Golden-winged Warbler

Status Review and Conservation Plan

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Editors: Amber M. Roth, Ronald W. Rohrbaugh, Tom Will, and David A. Buehler

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Chapter 1: Golden-winged Warbler Status Review

Chapter 2: Golden-winged Warbler Full Life Cycle Conservation Strategy

Chapter 3: Golden-winged Warbler Breeding Season Conservation Plan

Chapter 4: Golden-winged Warbler Non-breeding Season Conservation Plan (to be added in the future)

Photo by Roger Erikkson.

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This timber harvest in Pennsylvania depicts excellent breeding habitat for Golden-winged Warblers. It shows ample residual trees, shrubs, and saplings with a large herbaceous component. Photo by: Marja Bakermans.

ACKNOWLEDGMENTS

The Golden-winged Warbler Status Review and Conservation Plan was developed and reviewed under the guidance of the Golden-winged Warbler Working Group, a consortium of more than 75 biologists and managers engaged in research and conservation of this species (www.gwwa.org/). Funding for the initiative was provided by the National Fish and Wildlife Foundation and U. S. Fish & Wildlife Service, with more than $1 million in matching contributions provided by numerous partner organizations including American Bird Conservancy, Appalachian Mountains Joint Venture, Audubon North Carolina, Cornell Lab of Ornithology, Fundacion Proaves-Colombia, Indiana University of Pennsylvania, Ithaca College, Michigan Technological University, University of Minnesota, University of Tennessee, Wisconsin Department of Natural Resources, Tennessee Wildlife Resources Agency, and The Ruffed Grouse Society. We are grateful to the many individuals who contributed significant effort to specific portions of this document, as follows:

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PREFACE: A HISTORY OF INSPIRED RESEARCH AND CONSERVATION

As measured by the Breeding Bird Survey (BBS) over the last 45 years, Golden-winged Warbler (*Vermivora chrysoptera*) has experienced one of the steepest declines of any North American songbird. It has also been one of the most intensely studied songbirds. Together with its sister species, Blue-winged Warbler (*V. cyanoptera*), it has been the subject of numerous research projects by a host of talented field ornithologists beginning in the 1960s with Frank Gill, Lester Short, and especially Millicent and Robert Ficken, and continuing to the present day. Several ornithologists have devoted their entire careers to elucidating the knotty problems the species poses. Over the last 150 years, the range of Golden-winged Warbler has geographically shifted more than that of almost any other avian species. It has been labeled as a habitat specialist as well as an early successional pioneer generalist. It has been reported more commonly from low-lying wetlands in some regions and from uplands in other regions. It has been identified as a shrubland edge species associated with abandoned farmland succession and as a species of dynamic forested landscapes. It mates with Blue-winged Warbler where the two species come into secondary contact and forms readily identifiable hybrids in a hybrid mosaic zone, yet one can still find extensive areas where the two species remain at least phenotypically distinct. Despite the characteristic visual features signaling its distinct identity, introgression of Blue-winged Warbler mitochondrial genes is widespread; yet geneticists have been hard-pressed to find nuclear markers that reliably distinguish the two species. Golden-winged Warbler behavior relative to Blue-winged Warbler is puzzling at best: it overlaps territories with the other species yet still engages in aggressive interspecific interactions; individuals that appear to be clearly one species can sometimes sing the song characteristic of the other, or both songs; hybrids may sing the song of either parental type.

Because of the tantalizing science questions it poses, its rapidly declining populations, and its intrinsic aesthetic appeal, Golden-winged Warbler has attracted a large and dedicated group of passionate ornithologists and conservationists over the last decade. Except for the hybridization question, research on Blue-winged Warbler has essentially ground to a halt while work on Golden-winged Warbler has increased exponentially. The formation of the Golden-winged Warbler Working Group in 2003—and its international sister group, Alianza Alas Doradas, in 2005—has catalyzed a highly coordinated conservation initiative. The Working Group has inspired two major workshops or "summits" (in Siren, Wisconsin, and in Bogotá, Colombia), at least three symposia at major ornithological meetings, dozens of regional and local workshops and presentations, a rangewide Golden-winged Warbler Atlas Project, and a rangewide hybridization study. Most significantly, supported by four years of funding from the National Fish and Wildlife Foundation (NFWF) beginning in 2008, the Working Group's Rangewide Golden-winged Warbler Conservation Initiative coordinated a multi-scale study at eight sites in seven states from Minnesota to New York and south to Tennessee. This coordinated research project was to provide the science base for developing regionally specific guidelines for restoring and enhancing productive Golden-winged Warbler breeding habitat. The results of that work form the core of Chapter 3 of this document—the **Golden-winged Warbler Breeding Season Conservation Plan**.

In 2000, David Buehler, John Confer, and Ronald Canterbury were commissioned by the U.S. Fish and Wildlife Service to develop what was originally the *Status Assessment and Conservation Recommendations for the Golden-winged Warbler (Vermivora chrysoptera) in North America*. Over time, that original project received input from others and underwent numerous stalls, revisions, and reviews. The fact that the continuous arrival of new information so rapidly outpaced the writing and review schedule of the *Status Assessment* is fundamentally a tribute to the tremendous dedication and energy of the Golden-winged Warbler Working Group and its partners. However, the deadlines imposed by the

NFWF-funded *Breeding Season Conservation Plan*—coupled with the listing of Golden-winged Warbler as a Threatened species in Canada and a pending petition to list the species under the Endangered Species Act in the U.S.—have finally pushed what has now become the *Status Review* to the finishing line. The core of the original assessment, although with much new information, now forms the basis of Chapter 1 of this document—the **Golden-winged Warbler Status Review**. In this version, survey and trend estimates have been updated to include 2009 BBS data and to incorporate the currently preferred and more robust Bayesian approach for analyzing BBS trend information. Genetic data were updated to include birds sampled during the 2010 breeding season. The conservation and research recommendations of the original *Status Assessment* have been integrated with the results of the two summits, three 2009 regional Working Group meetings, and the business plan developed for NFWF; these now form the comprehensive framework of goals and objectives outlined in Chapter 2—the **Golden-winged Warbler Full Life Cycle Conservation Strategy**.

Finally, recognizing that all parts of the annual cycle of a long-distance migratory bird are inextricably linked to one another—and recognizing that conservation actions on the breeding grounds should be complemented by conservation during the non-breeding season—we have included in this document a placeholder for a fourth chapter. We anticipate that Chapter 4, the **Golden-winged Warbler Non-breeding Season Conservation Plan**, will be completed a few years after analysis of the 2011–2012 non-breeding season survey results and a site-specific review of Neotropical non-breeding season threats.

Chapter 1.

GOLDEN-WINGED WARBLER STATUS REVIEW

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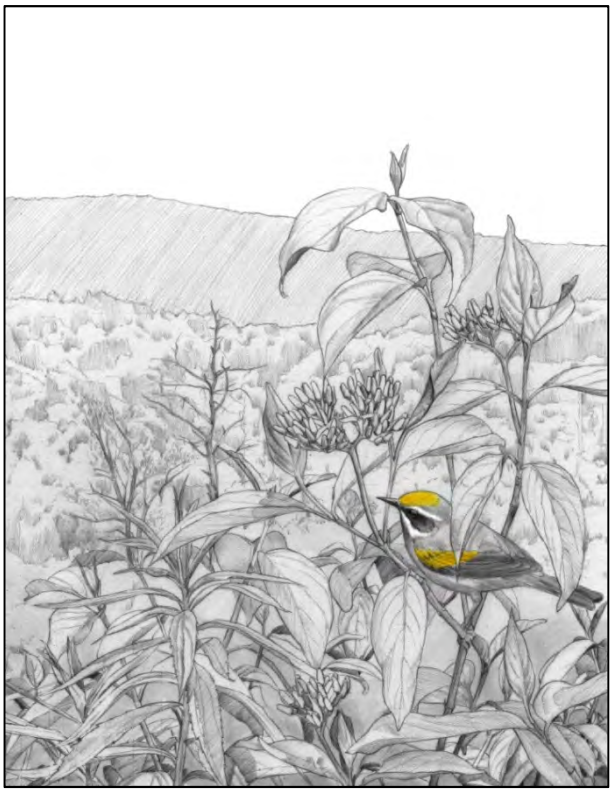

Illustration by Reyn Ojiri.

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ACKNOWLEDGMENTS

The *Golden-winged Warbler Status Review* was initiated over a decade ago when David Buehler, John Confer, and Ron Canterbury were funded by the U.S. Fish and Wildlife Service to elaborate on what was originally a status assessment begun by Chuck Hunter in 1999. Over time, that original project received input from others and underwent numerous stalls, revisions, and reviews. The continuous stream of new information that so rapidly outpaced the writing of the document is actually a tribute to the tremendous dedication and energy of the Golden-winged Warbler Working Group and its partners. In this version of the Status Review, survey and trend estimates have been updated to include 2009 BBS data and to incorporate the currently preferred and more robust Bayesian approach for analyzing BBS trend information. Genetic data were updated to include birds sampled during the 2010 breeding season. We are pleased finally to release the Status Review, at the same time acknowledging that new research and conservation action will just as quickly outdate much of the information it summarizes. We of course believe that such a level of conservation science commitment is a good thing, and we would prefer to think of this document as a *Status Transition* to a more hopeful future. We are grateful for the very many individuals who devoted time and energy to the surveys that provided the basis for inference about Golden-winged Warbler status—volunteers for the Breeding Bird Survey, Breeding Bird Census, Golden-winged Warbler Atlas Project, individual State and Provincial atlas projects, Golden-winged Warbler Non-breeding Season Survey, and Chicago Bird Collision Monitoring project, to name just a few. We are especially grateful to those who made significant contributions to specific sections of this document and to those who reviewed the final product, as follows:

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Chapter 2.

