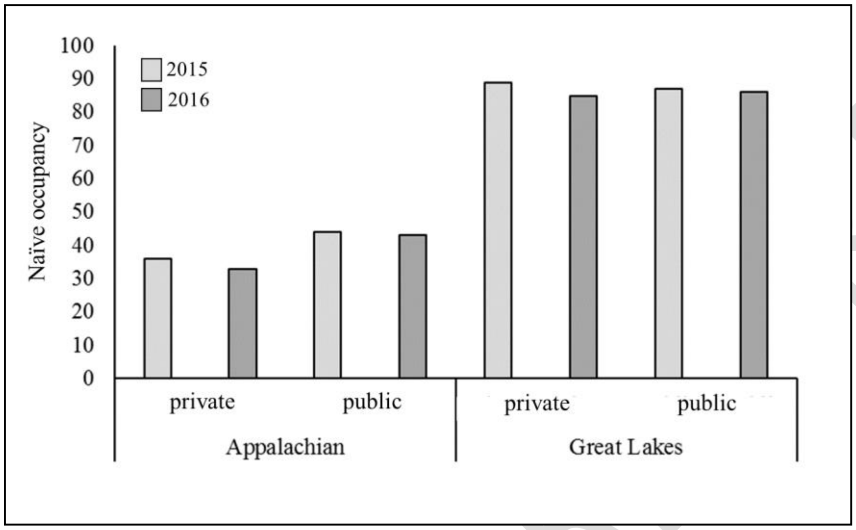

Figure 1. Naïve occupancy of American Woodcock in the Appalachian (PA, MD, and NJ) and Great Lakes regions (MN and WI) on lands managed under NRCS conservation practices targeting the Golden-winged Warbler and other early-successional wildlife species. Surveys were conducted April-May 2015-16 and only singing males were recorded.

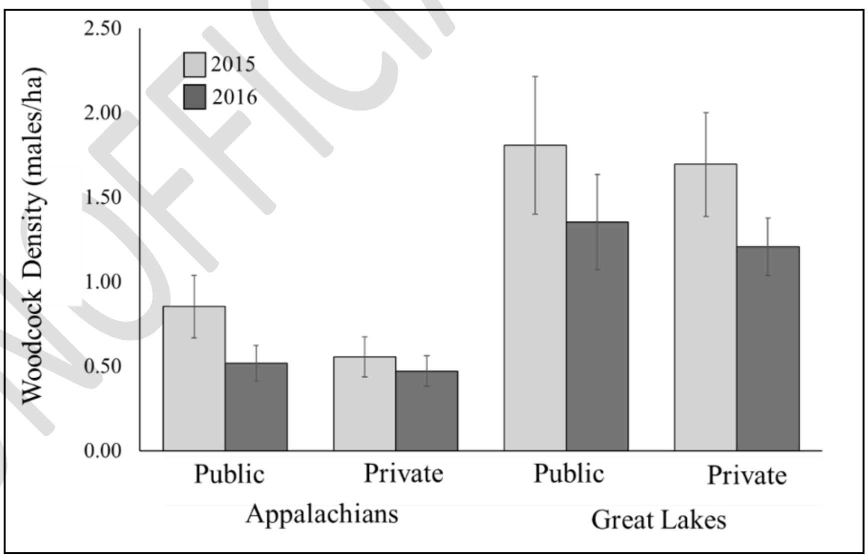

Figure 2. Density of American Woodcock in the Appalachian (PA, MD, and NJ) and Great Lakes regions (MN) on lands managed under NRCS conservation practices targeting the Golden-winged Warbler and other early-successional wildlife species. Surveys were conducted April-May 2015-16 and only singing males were recorded. Error bars represent 95% confidence intervals. Density estimates were generated using hierarchical distance-removal modeling in R.

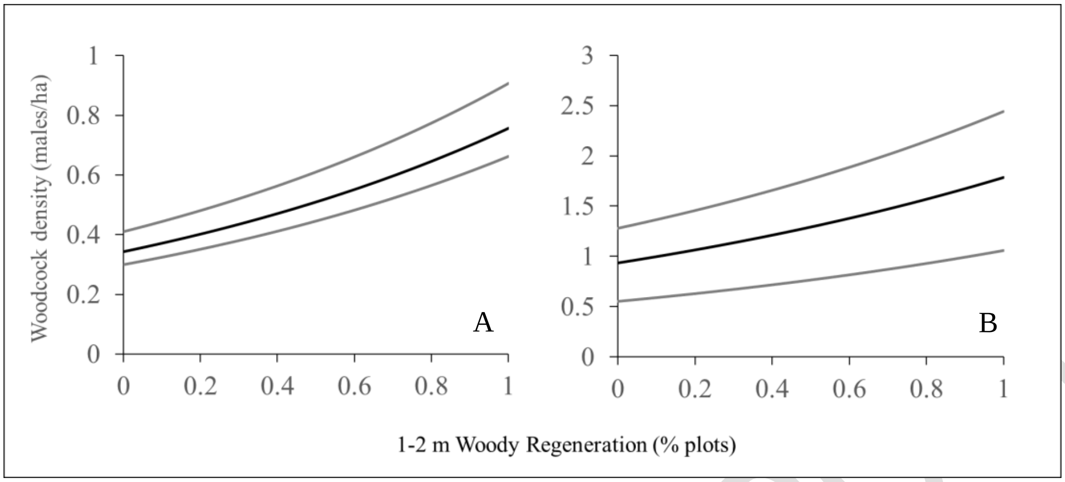

Figure 3. Modeled habitat relationships for American Woodcock within the Appalachian (A) and Great Lakes (B) regions. American Woodcock density was modeled using hierarchical distance-removal modeling in R. Black lines represent density estimates whereas gray lines represent 95% CI's.

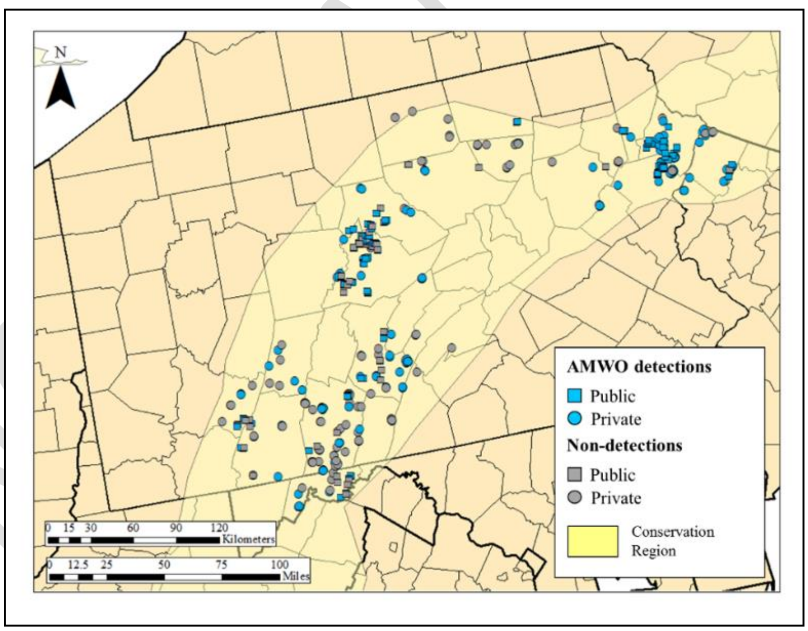

Figure 4. Locations surveyed for American Woodcock throughout the Appalachian region. Blue marker indicate sites where American Woodcock were detected whereas gray markers depict non-detections. Public land surveys are depicted with a square and private lands are shown with a circular marker.

From May 1 to May 24, woodcock monitoring was conducted on 229 sites treated in 2014-15 with habitat prescriptions as described in the BMP for Golden-winged Warbler habitat in the Great Lakes region. These sites were distributed across 15 counties throughout the northern half of Minnesota and two within northcentral Wisconsin. Of the sites monitored, 139 (71%) were on private land and 56 (29%) on public land. As within the Appalachian region, Great Lakes surveys were conducted on warm nights (>4.4° C) with fair weather conditions and began ~15 minutes post-sunset and continued for no more than 38 minutes/night. American Woodcock were detected (n=327 individual males) on 195 of the 229 (naïve occupancy = 85%) sites during the survey period (Fig. 1). Distance-removal models suggested that the densities of woodcock were equal on public lands (1.35 males/ha) and private lands (1.21 males/ha) within the Great Lakes (null model < 2.0 ΔAICc ownership model, Fig. 2). Similar to the Appalachians, woodcock density varied as a function of woody stems with sites supporting higher densities of 1-2m woody regeneration hosting higher woodcock densities (Fig. 3). Also similar across both regions, the geographic distribution of American Woodcock detections across the Great Lakes region was relatively even with woodcock being detected in nearly every county represented by surveys (Fig. 5).

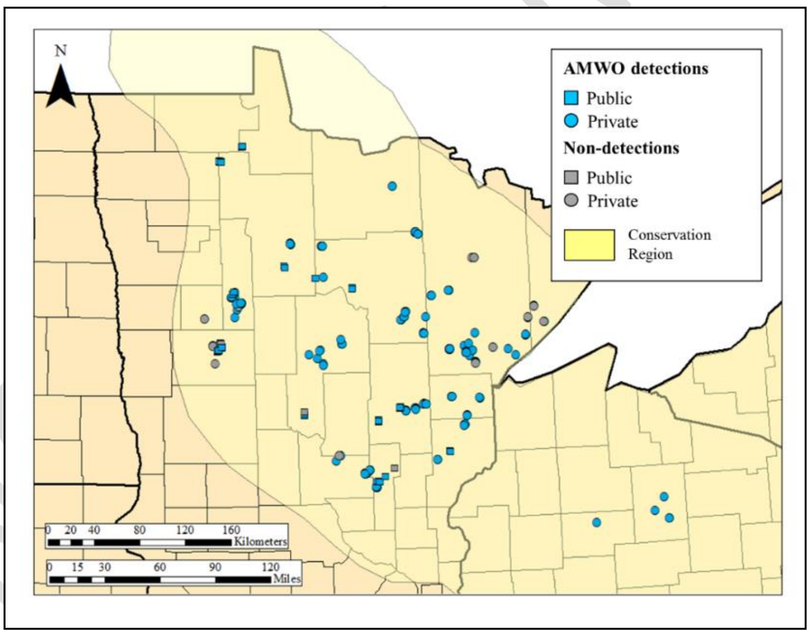

Figure 5. Locations surveyed for American Woodcock throughout the Great Lakes region. Blue markers indicate sites where American Woodcock were detected whereas gray markers depict non-detections. Public land surveys are depicted with a square and private lands are shown with a circular marker.

Part 2. Songbird Response to Habitat Management

We conducted passerine point counts from 15 May through 30 June, start and end dates varied by latitude. Points were surveyed between 15 May and 15 June in southern latitudes (*e.g.*, MD, PA, and NJ) and 25 May-30 June for northern latitudes (*i.e*., MN). The start and end dates for point count surveys varied regionally to coincide with a time that allows for the evaluation of a site's breeding bird community (minimizing the quantification of migrating non-residents) with maximum likelihood of detecting Golden-winged Warblers. Point count locations were surveyed twice, annually, for songbirds. Each point count survey consisted of a 10-minute passive period, followed by a 2-minute Golden-winged Warbler playback, and a final 1-minute passive period. This method is believed to maximize the detection probability for Golden-winged Warblers to nearly 1.0. Still, these data were collected in an occupancy framework to allow for the consideration of detection error.

The Appalachian states we conducted 890 all-species avian surveys at 445 locations (each surveyed twice) across 25 counties among Maryland, Pennsylvania, and New Jersey to quantify avian response to GWWA BMP. Survey locations were nearly evenly-distributed between private (n=208; 47%) and public (n=237; 53%) ownership. We detected a total of 19,446 individual birds of 141 different species. The number of individual birds detected on surveys ranged from 2 to 88 with an average of 21.8 birds detected/survey. Although most birds detected were of the order *Passeriformes* (92%), we detected birds from a wide variety of taxa including shorebirds (*e.g.*, Killdeer), birds of prey (*e.g*., Broad-winged Hawk), upland game birds (*e.g*., Ruffed Grouse), nightjars (*e.g*., Eastern Whip-poor-will), and Woodpeckers (*e.g*., Northern Flicker), among others. Of the most common bird species, nearly half are in serious population decline (≥1%, annually) within the eastern portions of their ranges. The five most commonly recorded species (in order of decreasing commonness) were: Eastern Towhee, Common Yellowthroat, Chestnut-sided Warbler, Ovenbird, and Red-eyed Vireo.

Appalachian Golden-winged Warblers were detected at 48 (18.97%) of all surveyed locations, 100% of which were within the state of Pennsylvania. Initial occupancy modeling (2016 results) suggested that detection probability was imperfect and modeled occupancy (Ψ= 0.25, 95% CI: 0.20-0.31) was 32% higher than naïve occupancy (Fig. 6). Furthermore, models revealed a strong effect of ownership domain on occupancy with public land sites hosting occupancy rates of 0.40 (95% CI: 0.31-0.49) in contrast to 0.12 (95% CI: 0.08-0.19) on private lands. Public land Golden-winged Warbler detections occurred within Delaware State Forest, Sproul State Forest, Forbes State Forest, and Pennsylvania State Game Lands: 48, 73, 81, 104, and 112. On private lands, Golden-winged Warbler detections were distributed among 15 landowners, however, all occurred within four counties: Pike, Monroe, Huntingdon, and Bedford. In general, Golden-winged Warbler occupancy was positively associated with increased woody cover; the top-ranked occupancy models included terms for sapling and shrub cover (in that order; see Fig. 7). Golden-winged Warbler detections were restricted to three areas of

Pennsylvania: 1. South-Central (Bedford/Huntingdon/Somerset Counties), 2. Central (Centre/Clinton Counties), and Northeastern (Pike/Monroe Counties, Fig. 8). Generally, habitat relationships within the Appalachians seemed to be stronger than within the Great Lakes suggesting that the species is more particular among our surveyed sites across this region.

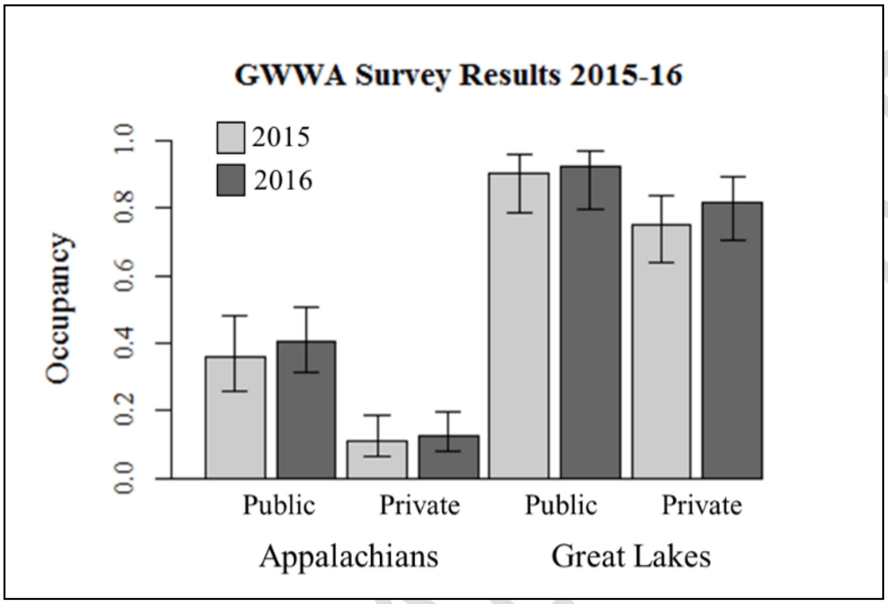

Figure 6. Bar graph showing the occupancy results of Golden-winged Warbler occupancy modeling for the Appalachian (PA, MD, and NJ) and Great Lakes regions (MN) in lands managed under NRCS conservation practices targeting the Golden-winged Warbler and other early-successional wildlife species. Surveys were conducted during May-June 2015, 2016. Occupancy estimates were generated using single-season occupancy models in *unmarked*. Error bars represent 95% CI's.

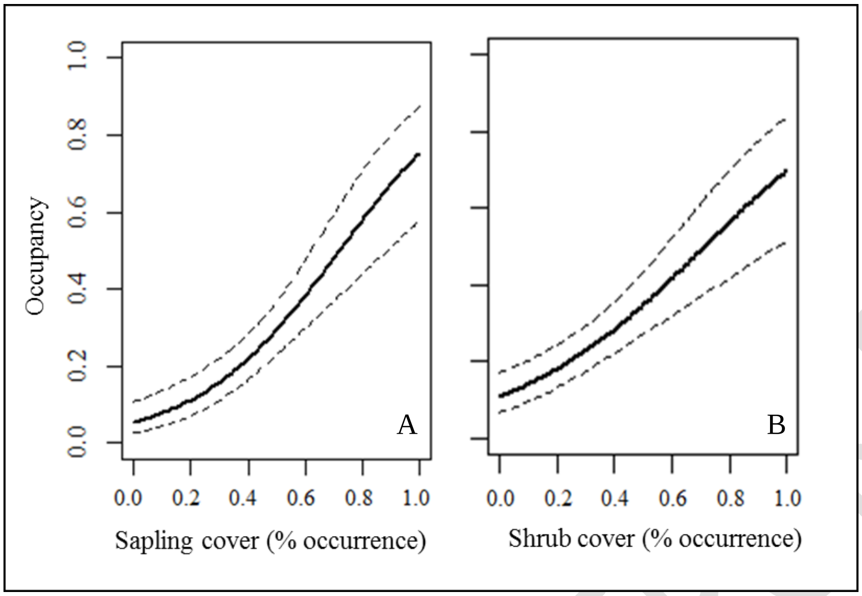

Figure 7. Golden-winged Warbler occupancy modeling results for the Appalachian region (top models). Occupancy probability increased linearly with increasing levels of sapling cover (A) as well as shrub cover (B). Solid lines represent occupancy estimates whereas dashed lines represent 95% CI's.

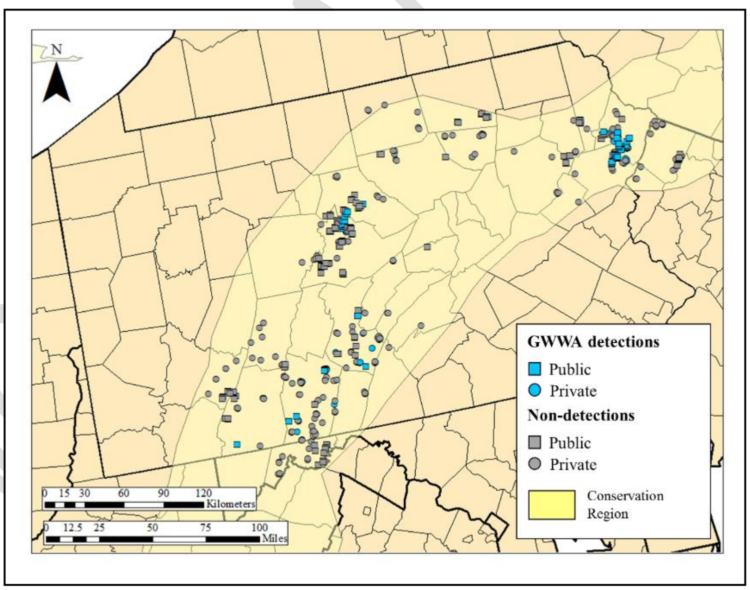

Figure 8. Locations surveyed for Golden-winged Warblers and associated songbird species throughout the Appalachian region. Blue marker indicate sites where Golden-winged Warbler were detected whereas gray markers depict non-detections. Public land surveys are depicted with a square and private lands are shown with a circular marker.

From 25 May-30 June, 2016, we conducted 756 all-species avian surveys at 378 sites (each site surveyed twice) across northern Minnesota and Wisconsin to quantify avian response to GWWA BMP within the Great Lakes. Private lands accounted for 198 (52.4%) of the survey locations while 180 sites (47.6%) occurred on publicly managed lands. In the Great Lakes, we detected a total of 12,029 individual birds of 124 different species. The number of individual birds detected on surveys ranged from 2 to 43 with an average of 16.98 birds detected/survey. Although most birds detected were of the order Passeriformes (91%), we detected birds from a wide variety of taxa including shorebirds (*e.g.*, Wilson's Snipe), birds of prey (*e.g.*, Red-shouldered Hawk), upland game birds (*e.g.*, Wild Turkey), Gaviiformes (*e.g.*, Common Loon), and Woodpeckers (*e.g.*, Yellow-bellied Sapsucker), among others. The 10 most common species detected were: Ovenbird, Golden-winged Warbler, Chestnut-sided Warbler, Veery, Common Yellowthroat, Red-eyed Vireo, Rose-breasted Grosbeak, White-throated Sparrow, Black-and-white Warbler and Alder flycatcher. The number of species detected at a single point ranged from 5 to 28, with an average of 17 species per point.

Great Lakes Golden-winged Warblers were detected at 295 (79.30%) of all surveyed locations. Initial occupancy modeling (2016 results) suggested that detection probability was imperfect (decreasing with advancing date) and modeled occupancy (Ψ= 0.89, 95% CI: 0.80-0.94) was 13% higher than naïve occupancy. Modeled occupancy (like naïve occupancy) was higher within the Great Lakes than the Appalachians (Fig. 6). Additionally, region-specific models revealed an effect of ownership domain on occupancy with public land sites hosting occupancy rates of 0.92 (95% CI: 0.80-0.97) in contrast to 0.82 (95% CI: 0.72-0.92) on private lands. While Golden-winged Warblers were common within the region, they were not ubiquitous and site occupancy was dependent upon habitat features such as 1-2 m woody regeneration (Fig. 9A) and grass cover (Fig. 9B). Overall, confidence intervals around habitat relationships were wide for sites across the Great Lakes suggesting that the species may be somewhat less picky within the region. Golden-winged Warbler detections in the Great Lakes were distributed nearly evenly across the surveyed region with the target species detected in most counties (Fig. 10).

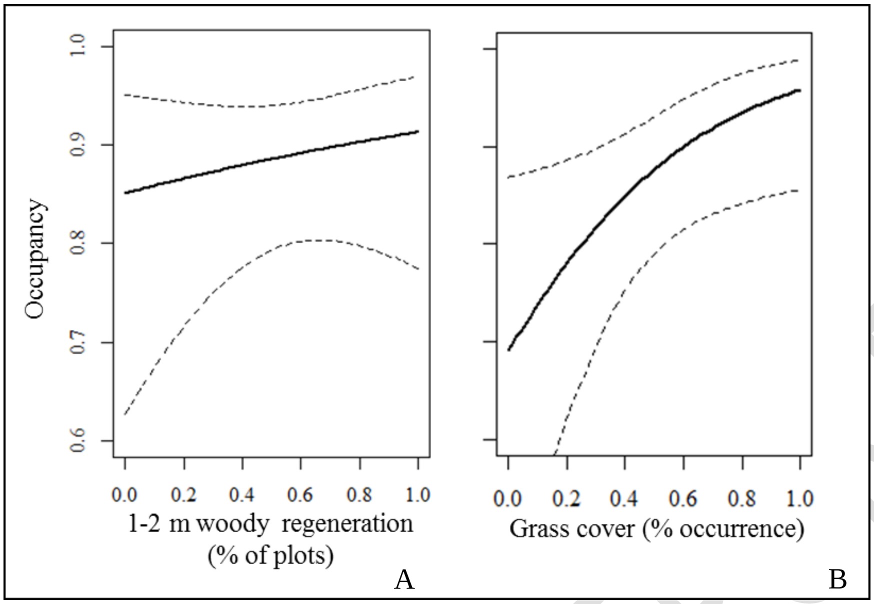

Figure 9. Some occupancy modeling results for Golden-winged Warblers in the Great Lakes region (top models). Golden-winged Warbler occupancy probability increased linearly with increasing levels of 1-2m woody regeneration (A) as well as % grass cover (B). Solid lines represent occupancy estimates whereas dashed lines represent 95% CI's.

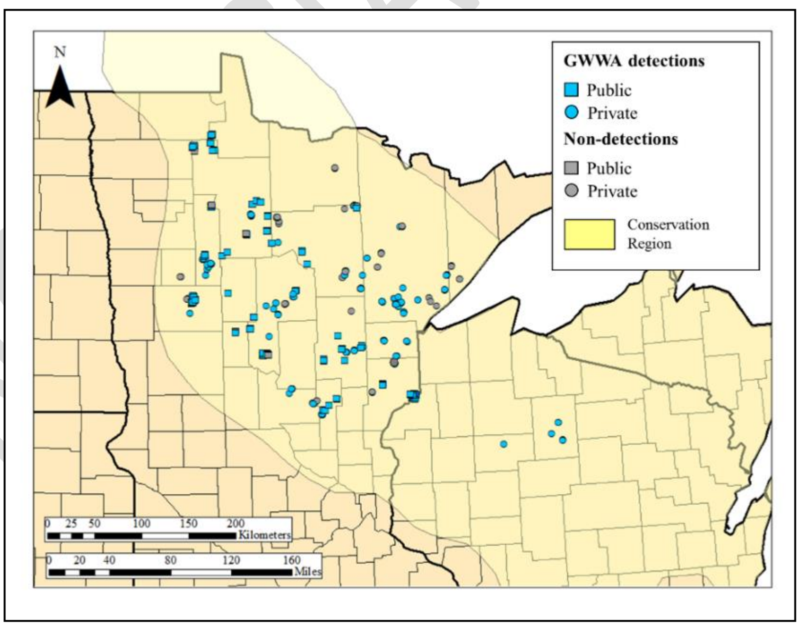

Figure 10. Locations surveyed for Golden-winged Warblers and associated songbird species throughout the Great Lakes region. Blue marker indicate sites with confirmed Golden-winged Warbler detections whereas gray markers depict non-detections. Public land surveys are depicted with a square and private lands are shown with a circular marker.