GOLDEN-WINGED WARBLER FULL LIFE CYCLE CONSERVATION STRATEGY

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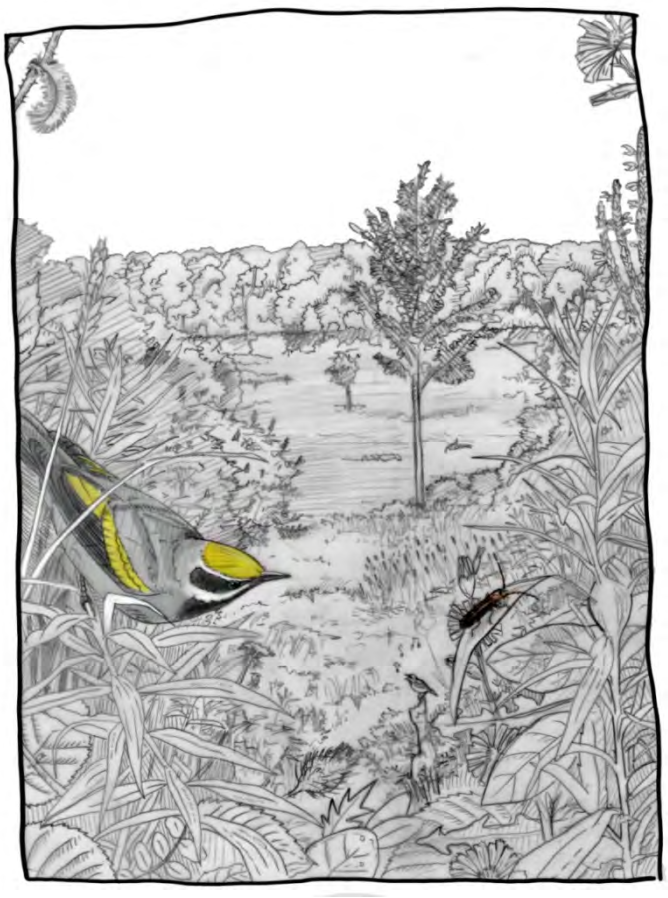

Illustration by Ann-Kathrin Wirth.

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Illustration by: Ann-Kathrin Wirth.

CHAPTER 2 SUMMARY

Golden-winged Warbler (*Vermivora chrysoptera*) populations have declined significantly across their breeding range for the past 45 years, based on analysis of North American Breeding Bird Survey (BBS) data. The eastern portion of the breeding population, primarily in the Appalachian Mountains Bird Conservation Region, has declined precipitously and is now largely disjunct from the Midwestern (Great Lakes) populations. Midwestern populations, which now comprise the vast majority of breeding pairs, are now starting to decline as well. Much of the decline of this species can be explained by habitat loss, while hybridization with Blue-winged Warbler (*Vermivora cyanoptera*) has exacerbated the declines and added complexity to the development of effective conservation strategies. These themes related to Golden-winged Warbler biology, ecology, and population status are further explored in Chapter 1 of this Status Review and Conservation Plan.

The Golden-winged Warbler Working Group was established in 2003 to provide a coordinated response to the declining Golden-winged Warbler populations. The Working Group has developed this full life cycle conservation strategy for this species based on contemporary knowledge about it breeding, migration, and wintering ecology. The strategy is based on the presumption that limiting factors on the breeding grounds, during migration, and on the wintering grounds need to be addressed to effectively counteract the factors currently responsible for population declines. On the breeding grounds, this strategy is based on delineation of focal conservation areas where maintenance of breeding populations is being promoted through implementation of habitat management guidelines. These guidelines (Chapter 3) have been developed based on a cooperative research project documenting habitat characteristics and relationships with successful nesting (see sidebar, page 2–11). The Working Group will conduct training workshops for public and private land managers to get knowledge about Golden-winged Warbler habitat prescriptions into the hands of people that can affect habitat management. Additional work is needed to delineate the migration pathways for Golden-winged Warbler to allow for the development of specific conservation strategies to protect migration stopover areas. The Working Group is also working on the wintering grounds to document distribution and habitat associations, and develop proactive conservation strategies to protect and restore quality wintering habitat that will ensure successful over-winter survival (Chapter 4). Success of the conservation strategy will be assessed through a coordinated monitoring program. This monitoring program will track the key components of the conservation strategy, including acres managed for Golden-winged Warbler, population response at multiple spatial scales, and changes in levels of genetic introgression within populations.

This conservation strategy has been developed with the needs of other priority species in mind. The species associated with Golden-winged Warbler have been identified in this document. We have also forged a working relationship with the regional Young Forest Initiatives (www.youngforest.org) coordinated by the Wildlife Management Institute, among others, to avoid duplication of effort and benefit from synergistic activities.

For your reference, a glossary of commonly used terms is provided in Appendix A. Other useful sources of information about Golden-winged Warbler are listed in Appendix B.

CONSERVATION STRATEGY

Understanding a species'ecology and demography throughout its life cycle is the key to identifying the factors leading to population decline or limiting population growth (see sidebar). Until we have definitive evidence identifying specific limiting factor(s); however, we advocate a full life cycle strategy to conservation that includes addressing several identified threats:

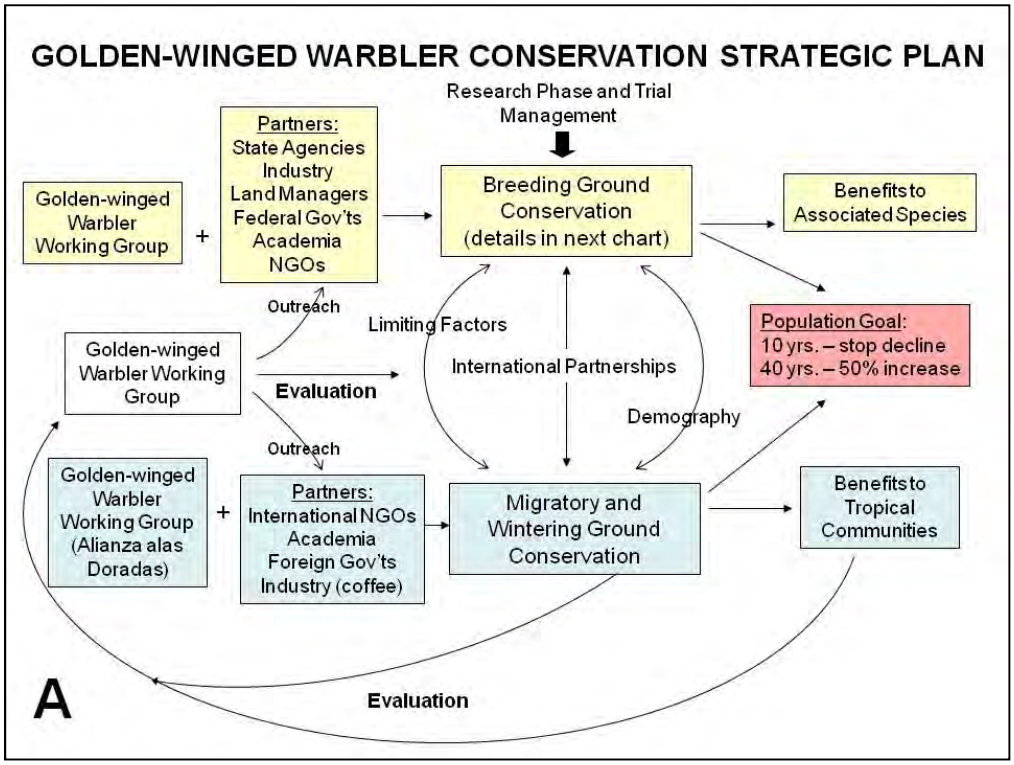
1. Increasing quality and quantity of breeding, stopover, and wintering habitats.
2. Minimizing hybridization with the closely related Blue-winged Warbler.
3. Promoting research into refining our understanding of the factor(s) leading to population decline and recovery.

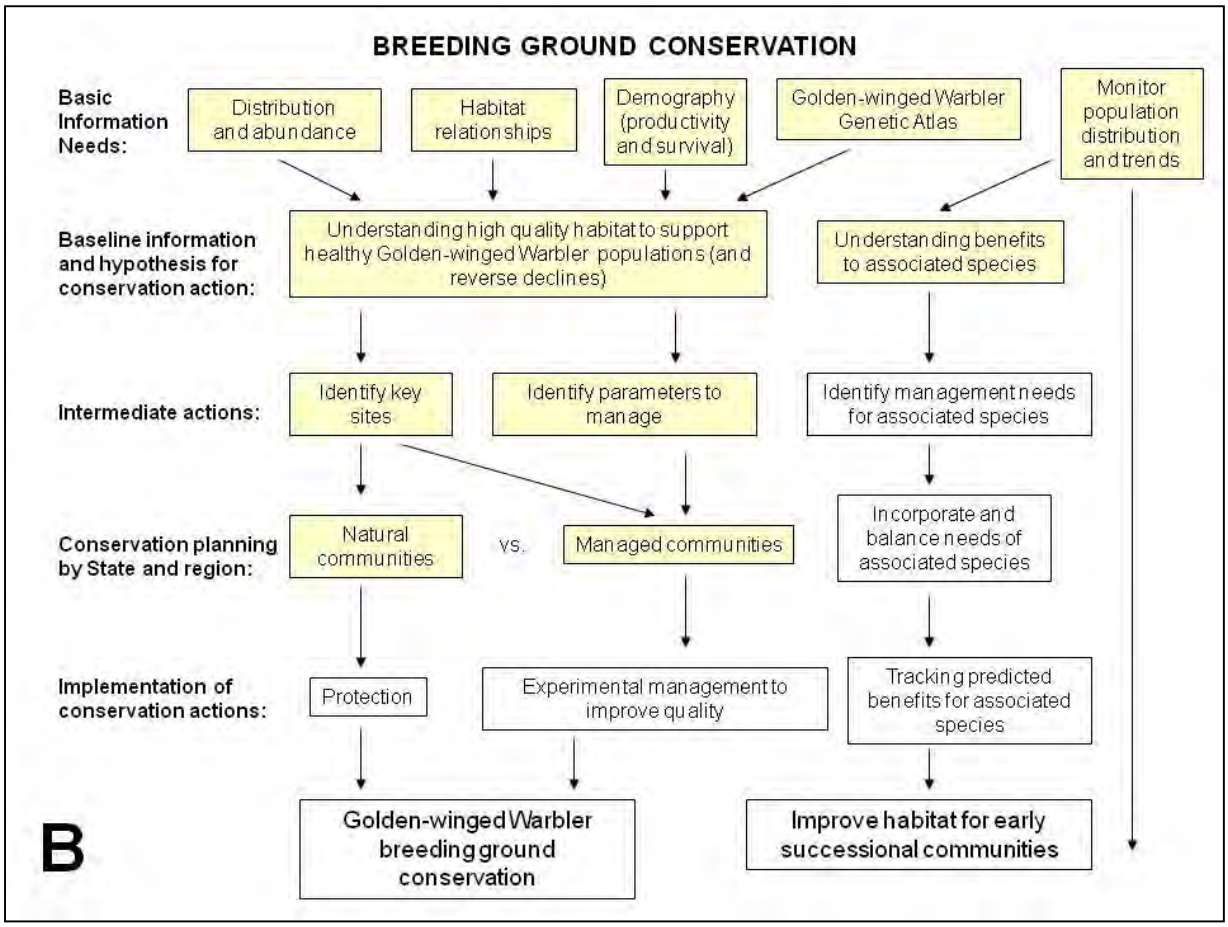
Example of Factors Limiting Population Growth