In addition to microhabitat effects on occupancy, we also considered the possible effects of habitat patch size and Priority Areas for Conservation (PACs). One pattern that emerged was the effect of patch size on detections; sites with Golden-winged Warbler detections were larger than those without detections, though confidence intervals overlapped due to size variation among sites (Fig. 11). This pattern was not observed within the Great Lakes and, when all Great Lake sites (private and public) were considered, the opposite trend was observed (Fig. 12). We also incorporated the variable "PAC" into our occupancy models to assess the importance of a points location (inside or outside of a PAC) on occupancy probability. Because Golden-winged Warblers were only detected in Pennsylvania, the PAC analysis only included data from this state (Poconos, Central PA, Southwestern PA, Southcentral PA, or no PAC). No Golden-winged Warblers were detected outside the PACs in Pennsylvania and the predicted density was therefore 0.0 males/ha (Fig. 13). In contrast, the Poconos and Central PA PACs hosted the highest densities.

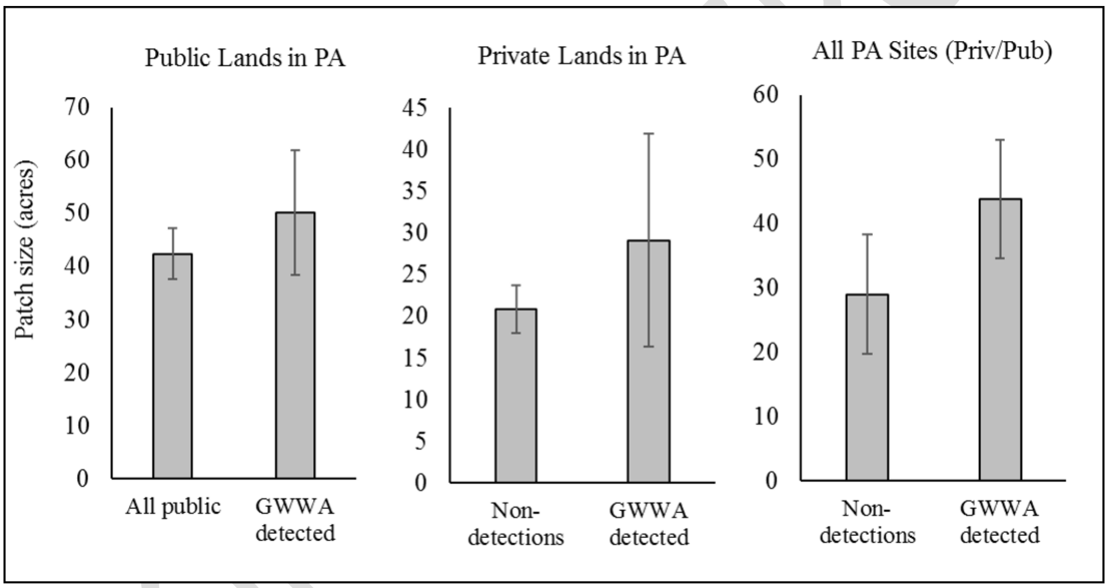

Figure 11. Sizes of Pennsylvania timber harvests where Golden-winged Warblers were detected and not-detected. The leftmost graph depicts public sites with Golden-winged Warblers as compared to the average size of public lands timber harvests. The central graph shows private sites with- and without Golden-winged Warblers. The rightmost graph shows all sites (private and public) where warblers were detected as compared to sites where they were not.

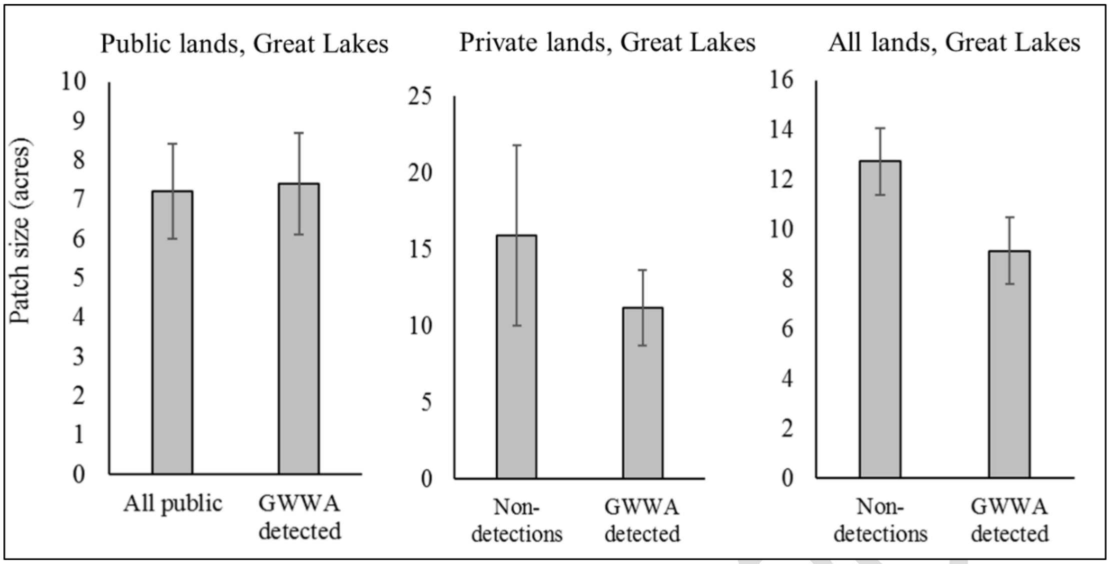

Figure 12. Sizes of Great Lakes management sites where Golden-winged Warblers were detected and not-detected. The leftmost graph depicts public sites with Golden-winged Warblers as compared to the average size of public lands timber harvests. The central graph shows private sites with- and without Golden-winged Warblers. The rightmost graph shows all sites (private and public) where warblers were detected as compared to sites where they were not.

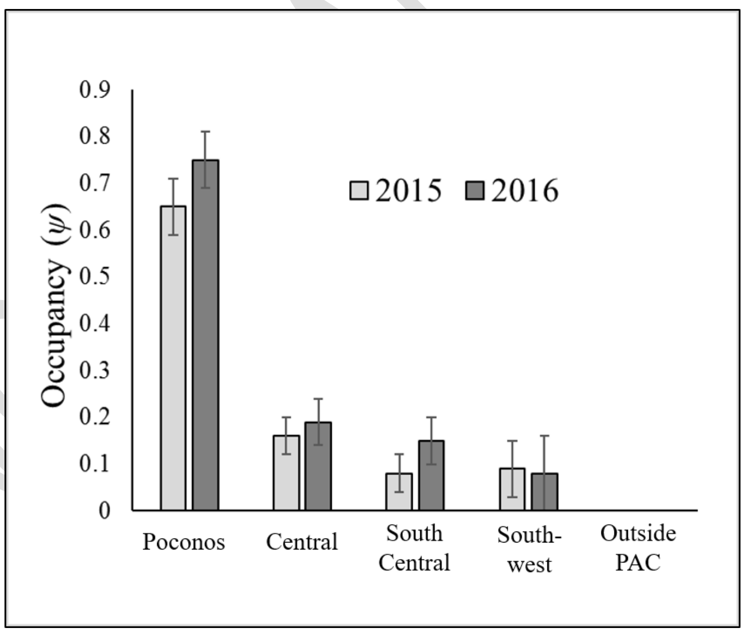

Figure 13. Predicted Golden-winged Warbler occupancy results across Priority Areas for Conservation (PACs).

Part 3. Vegetation Characteristics at Avian Survey Locations

To sample vegetation across areas managed for Golden-winged Warblers, we conducted 100 m radius vegetation surveys at each location surveyed for bird species. Surveys consisted of three 100 m transects along each of which we quantified three habitat components: vegetation strata, woody regeneration, and basal area. Vegetation strata were quantified using an ocular tube reading to record the percent cover of vegetation at each strata from ground level to overstory. Readings were collected at 30 locations/plot (every 10 m along each transect) where the presence of leaf litter, grass, forbs, ferns, *Rubus*, shrubs, saplings, and canopy were recorded. We recorded woody regeneration (*e.g.*, shrubs and saplings) at the same 30 locations as vegetation strata by recording presence of woody regeneration in three height classes (0-1m, 1-2m, or >2m), within 1 m of each reading. Finally, we made seven basal area recordings to quantify overstory tree retention using a 10-factor basal area prism (0, 50, and 100 m along each transect), recording the species of each residual tree as well. Ultimately, these surveys allow us to quantify many of the important habitat features associated with GWWA management, as outlined in the GWWA BMPs

From 15 June -30 July, vegetation surveys were conducted on 444 of the 445 sites we surveyed for avian species in the Appalachian region. Nearly all of the properties surveyed for vegetation in the Appalachians were derived through timber harvest. Introductory analyses demonstrate that sites recently-managed across the Appalachians for GWWA conform to the management guidelines in several ways: basal area varied from 0-70 ft.^{2}/ac. with a mean of 18.1 ft.^{2}/ac. Although private lands had significantly higher (two-tailed T-test: p=<0.005) residual basal area (20.86 ft.^{2}/ac) than public lands (12.84 ft.^{2}/ac; Fig. 14), both ownership types met the recommendations for Golden-winged Warbler habitat within the Appalachian region. Residual tree species were somewhat varied across the Appalachians, though most were oaks (*Quercus* spp., 51%), maples (*Acer* spp., 17%), or 'other' hardwood species (*e.g*., *Fraxinus* spp., 8%, Fig. 15). In addition to quantification of overstory trees, other relevant habitat features known to support Golden-winged Warblers were present. Most sites (96%) supported regenerating saplings, and sapling cover ranged from 0-100%. Similar trends were observed for shrubs (80% of sites hosted, range: 0-100% cover) and *Rubus* (78% of sites hosted, range: 0-95% cover). Further, all sites also supported herbaceous vegetation in some capacity. More complex analyses (*e.g.*, landscape-scale analyses) will be conducted in the coming months to explore how a suite of habitat characteristics relate to the bird communities supported by these young forest communities.

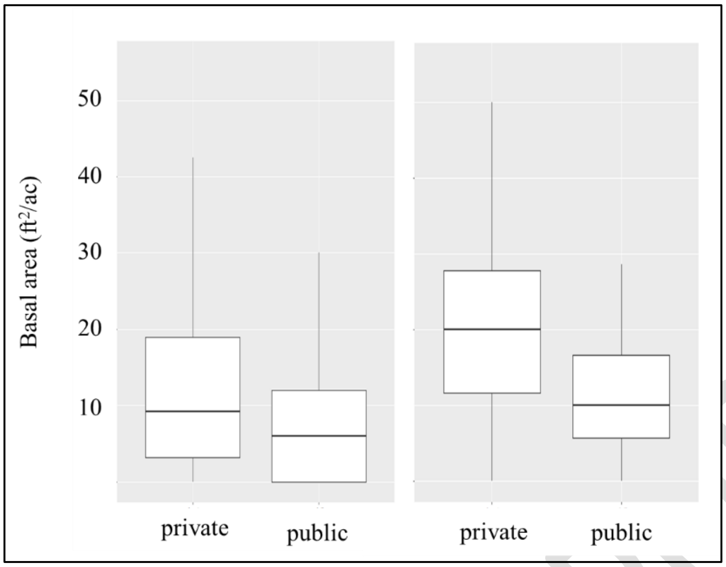

Figure 14. Boxplots depicting residual basal area for timber harvests across private and public lands throughout the Great Lakes (MN, WI, left) and high elevation Appalachians of (PA, MD, and NJ, right). Private lands supported significantly higher (two-tailed T-test $P<0.05$) levels of basal area than nearby public lands within both regions.

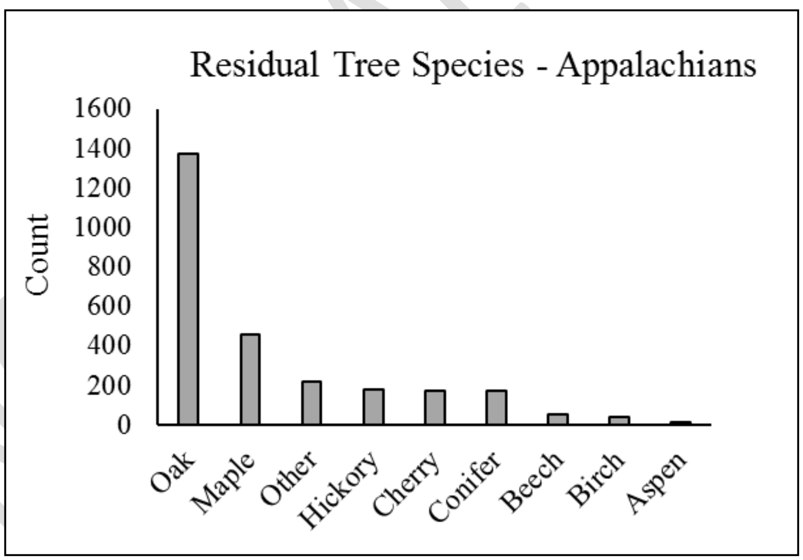

Figure 15. Tree groups identified during Appalachians vegetation surveys. Trees were quantified only within timber harvests (*i.e.*, retained legacy trees) using a 10-factor prism and identified to species.