Imagine that a population is like water in a leaky bucket. Because there are holes in the bucket, the water is continually draining out; this represents mortality in a population. To maintain the water level in the bucket, more water must be added periodically; this represents reproduction and recruitment into a population. If the rate of the water leaking from the bucket is equal to the water entering the bucket, then a population is stable. If the rate of the water leaking from the bucket exceeds the rate of the water entering the bucket, then a population is declining, as is the case for the Golden-winged Warbler. To increase population size, there are two options: 1) increase reproductive output (i.e. increase the rate of adding water to the bucket), and/or 2) increase annual survival and recruitment to the population. By increasing reproductive output, we can potentially increase a population, but this will be limited by the breeding ecology of the species. Golden-winged Warblers are single-brooded and produce at most 5–6 young per brood. If the rate of mortality exceeds the maximum reproductive potential of the species, then other conservation actions will be necessary for population recovery.

The primary premise behind this conservation strategy is that reproductive output may be increased by increasing the amount of habitat and by improving the quality of existing habitat. This straightforward notion; however, is complicated by the Golden-winged Warbler's interactions with the closely related Blue-winged Warbler. In some areas, therefore, suitable habitat might not be occupied by Golden-winged Warblers if Blue-winged Warblers are present. For this reason, land managers should seek to create habitat in locations and configurations that promote persistence of Golden-winged Warbler populations and minimizes interactions with Blue-winged Warblers.

The conceptual model in Figure 2–1A describes the strategic plan for Golden-winged Warbler conservation. This logic framework was originally developed as part of the National Fish and Wildlife Foundation's Early Successional Habitat (ESH) Initiative business plan. Included are the key components needed for successful implementation to meet the stated population goals with an emphasis on a full life cycle conservation approach. Figure 2–1B and C details the process being implemented by the Golden-winged Warbler Working Group to address conservation during the breeding and nonbreeding seasons. Though this document addresses rangewide and regional planning needs, additional meetings and planning may be needed at the state and local level to assist agencies with implementation. The next phase of implementation will require collaboration between a broad range of partners to protect and manage breeding habitat. The Golden-winged Warbler Working Group will play a fundamental role in providing technical assistance and outreach tools to assist partners in this next phase. Though baseline information on breeding habitat management has been collected, ongoing evaluation of management tools and guidelines will be necessary to improve our effect on populations.


GOLDEN-WINGED WARBLER CONSERVATION STRATEGIC PLAN
Research Phase and Trial Management
Partners:
State Agencies
Industry
Land Managers
Federal Gov'ts
Academia
NGOs
Golden-winged Warbler Working Group
+
Breeding Ground Conservation (details in next chart)
Benefits to Associated Species
Outreach
Limiting Factors
International Partnerships
Population Goal:
10 yrs. – stop decline
40 yrs. – 50% increase
Golden-winged Warbler Working Group
Evaluation
Demography
Outreach
Golden-winged Warbler Working Group (Alianza alas Doradas)
+
Partners:
International NGOs
Academia
Foreign Gov'ts
Industry (coffee)
Migratory and Wintering Ground Conservation
Benefits to Tropical Communities
A
Evaluation


BREEDING GROUND CONSERVATION
Basic Information Needs:
Distribution and abundance
Habitat relationships
Demography (productivity and survival)
Golden-winged Warbler Genetic Atlas
Monitor population distribution and trends
Baseline information and hypothesis for conservation action:
Understanding high quality habitat to support healthy Golden-winged Warbler populations (and reverse declines)
Understanding benefits to associated species
Intermediate actions:
Identify key sites
Identify parameters to manage
Identify management needs for associated species
Conservation planning by State and region:
Natural communities
vs.
Managed communities
Incorporate and balance needs of associated species
Implementation of conservation actions:
Protection
Experimental management to improve quality
Tracking predicted benefits for associated species
Golden-winged Warbler breeding ground conservation
Improve habitat for early successional communities
B

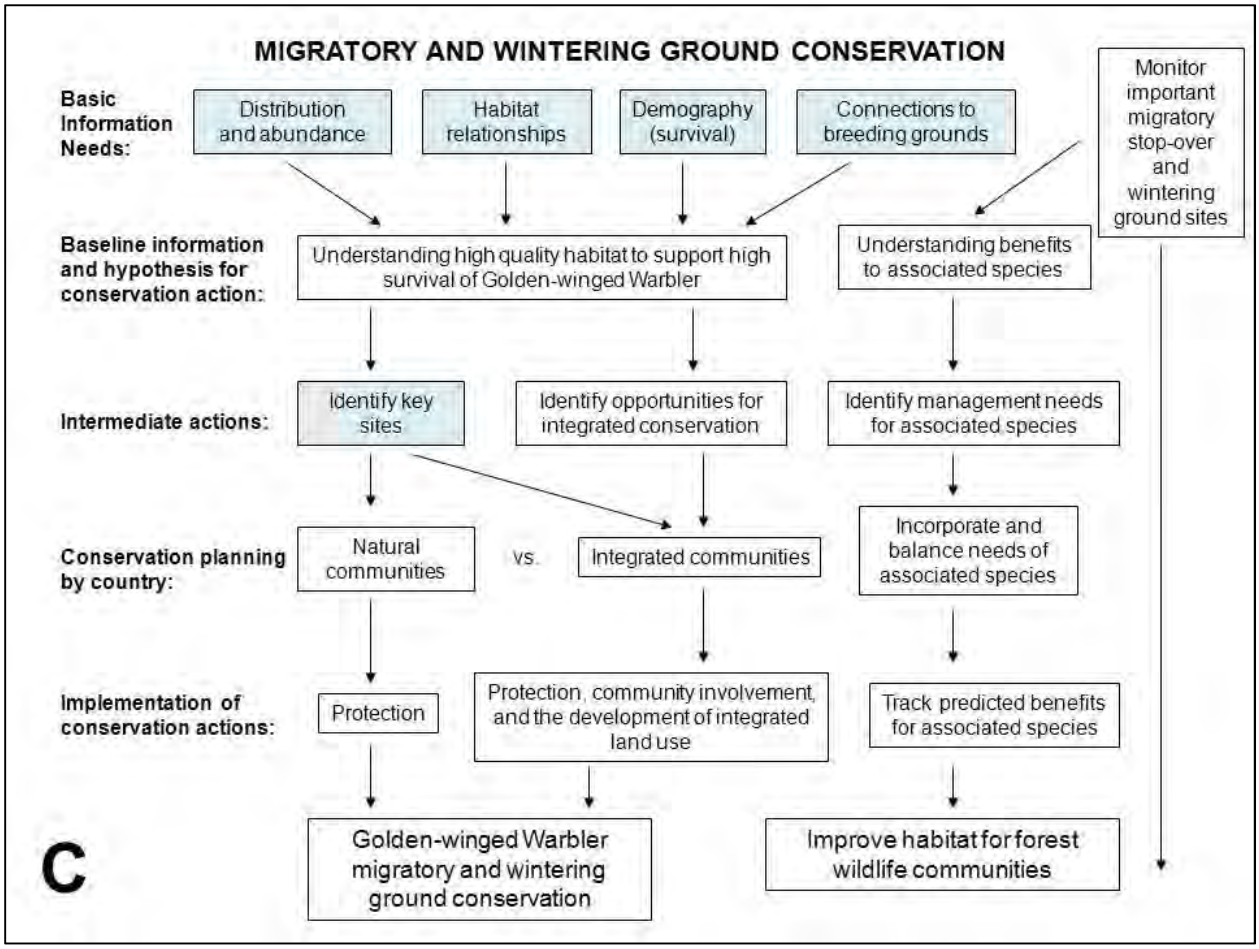


Figure 2–1. (A) Logic framework describing the overall strategy for Golden-winged Warbler conservation with (B) additional details on the breeding ground component and (C) wintering ground component. Note: in (B) and (C) shaded boxes indicate steps that are completed or underway.

The primary strategy for increasing Golden-winged Warbler populations on the breeding range is through creation, restoration, and maintenance of high quality habitat on a landscape scale. The progression of management phases toward population recovery will follow a conceptual model similar to that developed by the Royal Society for the Protection of Birds (Figure 2–2). The current focus for the Golden-winged Warbler Working Group and partners is to implement large-scale, adaptive management aimed at population recovery in places where further experimentation is either unnecessary or where there are locations and habitat types that have received little previous research. It will be important to evaluate population response at all phases of management to track progress toward population goals. Continued research will be needed to fill gaps in our knowledge about habitat suitability and to evaluate new management techniques and strategies. Given that ESHs can quickly succeed out of suitability for Golden-winged Warbler, all strategies will need to consider that the amount of available habitat may change over time. The rate of habitat turnover will vary depending on habitat type. For example, given poor site conditions and slow succession, reclaimed surface mines might remain suitable for decades, while an aspen clearcut might become unsuitable in as few as ten years. Long-term conservation plans should include provisions for habitat creation (e.g., timber harvesting), restoration (e.g., removing some trees and shrubs in old fields), and maintenance (e.g., periodic use of fire, brush-hogging, or grazing to slow succession). New

research following survival of Golden-winged Warbler through fledging (Streby and Andersen, pers. comm.) suggests that the Golden-winged Warbler is a bird of forested landscapes that depends on multiple seral stages at different stages of the breeding season. Thus, while ESH might be critical to nesting success, the overall forest landscape, including proximity to mature forest, may be important to long-term reproductive success (and hence population growth) of the species. Breeding season success calls for a dynamic forested landscape conservation approach.

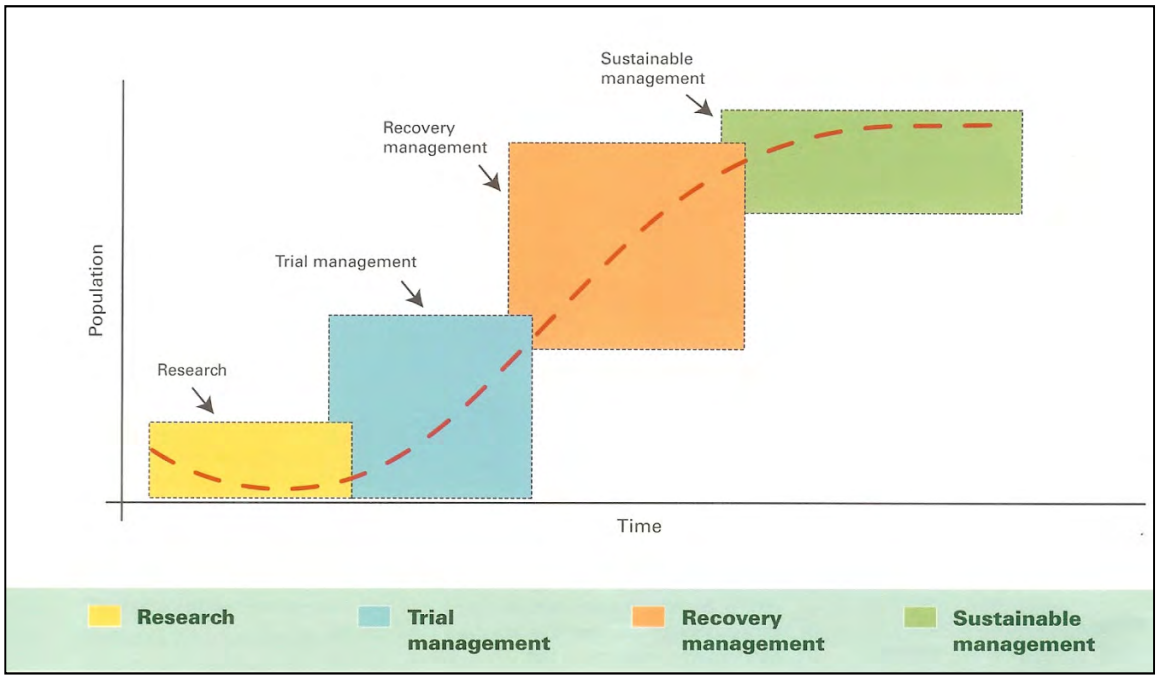


Figure 2–2. A conceptual model showing a progression of recommended habitat management actions based on different population levels (from the Royal Society for the Protection of Birds, reproduced from the US Fish & Wildlife Service's Henslow's Sparrow Conservation Action Plan, 2010).

CANADIAN RECOVERY STRATEGY

Because the breeding range of Golden-winged Warbler includes significant area in both the United States and Canada, working with partners on both sides of the border will be key to the success of the recovery of the Golden-winged Warbler across its range. Coordination of efforts among all agencies and organizations working to conserve Golden-winged Warbler populations will benefit rangewide conservation of the species. Key Canadian researchers and policy-makers have participated in the Golden-winged Warbler Working Group and in the collaborative research and monitoring efforts that form the basis of this conservation plan.

In Canada, the Golden-winged Warbler is listed as Threatened on Schedule 1 of the Canadian *Species at Risk Act* (SARA), which necessitates the preparation of a recovery strategy and action plan. The broad strategies and general approaches to recovery of the Golden-winged Warbler in Canada are presented in Table 2–1. Progress towards meeting the population and distribution objective will be measured by realizing no declines in abundance, distribution, and genetic purity in Canada five years after initiating implementation of the recovery plan. This goal of stabilizing Canadian populations

Table 2–1. Broad strategies to recovery and associated general descriptions of research and management approaches to address the main threats and limitations to Golden-winged Warbler populations in Canada.

Threat or Limitation	Priority	Broad Strategy to Recovery	General Description of Research and Management Approaches
Hybridization and competition with Blue-winged Warbler	High	Assess the significance of hybridization Understand differing habitat requirements	• Determine levels of hybridization with Blue-winged Warblers and effects on Golden-winged Warbler populations across the Canadian range. • Identify microhabitat / habitat features that differentiate Golden-winged Warbler habitat from Blue-winged Warbler habitat, and then manage for Golden-winged Warbler habitat. • Develop habitat management techniques, or identify existing forestry practices, that reduce the threats associated with hybridization and genetic swamping.
Population size and distribution information gaps	High	Inventory and monitoring	• Implement standard protocol to monitor Golden-winged Warbler populations (Golden-winged Warbler Working Group, www.gwwa.org/) and determine extent of range in Canada.
Wide-scale maturation of young forest and old fields; reduction of shrub layer; Loss of habitat through development and other activities in Canada and elsewhere	High	Habitat assessment, management and protection	• Determine suitable nesting and fledgling habitat requirements and availability at the regional level (i.e., provincial scale, Bird Conservation Region scale). • Investigate techniques and develop guidelines and/or identify existing forestry practices to maintain suitable habitat through commercial forestry and management of old fields and rights-of-way. • Determine land succession and habitat dynamics following farmland abandonment and forest clearing. • Establish stewardship agreements, working relationships, and investigate opportunities for habitat securement.
Nest parasitism by Brown-headed Cowbirds (*Molothrus ater*)	Medium	Research and monitoring	• Determine levels of cowbird parasitism and effects on Golden-winged Warbler nesting success across Canadian range.
Knowledge gaps concerning wintering range; wintering habitat requirements; threats to wintering areas	Medium	Collaborate and build partnerships with international agencies	• Collaborate with the United States and Central and South American counterparts to quantitatively describe wintering habitat characteristics and requirements to define important wintering and migration areas. • Collaborate with the United States and Central and South American counterparts to determine breeding subpopulations and subsequent wintering ground associations through stable isotope analysis and other methods.

covers a shorter time period (5 years) than the time period stated elsewhere in the rangewide conservation plan for stable populations (10 years). We assume that stabilization of the global population will take more time because of the extensive geographic range being addressed. SARA requires that the recovery plan is revisited every five years.

Critical Habitat Identification in Canada

Under SARA, Critical habitat, defined as the specific habitat necessary for the survival or recovery of a listed wildlife species, is identified in the recovery strategy or in the action plan for a species. The identification of critical habitat for Golden-winged Warblers is still ongoing. Given the level of threats and the broad distribution of the species, the current proposal is to use a coarse landscape-level approach to identify the amount of available suitable habitat within high density areas of Golden-winged Warbler abundance (e.g., in Ontario, along the southern edge of the Canadian Shield including the transition zone between the Boreal Shield and Mixedwood Plains ecozones; for a map go to: http://atlas.nrcan.gc.ca/auth/english/maps/environment/forest/forestcanada/terrestrialecozones/1). This amount, determined by selecting suitable habitat types and considering the configuration of these habitat types, is based on the needs of the species and its known habitat associations. Preliminary results for Ontario identified the total amount of critical habitat required to meet the population and distribution objectives for the species across its range in Ontario, and a similar approach to the identification of critical habitat will be applied for the remainder of the species' Canadian range (i.e., Manitoba and Quebec). Golden-winged Warbler habitat is dynamic, so the bounds placed on the configuration of necessary suitable habitat should be minimal.

ASSOCIATED SPECIES AND PLANS

As a group, bird species associated with shrubland and early successional forest communities in eastern North America have declined since the launch of the USGS BBS in 1966 (Hunter et al. 2001). Although there is still debate about historic baselines for these species within the eastern forest biomes, declining shrubland species have been identified as priorities for conservation based on several bird conservation plan sources. At a continental level, Partners in Flight (PIF) Watchlist species include Golden-winged Warbler, Blue-winged Warbler, and Prairie Warbler (*Setophaga discolor*), and Continental Stewardship species include Alder Flycatcher (*Empidonax alnorum*), Nashville Warbler (*Oreothlypis ruficapilla*), Chestnut-sided Warbler (*Setophaga pensylvanica*), Mourning Warbler (*Geothlypis philadelphia*), Eastern Towhee (*Pipilo erythrophthalmus*), White-throated Sparrow (*Zonotrichia albicollis*), and Indigo Bunting (*Passerina cyanea*). American Woodcock (*Scolopax minor*) is a U.S. Fish and Wildlife Service (USFWS) focal species and game bird with considerable habitat and breeding range overlap with the Golden-winged Warbler. Many other shrubland and young forest-dependent species are identified in regional PIF Plans and in State Wildlife Action Plans (Gilbart 2011). All of these species are identified as relatively high priority for conservation action due to long-term declining population trends due in part to loss or degradation of shrubland and young forest habitat.