From 24 June – 6 July vegetation surveys were conducted on 373 sites throughout northern Minnesota and Wisconsin. All of these sites were derived through timber harvest or shrub management; most private lands consisted of timber harvests and public lands were a mixture of both. Vegetation data were collected in the same manner as on sites in the Appalachians. Analysis of structural elements ~1yr post-management indicate that most sites provide habitat features relevant to GWWA, some within the ranges outlined in the GWWA habitat guidelines for the Great Lakes region. Basal area for all managed stands ranged from 0-90ft.^{2}/ac. with a mean of 11.43 ft^2/ac. Residual basal area, much like that observed in the Appalachian region, was significantly higher (two-tailed T-test, p-value= 0.004, Fig. 14) on privately owned sites (14.37 ft^2/ac.) than on publicly managed sites (7.96 ft^2/ac.). Residual trees were generally more diverse in the Great Lakes than within the Appalachians with aspen (*Populous* spp., 23%), oak (22%), and 'other' hardwood species (18%) constituting the most common (Fig. 16). Regeneration of small woody vegetation was occurring in all sites. Most sites supported saplings (91% of sites, range: 0-93%) and shrub (75% of sites, range: 0-82%) cover, as well as a mixed herbaceous layer. While some habitat attributes occurred at/below the minimum recommended levels for Golden-winged Warblers, this is unsurprising as management on these sites occurred only 2 years prior to vegetation sampling. Because the Golden-winged Warbler is a species reliant upon secondary succession, the occurrence rates that we reported here are only expected to increase as vegetation develops to better meet the species' requirements through the coming years of surveys, and we anticipate 2017 vegetation surveys will reflect this pattern.

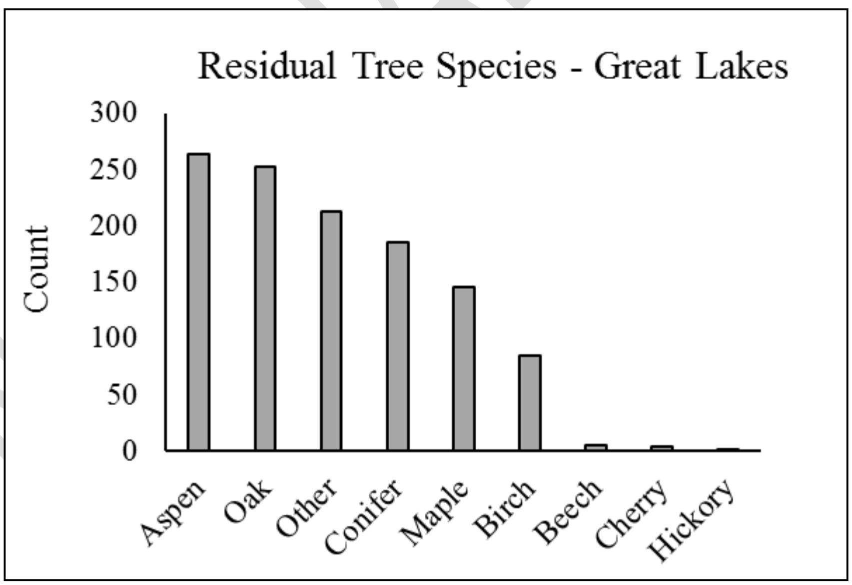

Figure 16. Tree groups identified during Great Lakes vegetation surveys. Trees were quantified only within timber harvests (*i.e.*, retained legacy trees) using a 10-factor prism and identified to species. In the Great Lakes, residual canopy trees were mostly aspen (*Populus* spp.) oak (*Quercus* spp.), and 'other' species like ash (*Fraxinus* spp.).

Part II. Development of Range-wide Priority Areas for Conservation (PACs) for Golden-winged Warblers.

Prepared by: Drs. Casey Lott (American Bird Conservancy) and Jeffery Larkin, Ph.D. (Professor of Wildlife Ecology and Conservation, Indiana University of Pennsylvania & American Bird Conservancy)

Background

A fundamental challenge for any large-scale conservation program is to put existing work into the context of range-wide conservation needs in order to evaluate the contribution of any one program toward meeting range-wide goals. The Golden-winged Warbler Breeding Season Conservation Plan of 2010 provided an initial spatial framework for this type of evaluation by dividing the geographic range of GWWA into 2 "Conservation Regions" (the Great Lakes and Appalachians) with a total of 34 "Focal Areas". "Focal Areas" are broad regions that were originally hand digitized in mapping software to surround bird occurrence data, modified by the ecological knowledge of workshop participants. While "Focal Areas" provide a useful starting point, more detail is necessary to prioritize habitat management in the most focused way possible to maximize conservation results. Since the original GWWA Breeding Season Conservation Plan was published (which included the GWWA Focal Area maps), additional research and monitoring has provided: a) improved information about the distribution of GWWA; b) better understanding about the response of GWWA habitat and individual GWWA to management; and c) greater insight into ecological criteria associated with GWWA occurrence and reproductive performance. American Bird Conservancy worked with IUP (and other partners from state agencies and the Golden-winged Warbler Working Group) to consolidated, synthesized, and incorporated this new information in the process of developing Priority Areas for GWWA Conservation (PACs) for GWWA within the WLFW project area.

Objectives

1. Delineate Priority Areas for Conservation (PACs) for Golden-winged Warblers.
2. Delineate areas within GWWA PACs that may have the highest success at attracting GWWA to created young forest nesting habitat.

Methods and Results

Delineating Priority Area for Conservation (PAC) boundaries

We used Golden-winged Warbler occurrence data within the geographic boundaries of the Appalachian Mountains Joint Venture for the 10 years between 2006 and 2015 to delineate the outer boundary of PACs. First, we acquired GWWA occurrence (or absence) data from several avian datasets (see Acknowledgments). All occurrence data were represented as precise points in a GIS (Figure 1). However, these points did not always refer to the exact locations where birds were observed consequently, we considered the precision of occurrence records in all analyses. In some cases, point locations were precise relative to bird occurrences (e.g., geographic coordinates had sub-meter accuracy for an explicit survey point where a bird was detected near the observer). In other cases, explicit points were imprecise relative to bird detections (even though they were still represented as precise points in GIS files). For example, many eBird checklists had an "effort distance" value that was greater than 0, indicating that the bird detection that was associated with the occurrence record came from an unknown location within x distance of the point location, where x was the effort distance value. Imprecise location records for GWWA were also displayed in GIS and visually compared with precise location records. All imprecise location records occurred within the large areas covered with more precise location records. Consequently, imprecise location records were removed from subsequent analyses.

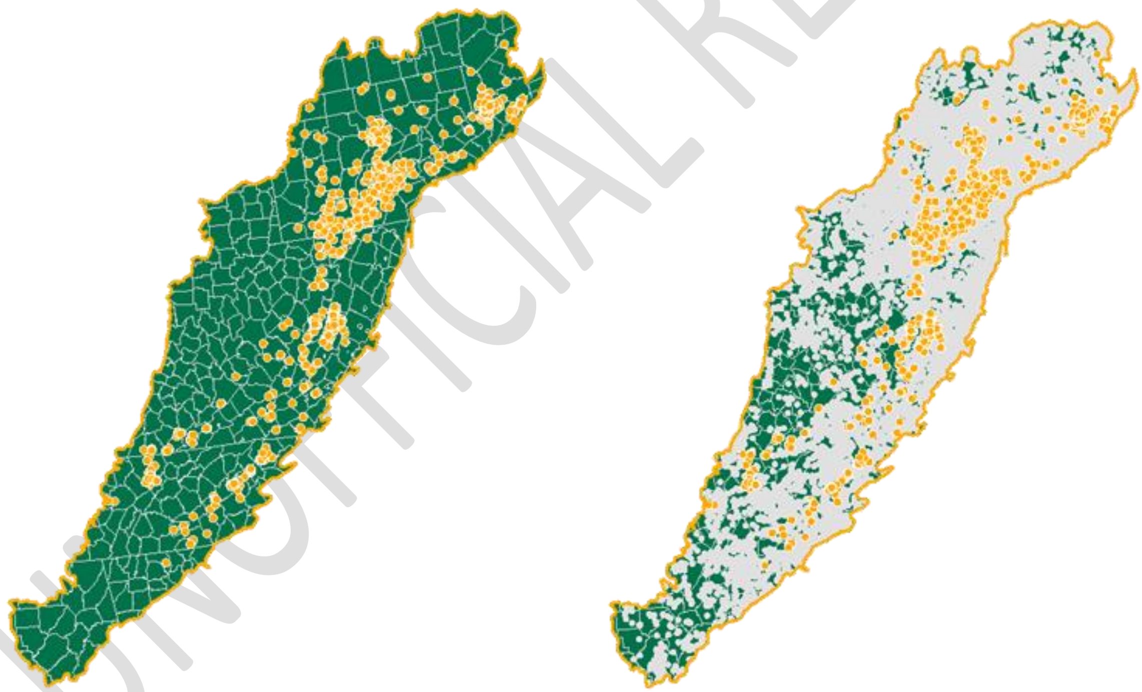

Figure 1. Image on left shows 2,105 locations with precise GWWA occurrence data collected between 2006-2015. Image on the right shows an additional 27,654 locations (grey dots) that were surveyed for forest birds between 2006-2015 where GWWA were not detected.

Next, we created 10 kilometer buffers around precise GWWA locations. Where buffers overlapped, boundaries were dissolved to create GWWA occurrence clusters where all occurrences were within 10km of another occurrence record. These occurrence clusters formed the outer boundaries of several spatially discrete PACs (Fig. 2). Occurrence clusters with less than 3 separate GWWA locations were removed as these were typically isolated observations in areas with little potential nesting habitat for GWWA that were densely surrounded by records from bird surveys where GWWA were not detected. We used a slightly modified[1] version of the GWWA Appalachian Region Conservation Region to create an outer project boundary for the WLFW-GWWA program.

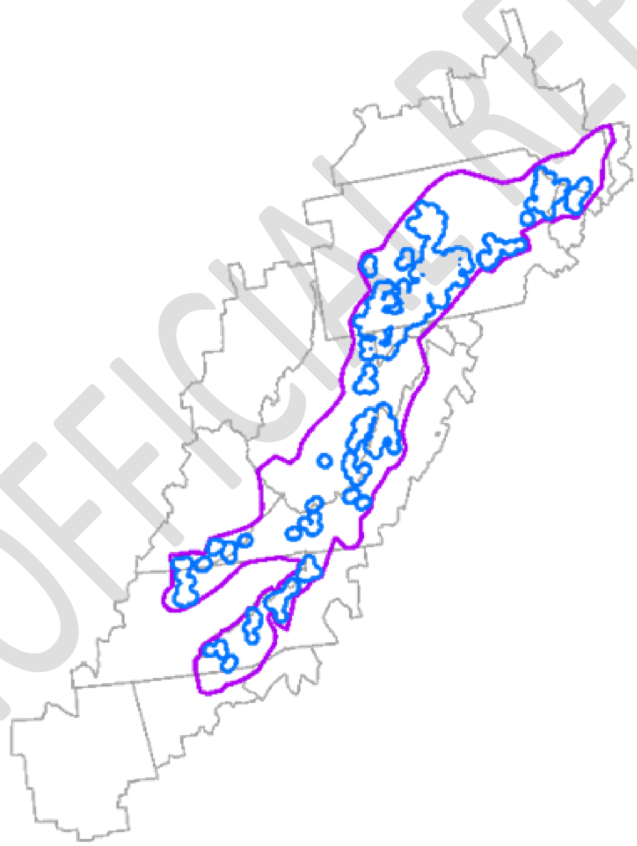

Figure 2. Open blue polygons show outer boundaries of GWWA Priority Areas for Conservation (PACs). Purple line shows the WLFW GWWA Project Boundary.[2]

[1] We re-positioned a small number of vertices from this original shape to encompass the entirety of PACs that were delineating using a larger occurrence dataset than was available at the time the 2012 GWWA conservation plan was written.

[2] These layers are provided as "GWWA_PAC_outer_boundaries.shp" and "GWWA_WLFW_project_boundary.shp".

Landscape-scale criteria affecting the suitability of project sites to create GWWA habitat

Prior analyses in the GWWA Conservation Plan and elsewhere (Roth et al. 2012, others summarized in Rohrbaugh et al. 2016) suggested that the proportion of non-coniferous forest cover, coniferous forest cover, development, and cropland areas affect GWWA distribution at the landscape scale. Consequently, we performed several different "moving window" analyses using the National Land Cover Dataset (NLCD) from 2011 to calculate the percentage of different land use types (e.g., development, forest) within a standard sized circle around any given 30km^2 NLCD raster cell. For these analyses, we used the "macro" landscape scale that was reported as most relevant to GWWA landscape ecology in Roth et al. (2012) and Rohrbaugh et al. (2016). The circle in the image on the left in Figure 3 (the "macro landscape window") is drawn using a 2.5 km radius. This creates a ~2,000 hectare (~5,000 acre) area inside the circle, around any given pixel, to summarize landscape context.