Golden-winged Warbler Conservation Initiative's Population and Habitat Study

Over the three years of the National Fish and Wildlife Foundation's (NFWF) Golden-winged Warbler Conservation Initiative, basic demographic data (nest success, annual reproductive output, clutch size, young produced per successful nest, parasitism rates, hybridization rates, and return rates) were collected at seven study sites in MN, NC, NY, PA, TN, WI, and WV (see Appendix D for description of study sites and principal investigators). These data helped develop population models to determine where and under what habitat conditions source/sink populations exist. Baseline data collected in the first year of the study were used to develop habitat manipulative experiments in some locations in years two and three that ultimately lead to the development of these management prescriptions across the Golden-winged Warbler breeding range. Other priority species that co-occur with the Golden-winged Warbler were monitored to extend the inference of this work to the entire early-successional bird community.

At least 38 shrubland and young forest bird species of conservation concern are frequently or potentially associated with Golden-winged Warblers and their habitat, and thus will likely benefit from increasing the acreage of habitat and improving the quality of degraded sites proposed in this plan (Table 2–2). This list is based on overlapping range and habitat with Golden-winged Warbler within the states in which these species are listed as Species of Greatest Conservation Need (Gilbart 2011). A subset of these species were monitored at some of the long-term Golden-winged Warbler research study sites in five states (NC, PA, TN, WI, WV; see sidebar; Appendix D) to measure their degree of association; these are ranked as High Association (H), Medium Association (M), and Low Association (L). Species that were not found at these study sites, but are found within the range of Golden-winged Warbler and have known association based on expert knowledge and *Birds of North America* species accounts, are also listed. Finally, we list several additional species that are considered forest-interior birds, but are associated with shrubby understory or disturbance within the forest – these species also had Medium or High association with Golden-winged Warbler at the long-term study plots and can be considered indicators of healthy forested landscapes within which management for Golden-winged Warblers may be most successful.

Some species such as Eastern Towhee and Field Sparrow (*Spizella pusilla*) have high association with Golden-winged Warbler in many parts of the range and are frequently listed as species of conservation concern in regional plans. Other species such as Ruffed Grouse (*Bonasa umbellus*), Yellow-bellied Sapsucker (*Sphyrapicus varius*), and Mourning Warbler are potential associates, but the landscape matrix in which the management is occurring will be important for them to benefit. Still others such as Canada Warbler (*Cardellina canadensis*) will take advantage of shrubland and young forest habitat when it succeeds to a stage when it becomes unsuitable for Golden-winged Warbler. American Woodcock and Eastern Whip-poor-will (*Caprimulgus vociferous*) are known to have high association, but are infrequently detected on diurnal surveys.

Clearly there is opportunity to address the needs of a suite of declining species through implementation of the Golden-winged Warbler conservation plan. We recognize the importance of integrating with other wildlife and habitat plans including the American Woodcock Conservation Plan, Ruffed Grouse Conservation Plan, PIF North American Landbird Conservation Plan, State Wildlife Action Plans, state bird conservation initiative plans, state and federal forest plans, Joint Venture implementation plans, and others. Where there are important points of overlap with these plans, we inserted sidebars to describe the opportunities for integration (see Chapter 3). Some federally and state listed species such as bog turtle (*Glyptemys muhlenbergii*) also have overlapping habitat requirements. In the future, an integrated plan and management guidelines are needed for addressing the full suite of species associated with shrublands and young forest habitats.

*Table 2–2. Shrubland and young forest birds associated with Golden-winged Warbler. An **X** under the state/province name indicates the species is designated as a Species of Greatest Conservation Need (SGCN,USA)[a] or Species at Risk (SAR, Canada)[b] in that state or province. The Association (GL/AP) column summarizes results from point count surveys conducted at a subset of NFWF population and habitat sites in five states (WI, PA, WV, TN, NC)[c]. These summaries are presented by region. GL=Great Lakes (1 site) and AP=Appalachians (4 sites). The quantitative assessment of association with Golden-winged Warbler is designated as High **(H)**, Moderate **(M)**, or Low **(L).** Species are included if they are listed as SGCN or SAR in at least one state or province within the Golden-winged Warbler range and if they overlap in geography and habitat. Adapted with permission from Gilbart (2011).*

Species	Association (GL/AP)[c]	CT	GA	KY	MD	MI	MN	NC	NJ	NY	PA	TN	VA	VT	WI	WV	MB	ON	QC
Golden-winged Warbler *Vermivora chrysoptera*		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Species associated with Golden-winged Warbler at 5 study sites																			
Northern Bobwhite *Colinus virginianus*	L (AP)	X	X	X	X	X		X	X	X	X		X		X	X		X	
Yellow-billed Cuckoo *Coccyzus americanus*	L-H (AP)	X				X		X	X			X	X		X				
Black-billed Cuckoo *Coccyzus erythropthalmus*	L (GL) M-H (AP)	X			X	X	X	X	X	X	X			X	X	X			
Northern Flicker *Colaptes auratus*	H (GL) M-H (AP)	X				X		X	X										
Alder Flycatcher *Empidonax alnorum*	H (GL) L-M (AP)	X			X			X			X	X				X			
Willow Flycatcher *Empidonax traillii*	L-M (AP)	X		X	X		X	X	X	X	X		X		X				
Eastern Kingbird *Tyrannus tyrannus*	L (GL) L (AP)	X				X		X	X				X						
White-eyed Vireo *Vireo griseus*	L-H (AP)	X				X						X							
Veery *Catharus fuscescens*	H (GL) M-H (AP)	X			X		X		X					X	X				
Brown Thrasher *Toxostoma rufum*	M (GL) M-H (AP)	X			X	X	X		X	X	X		X	X	X				
Blue-winged Warbler *Vermivora cyanoptera*	L (AP)*	X		X	X	X	X	X	X	X	X	X	X	X	X	X			
Nashville Warbler *Oreothlypis ruficapilla*	H (GL) L (AP)				X											X			
Mourning Warbler *Geothlypis philadelphia*	H (GL) L-M (AP)				X														
Magnolia Warbler *Setophaga magnolia*	L (AP)	X			X			X											
Chestnut-sided Warbler *Setophaga pensylvanica*	H (GL) M-H (AP)	X			X			X						X					
Prairie Warbler *Setophaga discolor*	M (AP)	X		X	X	X		X	X	X	X	X	X	X					
Canada Warbler *Cardellina canadensis*	L-M (AP)	X		X	X	X	X	X	X	X	X		X	X	X		X	X	X

Table 2–2. Continued.

Species	Association (GL/AP)[c]	CT	GA	KY	MD	MI	MN	NC	NJ	NY	PA	TN	VA	VT	WI	WV	MB	ON	QC
Yellow-breasted Chat *Icteria virens*	L-H (AP)	X				X			X	X	X		X					X	
Eastern Towhee *Pipilo erythrophthalmus*	H (GL) H (AP)	X			X	X			X				X	X					
Field Sparrow *Spizella pusilla*	M-H (AP)	X			X	X	X	X	X				X	X	X				
White-throated Sparrow *Zonotrichia albicollis*	H (GL) L (AP)						X		X										
Rose-breasted Grosbeak *Pheucticus ludovicianus*	H (GL) L-H (AP)	X		X			X	X	X				X						
Indigo Bunting *Passerina cyanea*	H (GL) M-H (AP)	X																	
Additional shrubland and young forest species overlapping with Golden-winged Warbler																			
Ruffed Grouse *Bonasa umbellus*		X							X	X				X					
Spruce Grouse *Falcipennis canadensis*						X	X			X				X	X				
Sharp-tailed Grouse *Tympanuchus phasianellus*						X	X								X				
American Woodcock *Scolopax minor*		X		X	X	X	X	X	X	X	X	X	X	X	X	X			
Eastern Whip-poor-will *Caprimulgus vociferus*		X			X	X	X	X	X	X		X	X	X	X	X	X	X	X
Olive-sided Flycatcher *Contopus cooperi*		X			X	X	X		X	X	X	X		X	X	X	X	X	X
Loggerhead Shrike *Lanius Indovicianus*			X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
Northern Shrike (winter) *Lanius excubitor*						X													
Bewick's Wren *Thryomanes bewickii*				X	X							X	X			X			
Hermit Thrush *Catharus guttatus*		X			X														
Gray Catbird *Dumetella carolinensis*		X							X				X						
Black-and-white Warbler *Mniotilta varia*		X			X				X				X						
American Redstart *Setophaga ruticilla*		X			X														
Kirtland's Warbler *Setophaga kirtlandii*			X			X							X		X			X	
Dark-eyed Junco *Junco hyemalis*		X			X														
Rusty Blackbird (winter) *Euphagus carolinus*				X			X		X	X			X	X	X		X	X	X

Table 2–2. Continued.

Species	Association (GL/AP)[c]	CT	GA	KY	MD	MI	MN	NC	NJ	NY	PA	TN	VA	VT	WI	WV	MB	ON	QC
Additional forest species associated with Golden-winged Warbler habitat at landscape level																			
Yellow-bellied Sapsucker *Sphyrapicus varius*	L (AP)		X		X		X	X	X			X	X			X			
Wood Thrush *Hylocichla mustelina*	M-H (AP)	X		X	X	X	X	X	X	X	X	X	X	X	X	X			
Hooded Warbler *Setophaga citrina*	L-H (AP)	X			X	X	X	X	X			X			X			X	
Cerulean Warbler *Setophaga cerulea*	M-H (AP)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Black-throated Blue Warbler *Setophaga caerulescens*	H (AP)	X			X	X	X		X	X		X		X	X				
Scarlet Tanager *Piranga olivacea*	M (GL) M-H (AP)	X			X				X	X	X		X						

[a] *Sources for Species of Greatest Conservation Need: individual State Wildlife Action Plans.*
[b] *Source for Canadian Species at Risk: Species at Risk Public Registry website (www.sararegistry.gc.ca/default_e.cfm).*
[c] *Association results are delineated by the probability of observing (visual, aural) the respective species based on point count surveys conducted in five states (WI, PA, WV, TN, NC). Probabilities are high (H) = >30%, moderate (M) = 15–30%, and low (L) = <15%. Some species (e.g. American Woodcock, Eastern Whip-poor-will, Ruffed Grouse) may be underrepresented based on the survey methodology.*
** Surveys were in Golden-winged Warbler only sites.*

CONSERVATION ACTIONS

The following strategic conservation actions were developed by Golden-winged Warbler Working Group members in a series of discussions and workshops beginning in 2005. The format for this strategy is similar to that for other Focal Species under the USFWS Focal Species Program. These represent the prioritized goals, objectives, and actions necessary to conserve Golden-winged Warbler throughout their range and annual life cycle. Specific goals and objectives will be addressed in the following chapters that provide management guidelines for the breeding season (Chapter 3) and non-breeding season (Chapter 4). In some cases, recommendations for how to proceed with an action are given.

Goal 1: Increase population size of Golden-winged Warbler by increasing quantity and quality of breeding habitat across the breeding range at multiple scales.

Objective 1.1: Implement management guidelines for improving and increasing breeding habitat for Golden-winged Warbler and associated early successional species.

Justification: The availability of high quality breeding habitat is seen as the key factor limiting populations on the breeding grounds. Golden-winged Warbler breeding habitat is more specialized than most other species associated with ESH. Careful attention to the context and

configuration of habitat preferred by Golden-winged Warbler is needed to ensure success. This will require active management on public, private, and tribal lands involving a diverse range of partners.

Conservation Action 1.1.1: Develop projects to implement regionally specific management guidelines, with emphasis in focal areas and on growing populations into adjacent areas. Management guidelines and descriptions of focal areas are provided in Chapter 3.

Conservation Action 1.1.2: Develop partnerships, particularly with state and federal land management/agencies, industry, military installations, and Non-governmental Organizations. These partners are especially important for creating, managing, and restoring habitat on properties they own and manage.

Conservation Action 1.1.3: Use incentives for creating breeding habitat by coordinating with landowner incentive and cost-share programs and the agencies that implement them (e.g., Natural Resources Conservation Service (NRCS)).

Conservation Action 1.1.4: Evaluate success of habitat management activities in meeting population goals at multiple spatial scales with monitoring protocols developed and implemented by the Golden-winged Warbler Conservation Initiative (See Objective 1.5; Evaluation Program).

Conservation Action 1.1.5: Implement an adaptive management strategy for long-term habitat creation and maintenance that is informed by continued research on Golden-winged Warbler habitat response, demographics, and genetic interactions.

Progress: The development of management guidelines in this document (Chapter 3) will assist land managers and policy makers; these should be periodically revisited and updated as new information becomes available (i.e., an adaptive management strategy). Though strategies have been developed for some of these actions in this document, specific tasks need to be identified and delegated to partners. The Golden-winged Warbler Habitat Best Management Practices for Forestlands in Maryland and Pennsylvania (Bakermans et al. 2011), which was developed with funding from the National Fish and Wildlife Foundation serves as an excellent model for state-level conservation action.

Objective 1.2: Conserve upland and wetland forest landscapes at geographic scales capable of mitigating anthropogenic activities that diminish the value of focal areas to Golden-winged Warbler populations.

Justification: Golden-winged Warbler is a species of forested landscapes that requires disturbed or ESH within that larger forested matrix. Populations will not persist in highly fragmented, urbanized, or mostly agricultural landscapes. Creation of new or improved ESH for this species must therefore be accompanied by efforts to conserve the surrounding forests. This potentially requires involvement in large-scale, complex issues that are not easily addressed by any single group or initiative. Protecting and conserving upland and wetland forest landscapes critical for Golden-winged Warbler conservation within identified focal areas will be most important.

Conservation Action 1.2.1: Protect large shrub wetland (e.g., shrub swamp, alder thicket, tamarack bog) complexes and communities threatened with development. This includes protecting and restoring ecological processes that maintain and create these areas.

Conservation Action 1.2.2: Promote protection and management of forest landscapes for

diversity of forest types and stand ages on a large scale by mimicking natural disturbance regimes.

Conservation Action 1.2.3: Work with federal, state, and provincial agencies responsible for forest management to ensure that maintenance/management of forest landscapes include components beneficial to Golden-winged Warblers.

Conservation Action 1.2.4: Incorporate results of climate change modeling to adjust conservation strategies for Golden-winged Warbler at large landscape scales.

Progress: Many efforts are underway to protect and conserve large forested landscapes within the range of Golden-winged Warbler. Important sites and partners, many of which are responsible for management of large forested landscapes, have been listed for each focal area in the breeding grounds management guidelines chapter of this plan. The National Fish and Wildlife Foundation's ESH Keystone Initiative (www.nfwf.org/AM/Template.cfm?Section=Wildlife_and_Habitat12&CONTENTID=22465&TEMPLATE=/CM/HTMLDisplay.cfm) is an important step toward large-scale effect on conservation for species dependent on this habitat, Golden-winged Warbler and American Woodcock in particular. This Initiative should be viewed as a model for how to tackle large habitat-oriented conservation problems and should be supported with new funding sources. Climatic and habitat modeling is underway to understand and predict Golden-winged Warbler and Blue-winged Warbler distributions and changes through time.

Objective 1.3: Support management action through developing and prioritizing policy recommendations with partner agencies and organizations.

Justification: Although public and private land managers are responsible for implementation of management plans and activities, they generally require the support and approval from administrators within their agency or organization before taking actions that may change internal policy or priorities. Conservation opportunities that are emerging from new industries, such as renewable energy, may require engagement at the inter-agency or industrial organization level. New funding sources for conservation are most likely to be created by interaction at the administrative level of agencies and organizations.

Conservation Action 1.3.1: Support current state and federal wildlife habitat incentive programs for landowners (480A, Wildlife Habitat Incentive Program, Department of Defense, EC Ecological Gifts Program, Forest Stewardship Program, etc.), and develop new opportunities for management of habitats suitable for Golden-winged Warbler and associated species.

Conservation Action 1.3.2: Encourage agencies and organizations to make protection and management of ESH a priority at the planning and policy-making levels of administration. Specific tasks include identifying and meeting with key policy groups, developing training and communication tools for key audiences, and increasing awareness of ESH issues within agencies and organizations.

Conservation Action 1.3.3: Inform practices and policies of energy industries with the potential to degrade or create quality Golden-winged Warbler habitat.

Objective 1.4: Better integrate Golden-winged Warbler conservation and management with similar actions for American Woodcock and other early successional species.

Justification: Conservation of Golden-winged Warbler and other early successional species will only be successful if implemented in concert with other similar efforts. Early successional vegetation in the regions of highest American Woodcock and Golden-winged Warbler densities has declined by 30% since the 1970s. The National Fish and Wildlife Foundation's ESH's Conservation initiative is dedicated to a 10-year investment that, if at least partially funded, could result in population increases of 19% (American Woodcock) and 50% (Golden-winged Warbler) above current levels within the next 40 years.

Conservation Action 1.4.1: Integrate with other management plans and Best Management Practices that focus on early successional forest and shrub habitats and species associated with Golden-winged Warbler.

We strongly recommend tying Golden-winged Warbler habitat management to the Wildlife Management Institutes' (WMI) Best Management Practices for Species of Greatest Conservation Need (as identified by State Wildlife Action Plans) associated with young forests in the eastern U.S. This may include developing demonstration areas for land manager training and habitat creation within the focal areas defined by this plan.

Conservation Action 1.4.2: Develop, in partnership with WMI and Joint Ventures, a business plan for the National Fish and Wildlife Foundation's ESH's Conservation Initiative.

Objective 1.5: Develop and implement an evaluation program that tracks progress towards meeting objectives and informs management decisions at all relevant scales.

Justification: Effective, adaptive management must include a monitoring component to evaluate local and population level responses to management actions. Monitoring protocols and strategies should be developed hierarchically to measure local response and inform the status of population recovery efforts. Partners receiving funding and resources to implement conservation actions will be responsible for tracking and reporting their contributions toward meeting population objectives and goals. Given the scale of the Golden-winged Warbler Conservation Initiative and the ESH Keystone Initiative, a web-based accomplishment-tracking tool will be essential for determining the effect of time and financial investments.

Conservation Action 1.5.1: Develop and implement a monitoring strategy that evaluates site-level response to management and tracks long-term trends in Golden-winged Warbler populations at regional and landscape scales.

Progress: The Golden-winged Warbler Conservation Initiative has developed and tested monitoring protocols at various scales. The North American BBS is considered adequate for tracking rangewide species trends, but not for regional trends. A new, spatially balanced monitoring design was developed and tested in the Appalachian Conservation Region, and is currently being implemented in nine states. This monitoring program has been administered by Cornell Lab of Ornithology and has been funded by USFWS, state partners, and National Fish and Wildlife Foundation. An efficient and effective field protocol has been tested and implemented. Site-level evaluation and monitoring has been carried out by initiative partners, but at present no single protocol has been developed to evaluate site-level response.