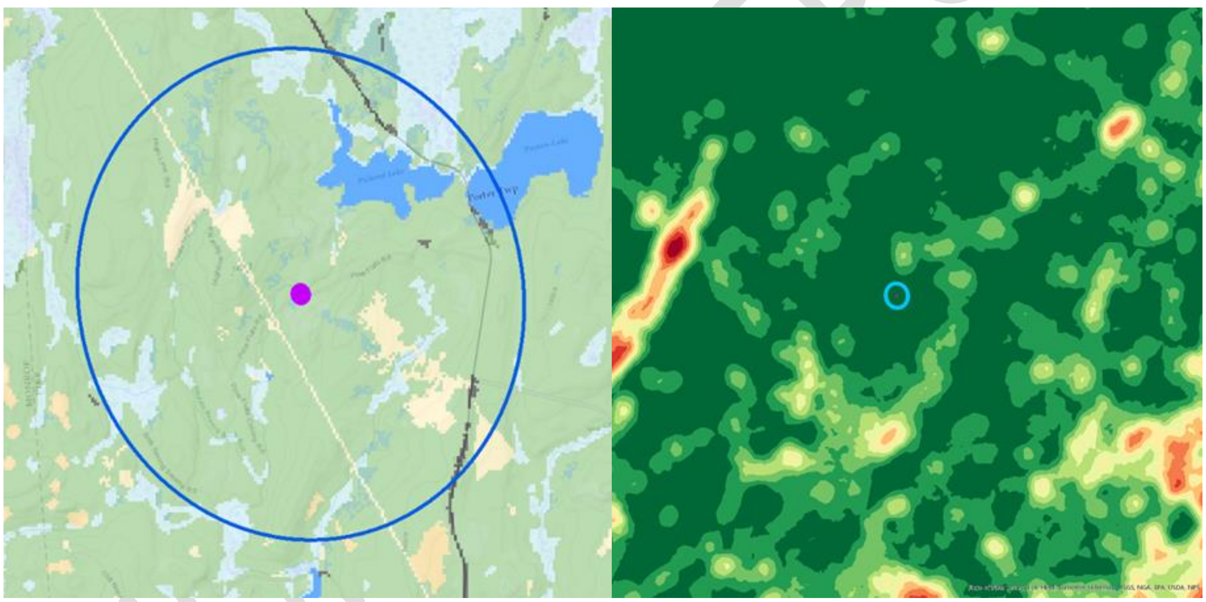

Figure 3. For "macro" landscape-scale analyses, a circle with a 2.5km radius is drawn around each 30m^2 pixel (pink dot) of the National Landcover Dataset (NLCD) (image on left). This creates an area, inside the blue circle, of ~2,000 hectares (~5,000 acres). Then, features of interest are summarized within this circle. For example, in the image on the left above, one could summarize the percentage of deciduous forest (green pixels), the percentage of herbaceous cover (beige pixels), the percentage of freshwater lakes (dark blue pixels), or the percentage of emergent wetlands (light blue pixels). The "moving window" analysis then is repeated for *every pixel on the map* (image on right). For "landscape feature maps" each 30m^2 pixel is then represented by the value of a summary statistic for the "macro landscape" around the pixel. For example, the image on the right, shows the percentage of development (with reddish colors = 100% and dark green colors = 0%) for the area centered around the pixel from the left image at a zoomed out scale of 1:500,000 (and all other 30m^2 pixels across a much larger landscape).

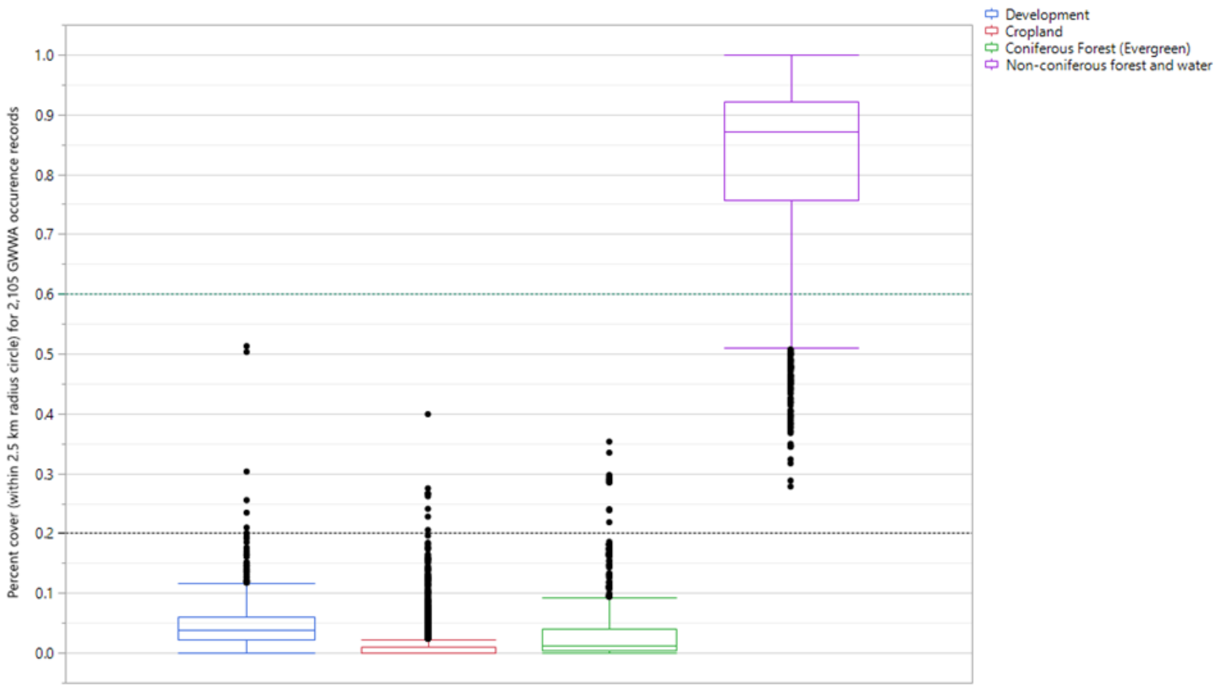

Figure 4. Box plots showing percentage cover measurements at 2,105 precise GWWA locations from 2006-2015 for four landscape variables measured at the "macro landscape" scale (see text): 1) medium to heavy development, 2) cropland, 3) coniferous forest, and 4) non-coniferous forest (see legend for colors associated with box plots. Dotted lines indicate selected thresholds for 1 landscape context that is positively associated with GWWA occurrence (>60 % non-coniferous forest cover) and for 3 landscape contexts that are negatively associated with GWWA occurrence (>20% development, cropland or coniferous forest contexts).

We first performed "macro landscape" percent cover analyses for "non-coniferous forest", which we defined by combining the following four NLCD (2011) cover types: 1) Mixed Forest, 2) Deciduous Forest, 3) Shrub/Scrub, and 4) Woody Wetlands. We performed similar "percent cover" analyses for: 1) coniferous forest, 2) medium to heavy development, and 3) cropland, which have been previously suggested to have a negative effect on GWWA habitat selection. Once these analyses were complete, we compiled percent cover estimates for each of our unique 2,105 GWWA occurrence records (Fig. 4) and used this data summary to select thresholds for percent cover at the "macro landscape" scale that promoted GWWA occurrence (>60% non-coniferous forest) and for cover types that tended to preclude GWWA occurrence (>20% coniferous forest, development, or cropland).

After the macro landscape analysis was completed to identify areas with >60% suitable non-conifer forest cover, we noticed that several large, contiguous linear forest patches (particularly along ridges) were not identified as suitable during moving window analyses, since the circular "landscape window" overlapped areas with large amounts of cropland or development in adjacent lower-elevation areas. We consider these large, linear, forest patches suitable for habitat management to benefit GWWA and other young forest birds. Consequently, we performed a second analysis to find all patches of non-coniferous forest that were >1,000 contiguous acres and combined these with the > 60% non-coniferous forest layer to create a "suitable forest landscape layer."

Final suitable forest landscape layer

The steps above led to the creation of a single shapefile that delineated a suitable forest landscape layer (Fig. 5). Each of the $30m^2$ pixels with a value of 1 in this layer meets the following criteria:

1. It is within 10km of a GWWA occurrence record from 2006-2015 (and this record is within 10km of at least 2 other GWWA records for the same period).
2. It meets 4 different suitable landscape criteria at the "macro-landscape" scale.
    a. > 60% non-coniferous forest[3]
    b. < 20% medium or heavy development
    c. < 20% cropland
    d. < 20% coniferous forest

[3]Pixels that failed to meet this first criteria were added to the "suitable forest landscape" if they were within a >1,000 acre patch of contiguous non-coniferous forest.

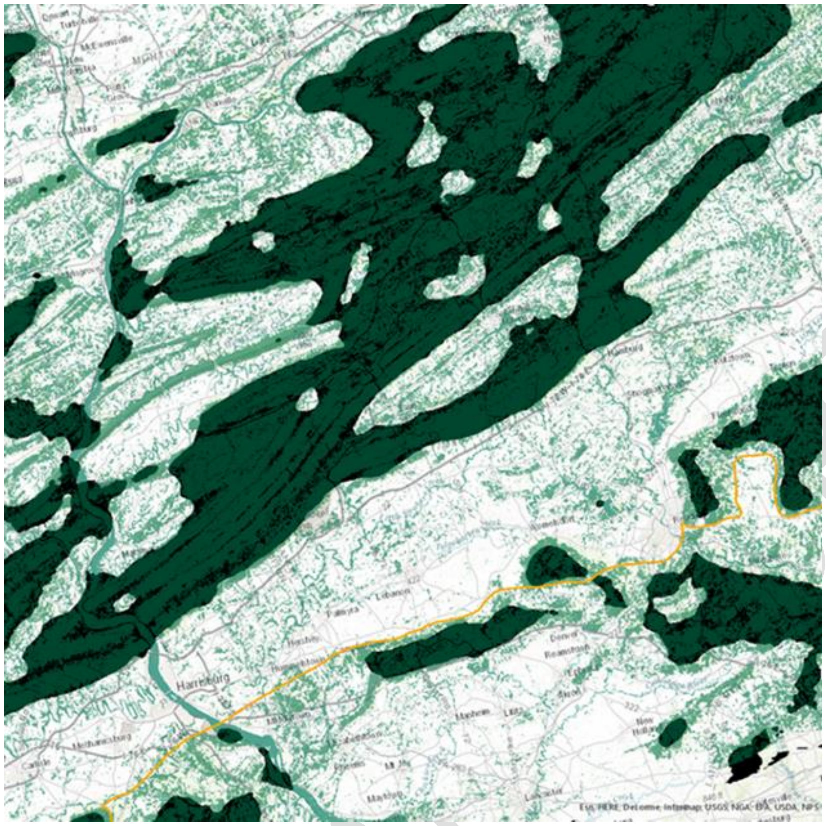

Figure 5. Dark black areas indicate locations where percentage forest cover (within the 2,000 hectare/5,000 acre circular window around each 30m^2 pixel) is >60%. Note that some relatively large areas of non-coniferous forest (light green) are NOT selected by the landscape-scale criteria due to the proximity of non-forest land within a circular window These areas were added to the suitable forest landscape layer if they were within >1,000 acre patches of contiguous non-coniferous forest.

Removing unsuitable areas for active management from the suitable forest landscape layer

Finally, we created a "no management" raster layer that displayed all pixels that were classified to any of the following 9 NLCD cover types where forest management for GWWA would be practically impossible due to roads, buildings, water, or other land-use that precludes forest management: 1) Open Water; 2) Developed, Open Space; 3) Developed, Low Intensity; 4) Developed, Medium Intensity; 5) Developed, High Intensity; 6) Barren Land; 7) Pasture/Hay; 8) Cultivated Crops; and 9) Emergent Herbaceous Wetland. Pixels that matched 1 or more of these "no management" cover types, or were above % cover threshold criteria for "landscape avoidance criteria" for conifer, development, or cropland were then subtracted from the "suitable forest" raster for GWWA management to delineate final "potential GWWA habitat areas" within PACs (Fig. 6).

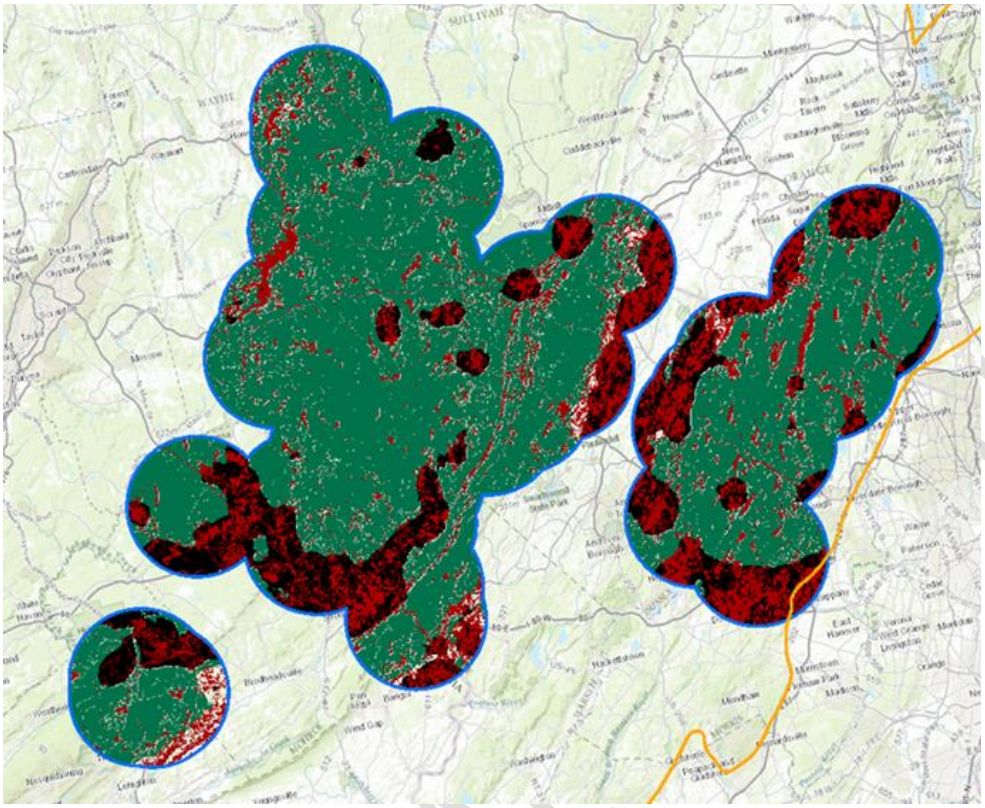

Figure 6. Black areas within PACs (blue circles) are locations with negative landscape contexts of >20% cover for development, cropland, or coniferous forest. Red areas are pixels with land-uses (e.g., development, cropland) that are not conducive for GWWA habitat management. Green areas meet are the remaining areas that meet suitable forested landscape criteria for GWWA.