Conservation Action 1.5.2: Expand current spatially balanced monitoring design (and associated partner network) to the Great Lakes Conservation Region and Canada to more

accurately track future population trends in these populations.

Conservation Action 1.5.3: Develop common metrics, statistical techniques and models for relating results of Golden-winged Warbler monitoring at site-level, regional, and rangewide scales.

Conservation Action 1.5.4: Track acreage created/improved by habitat management to evaluate progress toward habitat goals (Collaborate with WMI and the Appalachian Mountains Joint Venture to develop an online evaluation system).

Progress: WMI has begun working with a company to develop an online habitat tracking tool. The Golden-winged Warbler Working Group should be engaged to participate in and aid this process.

Conservation Action 1.5.5: Improve land cover (ESH in particular) classification using remotely sensed data, like LiDAR or other new techniques for identifying appropriate habitat, to predict Golden-winged Warbler occurrence and abundance.

Recommendation: A collaborative effort to fund this project should be made because this is a need for many species other than Golden-winged Warbler and is a high priority project for many agencies and organizations.

Objective 1.6: Improve our understanding of Golden-winged Warbler habitat management response and demographics to refine future conservation actions.

Justification: Perhaps the highest priority for Golden-winged Warbler conservation has been identification of the demographic and related ecological factor(s) leading to the observed decline of global and regional populations. As part of the Golden-winged Warbler Conservation Initiative, researchers have been obtaining specific survival information for adults and juveniles throughout their annual cycle, and nest productivity and fecundity information from 7–8 study sites on the breeding grounds. Results from these demographic studies have been incorporated into management guidelines for Golden-winged Warbler (Chapter 3). Yet these results provide only a coarse baseline, from a portion of the species' range. As management is implemented to increase and improve habitat, continued evaluation and study is essential for understanding response by breeding Golden-winged Warblers and for refining future management. Our goal is to have an understanding of population response that is comparable to our understanding for many gamebirds and other heavily managed species.

Conservation Action 1.6.1: Develop and implement experimental management projects, especially at long-term Golden-winged Warbler study sites, where population and demographic response can be carefully measured. Evaluate management practices from the perspective of source-sink demographics and use results to refine management guidelines.

Conservation Action 1.6.2: Use new models to help understand habitat and geographic characteristics that produce source and sink populations. Use results to help managers target the provision of more optimal habitat in areas predicted to be population sources.

Conservation Action 1.6.3: Use newly available technologies (e.g. radio tags) to study fine-scale habitat use by male and female Golden-winged Warblers, as well as by family groups and juveniles during the post-fledging period; incorporate results into future refinements of management guidelines.

Conservation Action 1.6.4: Evaluate potential survey protocols for assessing site-scale habitat management effects on Golden-winged Warbler demographics.

Recommendation: Develop two or three potential survey protocols and evaluate their effectiveness in reflecting actual nest demographic variables and compare their monetary and time efficiency.

Progress: Across six study areas, recent nest survival information has been summarized in the status review. Ongoing research into post-fledgling habitat use and survival will soon add to our knowledge of productivity related population metrics on the breeding grounds. Between-year adult survival and, to a lesser extent, juvenile survival have been collected and analyzed from both the breeding and wintering grounds.

Conservation Action 1.6.5: Examine temporal correlations of rangewide demographic parameters using an appropriate protocol. For example, one strategy warranting further study might be the establishment of new banding stations in the Monitoring Avian Productivity and Survivorship (MAPS) Program network coordinated by the Institute for Bird Populations. Demographic parameters of interest include annual indices of adult population size and post-fledging productivity and annual estimates of adult survivorship, adult population size, proportion of resident individuals in the adult population, recruitment into the adult population, and population growth rate (lambda).

Recommendation: Test the effectiveness of using MAPS stations and/or other demographic methodologies for achieving Golden-winged Warbler parameter estimation targets.

Objective 1.7: Clarify effects of Golden-winged Warbler and Blue-winged Warbler interactions and how these affect use of available habitat.

Justification: Hybridization and competitive interactions with Blue-winged Warblers represent a known threat to Golden-winged Warblers; these interactions strongly influence habitat use and ultimately may determine whether efforts to increase populations by creating new habitat are successful. Long-term conservation of both Golden-winged Warbler and Blue-winged Warbler as distinct species requires improved understanding of mechanisms and interactions that lead to replacement of Golden-winged Warbler by Blue-winged Warbler. Continued research and monitoring is needed to better understand these interactions and refine management strategies that mitigate the negative effects.

Conservation Action 1.7.1: Continue to study population effect of Blue-winged Warbler and Golden-winged Warbler interaction; differentiate habitat use by each species (as well as by their hybrids) and identify management techniques that will benefit Golden-winged Warbler.

Conservation Action 1.7.2: Identify and mitigate factors that influence Blue-winged Warbler replacement at sites previously settled by Golden-winged Warbler.

Conservation Action 1.7.3: Continue to develop techniques to identify genetically pure Golden-winged Warblers and hybrids using markers from nuclear DNA (i.e., identifying single-nucleotide polymorphisms).

Conservation Action 1.7.4: Use molecular techniques to explore the implications of mate choice and its relationship to hybridization/introgression and habitat use.

Progress: Additional advances in understanding behavioral aspects of this issue, especially as relates to mate selection are discussed in the Status Review. Habitat segregation appears to reduce genetic introgression in Sterling Forest, NY, where Golden-winged Warbler nest survival

appears to be higher in swamp forest relative to upland utility rights-of-way (Confer et al. 2010). It is critical to determine if similar situations exist elsewhere in the breeding range. For example, there are locations throughout the Appalachian Mountains that are largely dominated by phenotypically and genotypically pure Golden-winged Warblers despite the passage of the Blue-winged Warbler hybridization front decades ago.

Objective 1.8: Communicate the importance of Golden-winged Warbler conservation and habitat management to stakeholders.

Justification: Successful implementation of conservation actions will depend on effective communication via use of a variety of tools and delivery of messages in an appropriate way for different audiences.

Conservation Action 1.8.1: Develop a communication strategy and plan to best deliver conservation messages around the Golden-winged Warbler and ESH to diverse audiences.

Conservation Action 18.2: Deliver breeding-habitat management guidelines to land managers and landowners within the current breeding range.

Recommendation: This can be attained through training workshops or webinars, creation of demonstration areas, and development of outreach materials (handouts, video) for use at workshops and through other outlets. Create a one-page document that land managers could take with them to explain why young forest and shrub habitats are important.

Conservation Action 1.8.3: Promote conservation integration and communication with partners across the full range of the species in the Western Hemisphere.

Conservation Action 1.8.4: Maintain a dynamic, up-to-date website for the Golden-winged Warbler Conservation Initiative. Provide conservation assessment and plan documents, as well as tools for determining appropriate management and for tracking and evaluating conservation actions.

Conservation Action 1.8.5: Use current social science methods to evaluate delivery of information to target audiences.

Progress: A Golden-winged Warbler Conservation Initiative website was established in 2007 as the primary resource for Golden-winged Warbler and Golden-winged Warbler Working Group information. Educational posters and habitat management brochures were created and distributed to help inform land managers and the general public about the conservation needs and habitat management practices that will benefit Golden-winged Warbler. Additional tools and a clearer communication strategy are needed to diversify our communication tool kit and to reach other audiences. Golden-winged Warbler Habitat Best Management Practices for Forestlands in Maryland and Pennsylvania (Bakermans et al. 2011) developed with National Fish and Wildlife Foundation funding could serve as a model for training and communication.

Objective 1.9: Coordinate management and policy activities across countries within Golden-winged Warbler breeding distribution.

Justification: The Golden-winged Warbler breeding range includes both the eastern USA and parts of Canada. The conservation of migratory birds requires international cooperation and coordination for conservation to be successful rangewide. The Great Lakes Conservation Region and some focal areas cross this international boundary and will require

coordinated actions between land managers and policy makers in both countries to meet the goals of these areas.

Conservation Action 1.9.1: Work strategically with Canadian Golden-winged Warbler Recovery Team to identify synergies, management activities, and recovery efforts on the breeding grounds.

Progress: Some of the research reported in this plan was conducted through collaborations between partners in the USA, Canada, and Latin American countries. In the creation of this plan, the Canadian Golden-winged Warbler Recovery Team and the USFWS had representatives involved in writing and reviewing the content. These efforts establish a precedent and foundation for future international working relationships among Golden-winged Warbler scientists, conservation planners, and agencies.

Goal 2: Increase Golden-winged Warbler survival through protection and enhancement of habitat during the non-breeding season and by addressing non-habitat limiting factors.

Justification: Golden-winged Warblers spend at least eight months of the year away from their breeding grounds, and factors during the non-breeding season undoubtedly have a large effect on annual survival. As with many Neotropical migrant songbirds, however, we have only cursory knowledge of winter habitat requirements, threats, or even detailed distribution. Little is known, too, about migration pathways, as well as migration ecology, habitat use, and limiting factors. Efforts are currently underway to gather basic information on non-breeding ecology of Golden-winged Warblers and to develop a non-breeding conservation strategy with Latin American and North American partners.

Objective 2.1: Define winter distribution, identify habitats and elevations used during winter, identify characteristics that produce high quality habitat at non-breeding sites, and identify threats to quality habitat in their non-breeding range.

Conservation Action 2.1.1: Conduct standardized surveys within wintering-ground countries (Colombia, Venezuela, Panama, Costa Rica, Nicaragua, Honduras, Guatemala, Mexico) in areas prioritized by the initial predictive model of Golden-winged Warbler occurrence.

Conservation Action 2.1.2: Conduct analyses of wintering survey data, including assessment of important habitat characteristics and refinement of winter-range predictive occurrence model.

Conservation Action 2.1.3: Identify and evaluate key threats in areas of concentrated winter occurrence and use.