In summary, the sequence of steps taken above resulted in a single layer that indicates locations that may be suitable for GWWA habitat management (Fig. 7)[4]. These potential GWWA habitat areas within PACs included both public and private lands that met **all** of the criteria listed below.

1. Had > 60% non-coniferous forest cover at the "macro" landscape scale OR were within a contiguous non-coniferous forest polygon that was > 1,000 acres.
2. Had < 20% development, cropland, and coniferous forest cover at the "macro" landscape scale.
3. Were not located within one of the 9 different NLCD land cover classes (see above) that preclude forest management for GWWA.

[4] This is the GIS file called "GWWAworkarea.tif"

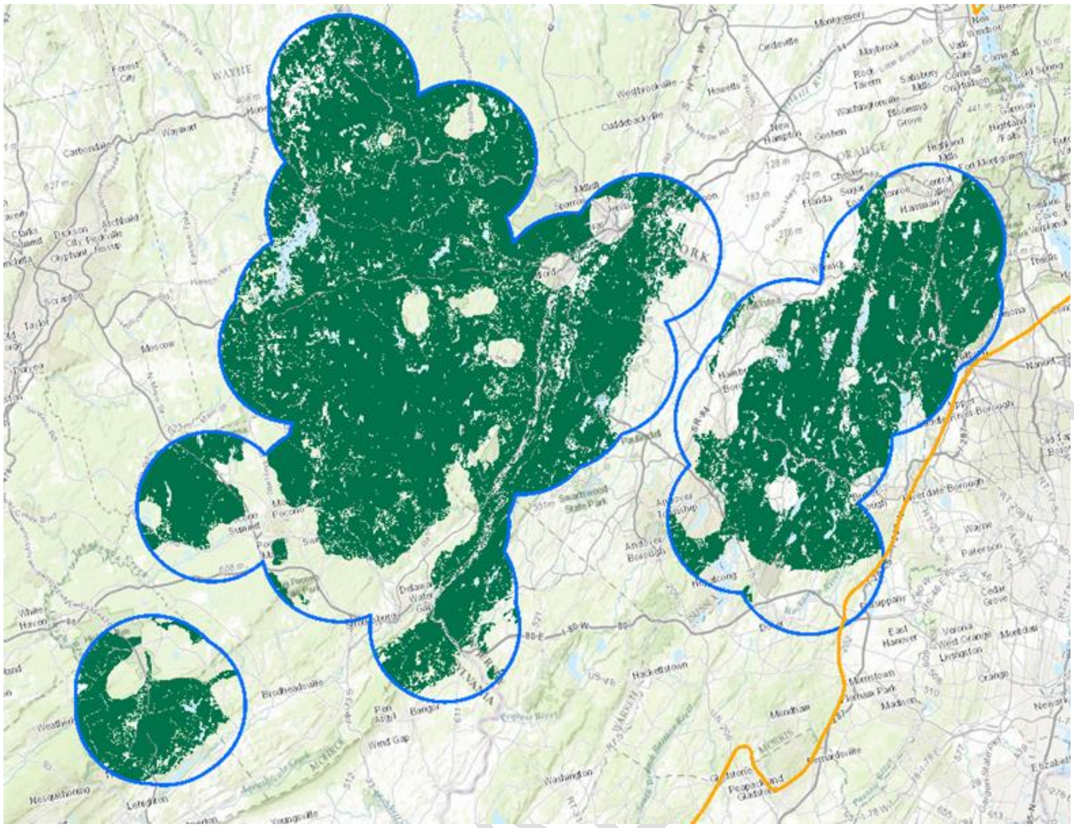

Figure 7. Green cells indicate areas that may potentially be used for GWWA habitat management. In other words, they meet both landscape and local-scale criteria for project development. Note: this image is the same as Figure 6 with unsuitable red and black areas removed.[5]

Acknowledgments for avian occurrence datasets

The following individuals and institutions contributed GWWA occurrence data that were used to delineate PAC boundaries: Kirsten Johnson, D.J. McNeil, and Emily Bellush of Indiana University of Pennsylvania; Douglas Gross of the PA Game Commission, Sergio Harding of the Virginia Department of Game and Inland Fisheries; The eBird Team at Cornell Laboratory of Ornithology; Sara Barker and Ron Rohrbaugh at the Cornell Laboratory of Ornithology; Kyle Aldinger of the National Wild Turkey Federation; Petra Wood of the USGS Cooperative Fish and Wildlife Research Unit at West Virginia University; Lesley Bulluck of Virginia Commonwealth University; Curtis Smalling of Audubon North Carolina; and Richard Bailey for the West Virginia Breeding Bird Atlas.

[5] This layer is provided as "GWWA_work_areas.tif"

Part III. Development of an online tool to evaluate the effectiveness of actions taken to improve habitat conditions for Golden- winged Warblers.

Prepared by: Drs. Casey Lott (American Bird Conservancy) and Jeffery Larkin, Ph.D. (Professor of Wildlife Ecology and Conservation, Indiana University of Pennsylvania & American Bird Conservancy)

Background

One of the most important pieces of any habitat management program is to clearly document exactly what on-the-ground habitat manipulation has been done (what type, at what extent, where and when) and the overall effect (positive, negative, or neutral) that this work has had on key performance targets for habitat (e.g., more acres of early-successional shrubland) or wildlife (e.g., more singing male Golden-winged Warblers). American Bird Conservancy (ABC) and Indiana University of Pennsylvania (IUP) are collaboratively working to develop an integrative data management and program evaluation tool that will allow for comprehensive summary and evaluation of management actions and conservation outcomes designed to improve habitat conditions for Golden-winged Warbler and American Woodcock on their breeding grounds.

The goal of this system will be to synthesize program data into a format where users can easily find the exact information they need using standard internet navigation actions (selection of drop down menus or check boxes, pointing and clicking on part of a map or graph to get more detailed information). While best practices in data management will underpin this system, users will not need to be familiar with how to query information from relational databases or develop complicated pivot tables in spreadsheet software. We will use Tableau Business Intelligence Software, to which ABC has a multi-seat license, to develop a simple, intuitive, online data retrieval system that will make data exploration (and clear understanding of program performance) accessible to all users. The system will be designed to integrate data provided (or used) by each of the following four user groups:

1. NRCS/IUP/ABC conservation planners and project PI's who track habitat actions.
2. Foresters/land managers who apply on-the-ground habitat management treatments.
3. Bird/habitat monitoring crews who collect data on bird and habitat performance metrics.
4. Program officers and leadership who need high level summaries of on-the-ground actions, their effectiveness, and progress towards targets.

This program evaluation tool will include:

1. Interactive data visualizations that summarize the type of habitat management treatments that have been completed to improve habitat conditions for target bird species (with the ability to drill down to the project scale to get more detailed results).

2. Interactive data visualizations that summarize post-management bird and habitat monitoring results (again, with the ability to drill down to see results for specific project areas).
3. A number of different data visualizations that link management treatment and bird/habitat response data to evaluate program effectiveness at multiple spatial or temporal scales.

Project Activities

The first challenge in developing an integrated data management system is gathering the existing data from all potential contributors. This process has been completed for two different regions (Appalachians: WLFW, Great Lakes: RCPP) for three different data types that form the foundation of the data management system: 1) bird survey data; 2) vegetation survey data; and 3) management treatment data. Specifically, the three data sources above have been consolidated and linked, by a common identifier, so that individual management treatments can be paired with post-treatment bird and vegetation data. Due to minor inconsistencies in how different data types were collected or recorded across regions, all management treatment areas were delineated as GIS shape files. Then, bird and vegetation data were overlaid on management areas to ensure that all management, bird, and vegetation data were correctly linked to the same site for evaluation purposes. All GIS work was done only to link data sources and neither shape files, nor information about specific properties or landowners, will be divulged in the forward-facing data tool. To this end, we developed a system to anonymize all data so that project-specific results could be summarized without pointing to a specific landowner or property. This was done simply by creating a master table, which will only be available to those with NRCS data privileges, pairing real landowner names and project numbers with fake landowner names and project numbers. NRCS coordinators and program managers can use the real names and spatial information to manage projects, however, the data management tool will present only fake landowner names, summarized at the spatial scale of county or larger, preserving the privacy of individual program participants. Finally, we explored several different options for file sharing in order to transfer files from NRCS managers, bird and vegetation survey crews, and data tool developers working in different locations. We propose the use of Intermedia's SecuriSync, which is an enterprise-scale file sharing system that meets industry standards for data security. SecuriSync does not require the installation of new software on participating computers. We see information transfer via SecuriSync as preferable to exchanging files with private information via email or other cloud based file sharing systems that are not allowed on NRCS computers, such as Dropbox. Now that the information described above has been consolidated, spatially referenced, linked, and anonymized, the next step will be the actual development of the management evaluation tool in Tableau.

Part IV. Landowner Response to NRCS Conservation Programs Targeting Early Successional Habitat: Attitudes, Satisfaction, Retention, and Intentions to Manage Habitat in the Future

Prepared by: Dr. Ashley Dayer & Seth Lutter (Virginia Tech) and Jeffery Larkin, Ph.D. (Professor of Wildlife Ecology and Conservation, Indiana University of Pennsylvania & American Bird Conservancy)

Background

The Working Lands for Wildlife's Golden-winged Warbler Initiative through the Natural Resource Conservation Service (NRCS) in the Appalachian states and a RCPP partnership between American Bird Conservancy and NRCS in the upper Great Lakes states aim to create and restore early-successional habitats for species of conservation concern. Through these two efforts, since 2012, 293 private landowners have signed contracts to implement conservation practices for Golden-winged Warbler and American Woodcock habitat on nearly 10,000 acres. While the biological effectiveness of this effort (i.e., vegetative and bird responses), is being evaluated, the social effectiveness of this effort, in terms of private landowner response, remains largely unknown. Understanding how social factors mediate outcomes of NRCS conservation programs is essential to ensure long-term management of this ephemeral habitat. The following questions about how participation in this voluntary incentive program affects landowners are especially important within this context: (1) Which factors predict landowner satisfaction with their habitat management (e.g., outcomes for target species, effects on non-target species, aesthetics, financial benefits)? (2) Which of these factors predict increases in landowner retention in the program, recruitment and participation in other incentive programs, adoption of conservation practices in the absence of payments, or recruitment of their neighbors in the program? (3) Can communication of information about biological effectiveness increase satisfaction and participation-related behavioral intentions? Answers to these questions would inform future efforts to promote retention of landowners in habitat management activities. Furthermore, information about social effectiveness and social factors could be paired with information about biological effectiveness to determine how these two aspects of conservation programs relate.

Research Overview

We propose conducting a phone survey of private landowners who own the sites that were treated with habitat prescriptions and monitored in summer 2015 and/or 2016 as part of the wildlife response Conservation Effects Assessment Project. Using biological data collected at sites in 2015 and 2016, we will summarize for each landowner the response of birds to their habitat management efforts. Within two months of landowners receiving the letters, we will begin administration of a phone survey. The phone survey instrument will include questions about landowner motivations for participation in the program, satisfaction with the habitat management, drivers of their level of satisfaction, and intentions to participate in habitat management incentive programs in the future as well as management without any incentive funds. We will also review the wildlife results on their property and explore their perceptions of these results. Each phone survey will take approximately 20-30 minutes. We expect a 50% response rate of the approximately 193 landowners, or 96 respondents.

Project Activities

This document serves as the first project report for the human dimensions project subcontracted to Virginia Tech, as part of the IUP-RI Conservation Effects Assessment Project "Assessing Wildlife Response to NRCS Conservation Programs Targeting Early Succession Habitats." The primary deliverables during the first quarter were:

- Establishment & meetings of project team
- Development of phone survey research questions, methods, and timeline for research implementation
- Coordination with NRCS to determine that a formal Information Collection Request was not necessary
- Development of draft phone survey instrument
- Development of biological survey results letter and other NRCS communications, in coordination with IUP & NRCS

Detailed description of each of these deliverables follows. Additionally, the phone survey instrument is attached to this report as an appendix.

Establishment & Meetings of Project Team

Graduate student (M.S.) Seth Lutter was brought on board by Virginia Tech to work on this project, starting in August 2016. This project serves as the basis for his Masters thesis in the Department of Fish and Wildlife Conservation. His advisor is Dr. Dayer, the PI for the project. Dr. Dayer and Lutter coordinated regular Web-ex meetings with the project team, including Dr. Jeff Larkin, Emily Bellush, Renae Poole, Darin McNeil, Callie Bertsch, Charlie Rewa, and Dr. Amanda Rodewald.

Development of Research Questions, Methods, and Timeline

Research Questions

Working in concert with the CEAP research team, we clarified the research questions for the project, originally written in the project proposal. These questions explore how landowner participation in this voluntary conservation incentive program for early successional habitat affects landowners:

1. What factors influence overall program satisfaction of private landowners who enrolled in a wildlife habitat conservation incentive program?

2. What factors influence intentions of private landowners who enrolled in a wildlife habitat conservation incentive program to continue their management post-program?

3. Do result mailings that include property level biological data influence overall program satisfaction and post-program management intentions of private landowners who enrolled in a wildlife habitat conservation incentive program?

Methods

A total of 193 private landowners own properties that were treated with habitat prescriptions and monitored in 2015 and/or 2016 as part of the wildlife response Conservation Effects Assessment Project. Located in Pennsylvania, Maryland, New Jersey, Wisconsin, and Minnesota, these landowners constitute the population of interest for the present research study. An approximately 20-30 minute long structured telephone survey will be implemented to address Research Questions 1-3. Further, a quasi-experimental design will be implemented to assess the role of biological result mailings (Research Question 3). The result mailing treatment group (n=123) will consist of landowners who were delivered two result mailings- in October 2015 and in December 2016. A second group of landowners (n= 70) whose properties were monitored for a single year and have received no result mailing will serve as a pseudo-control group. The pseudo-control group of landowners will receive delayed result mailings only after telephone surveys have been completed, in March 2017. We will then conduct a condensed follow-up telephone survey of willing landowners in the pseudo-control group. The follow-up will take place in May 2017, approximately three months following the initial survey. Only those landowners who responded to the initial survey and agreed to a follow up will be contacted for the follow-up.

Timeline

The timeline for survey implementation was agreed upon as follows:

- December: Results letters mailed to landowners who already received results letters last year (have been monitored for two years). Results letters held for other landowners.
- December: NRCS CEAP leadership & CEAP partners will inform NRCS state and field offices of upcoming telephone survey.
- January 3, 2017: CEAP partners will inform landowners who have been monitored of an upcoming phone survey conducted by Virginia Tech.
- January 5, 2017: Virginia Tech begins phone survey administration, starting with landowners who have NOT received a results letter. At the end of each survey, we will ask these landowners if they would be willing to take a short follow-up survey after they have received their results letters.
- February 28, 2017: Goal for completing all phone surveys with landowners who have NOT received a letter (or determining that it is not possible to reach these landowners). Virginia Tech will notify CEAP partners so they can send the results mailings right away.
- March 31, 2017: Goal for completing all phone surveys of those who received results mailing in November.
- May 2017: Short follow-up phone survey with landowners who received the results mailing in early March.

Development of Draft Phone Survey Instrument

An approximately 20-30 minute long structured telephone survey instrument was constructed using iterative question design and review by social scientists, private lands researchers, and graduate students at Virginia Tech. NRCS staff and the Conservation Effects Assessment Project research team, including the IUP-RI PI Dr. Larkin, have reviewed the survey and discussed edits. The survey will be pre-tested with Virginia Tech graduate students, content area experts, and finally with 5-10 private landowners who have participated in similar NRCS habitat conservation programs. The survey is subject to Virginia Tech's Institutional Review Board human subject research oversight and approval. Please see attached for a copy.

Coordination with NRCS

Drs. Dayer and Larkin consulted with Charlie Rewa (NRCS) and the USDA Office of the Chief Information Officer and the OMB Office of Information and Regulatory Affairs and determined that a formal Information Collection Request pursuant to the Paperwork Reduction Act was not necessary for Virginia Tech researchers to conduct this survey. All members of the assessment team are covered by current 1619 compliance acknowledgement agreements. Prior to survey implementation, the NRCS national office CEAP project team will be making courtesy contacts with the NRCS state offices and field offices in counties where projects were monitored to notify them that Virginia Tech will be conducting the survey.

Development of Biological Survey Results Letter & Other Communications

Dr. Dayer and Lutter coordinated with the project team to produce the biological survey results letter. They reviewed the letters to ensure that best practices for communicating with landowners were being followed. Additionally, they provided suggestions for messaging that would enhance the effectiveness of the letters in communicating to landowners. Finally, consideration was given to consistent language between the letters and the phone survey instrument. After several rounds of review, Emily Bellush and Renae Poole finalized the mailings for distribution and sent them to landowners in December.

Part V. Fledgling Golden-winged Warbler Habitat Use, Movement and Survival Across Two Managed Forest Landscapes in Pennsylvania

Prepared by: Cameron Fiss, Indiana University of Pennsylvania; Darin J. McNeil, Jr., Cornell University; Dr. Amanda Rodewald, Cornell Laboratory of Ornithology; and Dr. Jeffery L. Larkin, Indiana University of Pennsylvania & American Bird Conservancy

Background

A key breeding cycle component in many songbirds is the post-fledging period – the period between young leaving the nest and before departing on migration. Post-fledging research involving species similar to Golden-winged Warbler has shown high levels of mortality, as well as shifts in habitat use away from typical nesting cover during this critical interval. Thus, we investigated Golden-winged Warbler post-fledging habitat use, movement, and survival in two distinct managed forest to better understand habitat associations for these birds across their entire breeding cycle. This study marks the first of its kind to be conducted in the Appalachian segment of the Golden-winged Warblers breeding distribution, where populations have been declining the sharpest. We collected data from fledglings in the Poconos region of northeast Pennsylvania within Delaware State Forest during the 2014 and 2015 breeding seasons, and from the Pennsylvania Wilds region of central PA within Sproul State Forest and an adjacent State Game Lands during the 2016 breeding season (Figure 1). Additionally, we anticipate collecting another year (2017) of data in central PA. This information will allow land managers to better understand the habitat needs and space use requirements of Golden-winged Warblers during this short, but critical time period. Ultimately, when considered with current knowledge regarding nesting habitat, this new information will allow for the planning of landscapes that maximize full Golden-winged Warbler breeding season productivity in the Appalachians.

Objectives

1. Quantify habitat use of Golden-winged Warbler fledglings on the landscape and micro-scales within two landscapes of the Appalachian segment of the breeding range
2. Quantify Golden-winged Warbler fledgling space use and movement.
3. Estimate and compare Golden-winged Warbler fledgling survival
4. Determine if fledgling Golden-winged Warblers are selective in their use of habitat

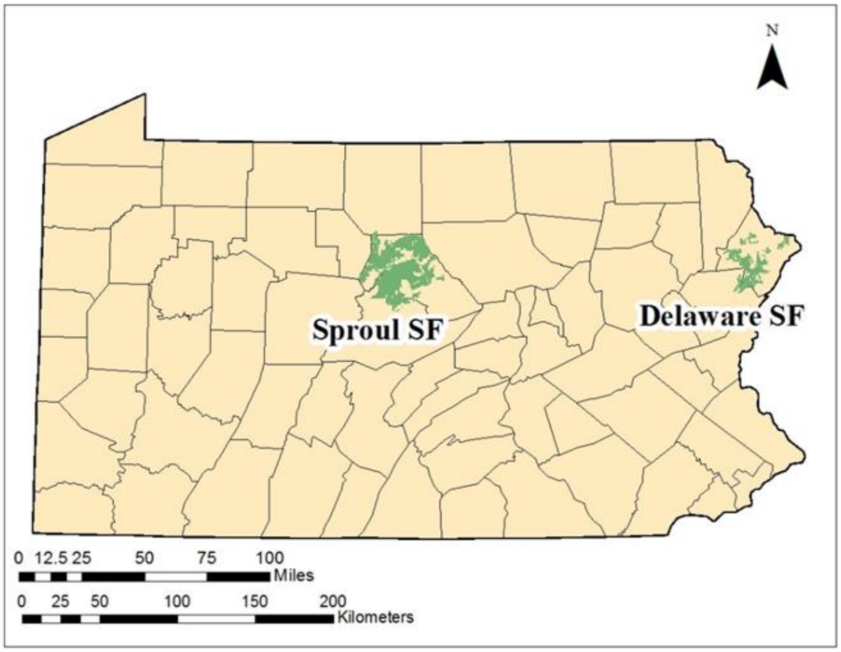

Figure 1. Map of Pennsylvania showing the two state forests which were the primary locations of Golden-winged Warbler fledgling habitat, survival, and movement study. Delaware State Forest contained all study sites used between 2014 and 2015. Sproul State Forest contained all study sites used during the 2016 breeding season.

Methods and Results

We searched for Golden-winged Warbler nests in 11 timber harvests across both study sites from 2014 to 2016 using standard nest searching methods. Upon finding nests, we recorded their location and began monitoring their progress thereafter on a three day interval. As nestlings approached fledging (~7-8 days post-hatch), we randomly removed two from the nest to tag with radio-transmitters. Depending on the juvenile's mass, we used either a 0.35g or a 0.41g radio-transmitter. We attached transmitters using a figure-eight style harness (Rappole and Tipton 1991), which loops over both of the bird's legs allowing the transmitter to rest on the bird's back (Fig. 2). Both transmitter and harness together did not exceed 5% of the bird's mass. Additionally, each juvenile was banded with a numbered USGS aluminum leg band for identification purposes. After attaching both transmitter and leg band, juveniles were returned to the nest. We began tracking each juvenile daily upon fledging to monitor survival and record habitat use variables. We recorded habitat variables at two scales: 1) the macro scale, in which we recorded the forest cover type (e.g. early-successional, pole, mature) the juvenile was using, and 2) the micro scale, in which we recorded within stand features (e.g. sapling height, vegetation density) around juvenile locations. In addition to recording habitat information where we relocated birds, we also recorded habitat variables at paired random locations that were "available". Therefore on each day, every juvenile had a "used" and paired "available" survey location. These used and available data points will allow for future analyses that elucidate the extent to which fledglings *selected* for habitat. In other words, did fledglings use certain cover types or fine scale habitat features disproportionately to the amount at which they occur on the landscape.

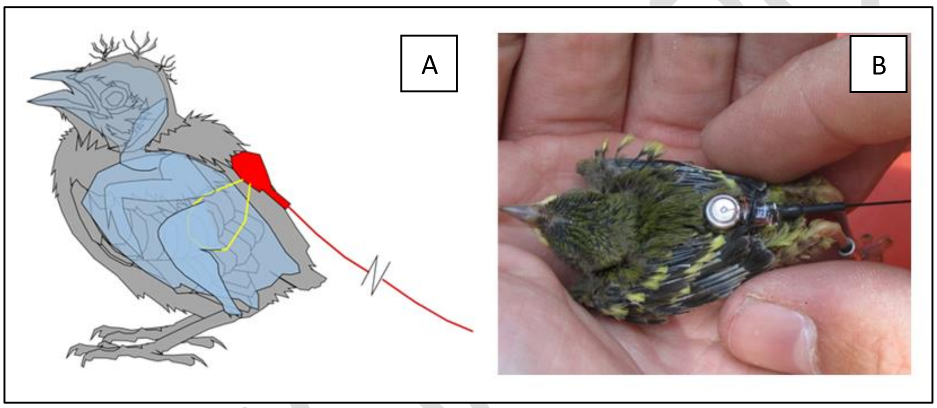

Figure 2. Radio-transmitter attachment diagram for Golden-winged Warbler fledglings. A) Profile view of fledgling with a figure-eight style harness (shown in yellow) looped around the legs. Radio-transmitter and antenna are shown in red resting on the juvenile's back. B) Juvenile Golden-winged Warbler with newly attached radio-transmitter and aluminum USGS leg band.

During the 2014 breeding season in Pennsylvania, 40 Golden-winged Warbler nests were located and monitored across six timber harvests, managed in accordance to the GWWA BMP throughout Delaware State Forest. Of the nests found, 23 (58%) successfully fledged young, which produced 86 total fledglings. A total of 47 juvenile Golden-winged Warblers were radio-marked. We tracked 17 juveniles daily from the point they fledged, of which 12 (70%) survived to independence. Additionally, we tracked 12 juveniles that were caught after fledgling, of which 7 (58%) survived to independence. Five fledglings slipped out of their radio-transmitter harnesses' shortly after being radio-marked, two of which were seen with radio-marked siblings, and the other three were not detected again. The remaining 13 birds died before fledgling. A total of 29 fledglings were tracked daily. Nineteen total fledglings (66%) survived throughout the entire 30-day tracking period. There was a total of 10 fledgling deaths, which were attributed to mammalian depredation (n=7) and avian depredation (n=3). This 66% fledgling survival allowed us to quantify habitat for n=450 “used” fledgling locations and n=450 “available” locations. Radio-marked fledglings moved an average of 133 meters per day. The largest recorded distance travelled by a fledgling in a single day was 1.26 kilometers.

During the 2015 breeding season in Pennsylvania, 41 Golden-winged Warbler nests were located and monitored across six timber harvests managed in coherence to the GWWA BMP throughout Delaware State Forest. Of the nests found, 26 (63%) successfully fledged young, which produced 122 total fledglings, of which 43 were radio-marked and banded. All birds were tracked daily; 33 of which survived throughout the entire period. Of the fledglings studied in 2015, all deaths (n=10) occurred within the first four days post fledging. Of these, four were associated to unfavorable weather conditions immediately after fledging, three deaths were attributed to mammalian depredation, and two deaths were attributed to snake depredation. One bird disappeared shortly after being radio-marked and was not detected throughout the remainder of the season. Because survival was high (77%), we were able quantify habitat for n=907 “used” fledgling locations and 907 “available” locations. Radio-marked fledglings moved an average of 149 meters per day in 2015. The largest recorded distance travelled by a fledgling in a single day was 1.68 kilometers.

During the 2016 breeding season, 39 Golden-winged warbler nests were located and monitored across five timber harvests managed in coherence to the GWWA BMP and one early-successional stand regenerating from a forest fire throughout Sproul State Forest in central Pennsylvania. Of the 39 nests located, only 12 (31%) successfully fledged young producing a total of 28 fledglings, 27 of which were radio-tagged. An additional five juvenile Golden-winged Warblers were captured and radio-tagged after they had fledged from unknown nests. Thus, we tracked 32 fledglings daily. Of the 32 fledglings tracked daily, 11 (34%) survived the entire tracking period. There were 21 fledgling mortalities in 2016, nine were attributed to mammalian depredation, five were attributed to avian predators, and one was attributed to a Milk Snake (*Lampropeltis triangulum*). Additionally, two fledglings appeared to be abandoned, and four died from unknown causes. Although nesting success and fledgling survival were relatively low in 2016, we were still able to quantify habitat at 404 “used” and 404 “available” fledgling locations. Radio-marked fledglings moved 123 meters per day in 2016, and the largest single day movement was 1.09 kilometers.

Generally, across all three breeding seasons (2014-2016) and both study sites, Golden-winged Warbler fledglings experienced high levels of mortality early in the post-fledging period. Across our two study systems, 24 of 41 (59%) fledgling mortalities occurred with the first four days after leaving the nest (Fig. 3). After roughly four days post-fledging, juveniles were predated much less frequently. In fact, in 2015 no juveniles were predated after day nine post-fledging. Additionally, fledgling Golden-winged Warblers moved consistently further on a daily basis as they aged (Fig 4). By day 30 post-fledging, juveniles in both Delaware and Sproul State Forests were moving over 300 meters each day. Many fledgling Golden-winged Warblers also moved considerable distances across the landscape (Fig 5). In Delaware State Forest by day 30, fledglings were on average >850 meters (median= 920m) from their nest. In Sproul State Forest by day 30, fledglings were on average >650 meters (median= 850m) from their nest. Habitat use trends were also similar between DSF and SSF. Across both study sites, fledglings used early successional forest almost exclusively during the first five days outside the nest (Fig. 6). As juveniles aged, they began to use a variety of different cover types, particularly in Delaware State Forest, where fledglings used more mature forest and wetland cover types by day 22 than they did of early-successional cover types. In Sproul State Forest, early-successional forest remained the most dominant cover type used throughout the post-fledging period, although shrubland cover was also used regularly.

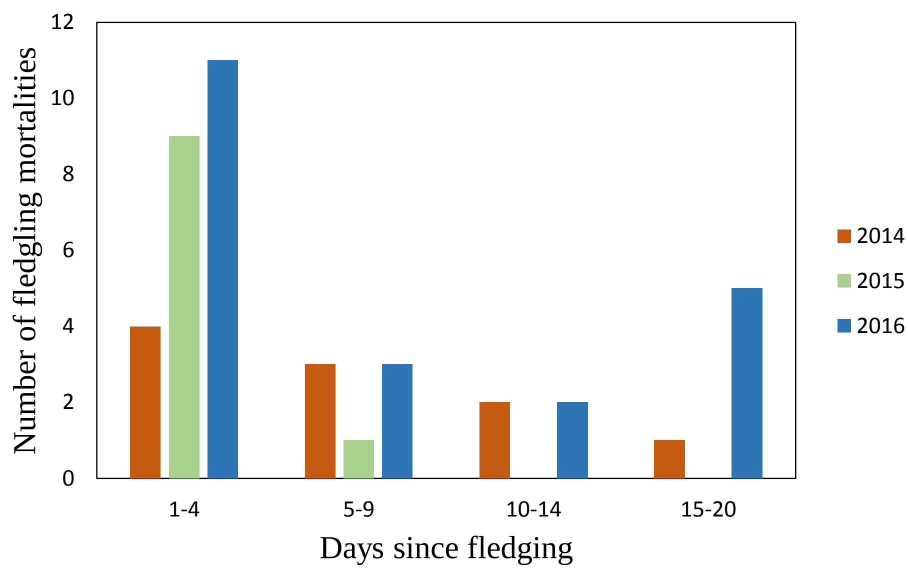

Figure 3. Bar graph indicating timing (days since fledging) of Golden-winged Warbler fledgling deaths across three separate breeding seasons in Delaware State Forest PA (2014-2015) and Sproul State Forest PA (2016).

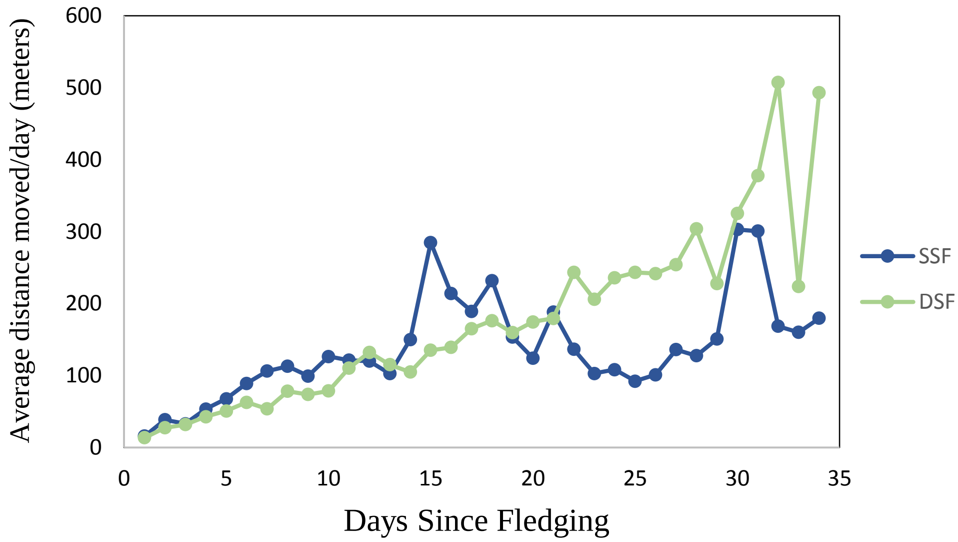

Figure 4. Graph displaying a comparison of average daily movements made by Golden-winged Warbler fledglings in Delaware State Forest (DSF) PA during the 2014 and 2015 post-fledging period and Sproul State Forest (SSF) PA during 2016 post-fledging period.

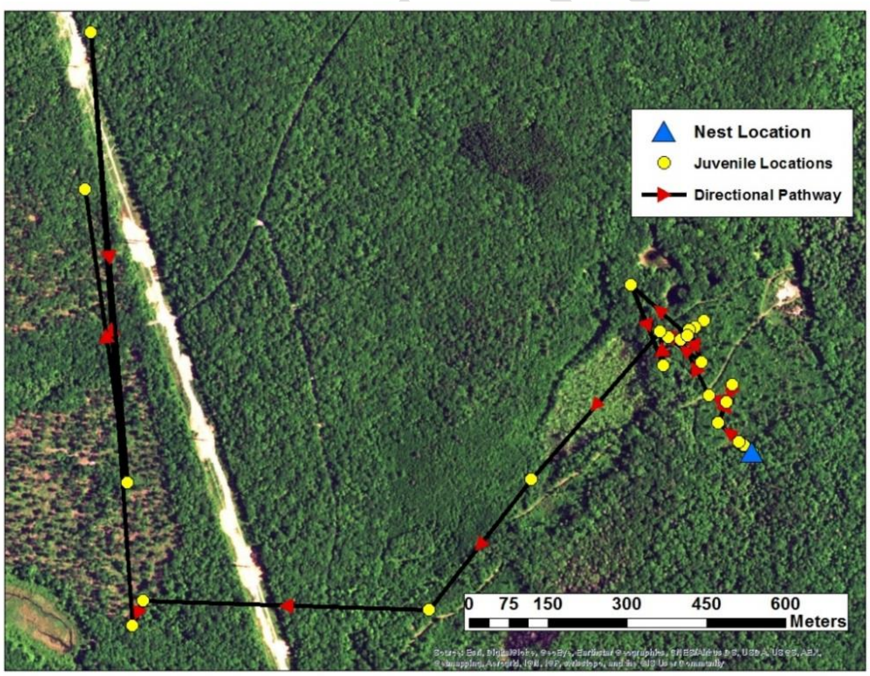

Figure 5. A map displaying the daily movements of a juvenile Golden-winged Warbler within the Delaware State Forest of northeast Pennsylvania during the 2015 breeding season. The fledgling's nest is indicated by the blue triangle and yellow circles are points where the fledgling was relocated using radio-telemetry. The black line indicates a "straight-line" pathway between fledgling relocations, but does not display the exact route the bird used to get to each location.

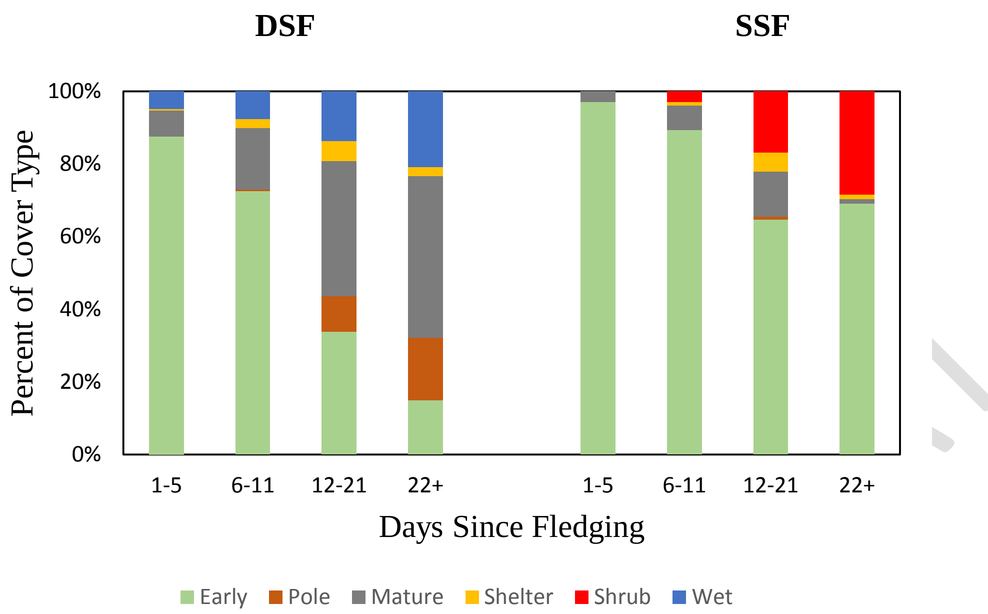

Figure 6. A comparison of Golden-winged Warbler fledgling forest cover type use between Delaware State Forest (DSF) during the 2014 and 2015 breeding seasons, and Sproul State Forest (SSF) during the 2016 breeding season. Habitat use is broken into five time intervals of fledgling development (days since fledging). Wetlands were only present in DSF study area and absent from SSF. Shrublands were present in SSF and absent in DSF.

Future Work

In this report we only provided a general over of our finding associated with the understudied the olden-winged warbler post-fledging period. Many analyses regarding Golden-winged Warbler fledgling movement, habitat use, habitat selection, and survival are ongoing and will hopefully elucidate to a much larger extent the requirements of these birds during the post-fledging period. Habitat selection analyses will investigate on the landscape scale which cover types are used by fledglings disproportionately to the amount they occur on the landscape. Selection analyses will also investigate which micro-scale habitat features within different cover types Golden-winged Warblers prefer. Additionally, future survival analyses will attempt to elucidate which cover types and features within cover types maximize fledgling survival, and whether fledglings are seeking out these features. Ideally, future results will allow us to better inform land managers about spatial scale, landscape composition, and vegetation structure that maximize Golden-winged Warbler reproductive success.

Acknowledgements

We are grateful to all of the funders for this project, including NRCS-CEAP. While this project was funded primarily through CEAP, we are very grateful to the National Fish and Wildlife Foundation, the Pennsylvania Game Commission, American Bird Conservancy, and Virginia Tech for providing additional funding. We are grateful to Sharon Petzinger and the New Jersey Dep't of Fish & Wildlife for their assistance with field work. We are also grateful for the continued support of the PA-DCNR. Further, we are grateful to the Maryland DNR, Rice Lake National Wildlife Refuge, and Tamarack National Wildlife Refuge for assistance and access to their lands. Finally, we are grateful for the tireless efforts of many volunteers and paid field technicians.