Conservation Action 2.1.4: Examine annual overwinter survival and body condition (fitness) and relate these to frequently used habitat types (especially primary forest, secondary forest, and agroforestry systems) and their characteristics.. One strategy warranting further study might be to determine the number of new stations needed to generate enough data for robust analyses as part of the Monitoreo de Sobrevivencia Invernal (MoSI) program coordinated by the Institute for Bird Populations.

Recommendation: Test the effectiveness of using new MoSI stations in shade coffee or cacao plantations and wet forest in wintering ground areas with known Golden-winged Warbler occurrence.

Objective 2.2: Complete wintering grounds conservation strategy in partnership with organizations and governments in Central and South America.

Conservation Action 2.2.1: Identify focal areas for wintering ground conservation, based on results of winter-rangewide surveys.

Conservation Action 2.2.2: Identify conservation strategies (e.g. protection, restoration), based on analysis of key threats within wintering ground focal areas.

Conservation Action 2.2.3: Implement pilot conservation projects within wintering ground focal areas, and evaluate response.

Conservation Action 2.2.4: Develop communication and outreach strategy for implementation of wintering ground conservation actions.

Objective 2.3: Identify important migratory stopover habitat and priority areas for conservation.

Conservation Action 2.3.1: Compile existing records during migration and document habitats associated with those sites. Evaluate the vulnerability of stopover habitats to significant land-use change.

Objective 2.4: Assess connectivity between breeding grounds and non-breeding areas in order to more closely link demographic parameters and establish linkages for collaborative conservation actions.

Justification: Linkages between breeding and wintering populations will help us identify the factors that are driving the observed population declines on the breeding grounds.

Conservation Action 2.4.1: Use emerging technologies and methods (e.g. geolocators, stable isotopes) to establish linkages between breeding and wintering populations.

Conservation Action 2.4.2: Evaluate potential carry-over effects of overwinter body condition (fitness) on reproductive output.

Progress and Recommendation: Stable isotope research is ongoing to attempt to make linkages between breeding and wintering populations, however a larger sample of individuals from across the wintering grounds is needed. Studies using geolocators would further improve the understanding of breeding and wintering population connectivity.

Objective 2.5: Identify significant migratory obstacles and scale of possible effect on populations.

Justification: A recently published study (Arnold and Zink 2011) determined that Golden-winged Warblers are "super-colliders" with a collision risk at buildings and towers much greater than expected based on their population size. This emerging issue (i.e., development of cell towers and wind turbines) is cause for concern for many species and in particular for Golden-winged Warbler if it is at relatively greater risk than most other species. The population effect of this issue needs to be assessed especially in relation to the predicted increase in the number of these structures across the eastern United States.

Conservation Action 2.5.1: Evaluate effect of migratory obstacles (wind turbines, communication towers, and buildings) on annual survival.

Conservation Action 2.5.2: Assess potential risk from wind power development in migration corridors.

Progress and Recommendation: Recent research through University of Minnesota's Bell Museum has brought attention to this issue especially for Golden-winged Warblers. Follow-up research is needed to verify the risk to this species and to estimate demographic effects.

Objective 2.6: Coordinate management and policy activities across countries within Golden-winged Warbler wintering distribution.

Conservation Action 2.6.1: Support collaborations through Alianza alas Doradas on the wintering grounds and maintain communication with North American partners.

Progress: Alianza alas Doradas formed in 2007 as the wintering grounds component of the Golden-winged Warbler Working Group. Active collaborations exist among Fundacion ProAves Colombia, Cornell Lab of Ornithology, American Bird Conservancy, Audubon North Carolina, and USFWS, and with representatives from most countries within the wintering range. These efforts establish a precedent and foundation for future international working relationships among Golden-winged Warbler scientists, conservation planners, and agencies.

Chapter 3.

GOLDEN-WINGED WARBLER BREEDING SEASON CONSERVATION PLAN

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RECOMMENDED CITATION

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Photo by: Donald Mullaney.

CHAPTER 3 SUMMARY

This plan (Chapter 3 of the overall Conservation Plan) outlines goals, objectives, and actions needed for the effective conservation of Golden-winged Warbler (*Vermivora chrysoptera*) on its breeding grounds. The plan is written primarily for conservation planners and land managers, but will also be useful to policy makers, scientists, and representatives from agencies and industry. The basis for the breeding grounds conservation strategy is the delineation of focal areas where stabilizing and ultimately restoring Golden-winged Warbler populations will occur. These focal areas are delineated based on current and historic distribution, hybridization risk, and current and future management potential. Habitat and population goals are stepped down from the region to the focal area to provide managers with conservation targets at a local scale. Land ownership and potential partners for each focal area are also identified.

Management for Golden-winged Warbler habitat must occur at multiple spatial scales, ranging from the landscape to the patch or stand, to even within the patch. At each spatial scale, Golden-winged Warblers respond to the structure and composition of available habitat. Golden-winged Warblers occur largely in forested landscapes, within which varying conditions can occur that support breeding populations, including habitats derived from forest management, wetland habitats, and habitats in a variety of upland settings undergoing succession after grazing, strip mining, or field abandonment. At the patch scale, Golden-winged Warbler habitat is comprised of a dynamic combination of herbaceous elements (grasses and forbs), woody shrubs/saplings, and open mature hardwood trees. Within a territory, the habitat elements are distributed in fine-scale clumps. Nest sites typically occur in a variety of grasses and forbs that form clumps for secure nest placement on the ground. This plan contains habitat guidelines that outline the range of conditions, leading to desired habitat structure and composition. Techniques to maintain, create, or restore these conditions are also described, including the use of forest management, prescribed fire, mowing and brush-hogging, and grazing.

Success of the conservation strategy will be assessed through a coordinated monitoring program. This monitoring program will track the key components of the conservation strategy, including acres managed for Golden-winged Warbler, population response at multiple spatial scales, and changes in levels of genetic introgression within populations.

Additionally, Chapter 1 of the Golden-winged Warbler Status Review and Conservation Plan contains detailed information on the biology and ecology of the species and an overall review of its population status at multiple scales. Chapter 2 provides rationale and explicit goals and objectives of the Golden-winged Warbler Working Group's full life cycle conservation strategy for the species. A glossary of commonly used terminology appears in Appendix A, while Appendix B provides a list of supplementary resources.

INTRODUCTION

The Golden-winged Warbler is a high-priority, rapidly declining songbird dependent on early successional and other shrubby habitats for successful breeding. It is listed as *Threatened* in Canada and is considered a *Focal Species* by the U.S. Fish and Wildlife Service (USFWS). In 2010, the species was petitioned to be listed under the U.S. Endangered Species Act; however, a final ruling has yet to be made. The Golden-winged Warbler is also a Keystone Species, along with American Woodcock (*Scolopax minor*), under the National Fish and Wildlife Foundation's Early Successional Habitat (ESH) Initiative and associated business plan. The goal of this Conservation Plan, in accordance with the ESH business plan, is to reverse declines of Golden-winged Warblers and restore populations to recent historical levels by improving habitat for this and other associated ESH species throughout their breeding range in eastern and central North America.

This plan outlines goals, objectives, and actions needed for the effective conservation of the Golden-winged Warbler on the breeding grounds. The plan is written primarily for conservation planners and land managers, but will also be useful to policy makers, scientists, and representatives from agencies and industry. Conservation and habitat management during the non-breeding season will be important components to a successful conservation strategy and will be addressed in the Non-breeding Season Conservation Plan (Chapter 4).

This plan for the breeding grounds assumes knowledge about Golden-winged Warbler distribution, breeding ecology, behavior, general habitat requirements, hybridization with Blue-winged Warbler (*Vermivora cyanoptera*), and threats to populations. If not familiar with these topics, please review the Golden-winged Warbler Status Review (Chapter 1), the Golden-winged Warbler Working Group website www.gwwa.org/, and The Birds of North America account http://bna.birds.cornell.edu/bna before implementing the following conservation actions and habitat management guidelines. In addition, we encourage conservation planners and land managers to consider this plan in the context of all-bird and community-based conservation, particularly for species associated with shrubland and young forest communities in forested landscapes. This plan identifies at least 38 bird species of conservation concern associated with Golden-winged Warbler during the breeding season (see Table 2–2).

The primary sources of information used in developing this plan were taken from the Golden-winged Warbler Working Group's Rangewide Golden-winged Warbler Conservation Initiative. From 1999–2005, the Golden-winged Warbler Atlas Project delineated present-day range and concentration areas, mapped an index of Golden-winged Warbler X Blue-winged Warbler hybridization, and assessed rangewide habitat use. In 2008–2010, a collaborative research project, involving eight primary study areas in seven states (Appendix D), provided a better understanding of the Golden-winged Warbler's breeding ecology, habitat associations, genetic introgression with Blue-winged Warbler, and associated bird communities (see sidebar, page 2–11). This project produced important information needed to generate habitat management guidelines, a conservation strategy, and to identify the necessary actions for conservation of this species that are the basis of this plan.

Note that hybridization between Golden-winged Warbler and Blue-winged Warbler likely threatens the genetic integrity and distinctiveness of both species. Both species are identified as high conservation priorities by many states and organizations and their conservation may be indelibly intertwined. Although the goal of this plan is to promote healthy Golden-winged Warbler populations, our recommendations may

not prevent establishment by Blue-winged Warbler. In areas outside the current range of Golden-winged Warbler, promotion of healthy Blue-winged Warbler populations may be desirable.

Our overall approach to developing a breeding grounds conservation strategy, reflected in the outline of this plan, is as follows:

1. Define conservation regions and focal areas for targeted conservation action.
2. Set population and habitat goals at rangewide, conservation region, and focal area scales.
3. Develop regional and habitat specific management guidelines for improving breeding habitat for Golden-winged Warblers and associated species.

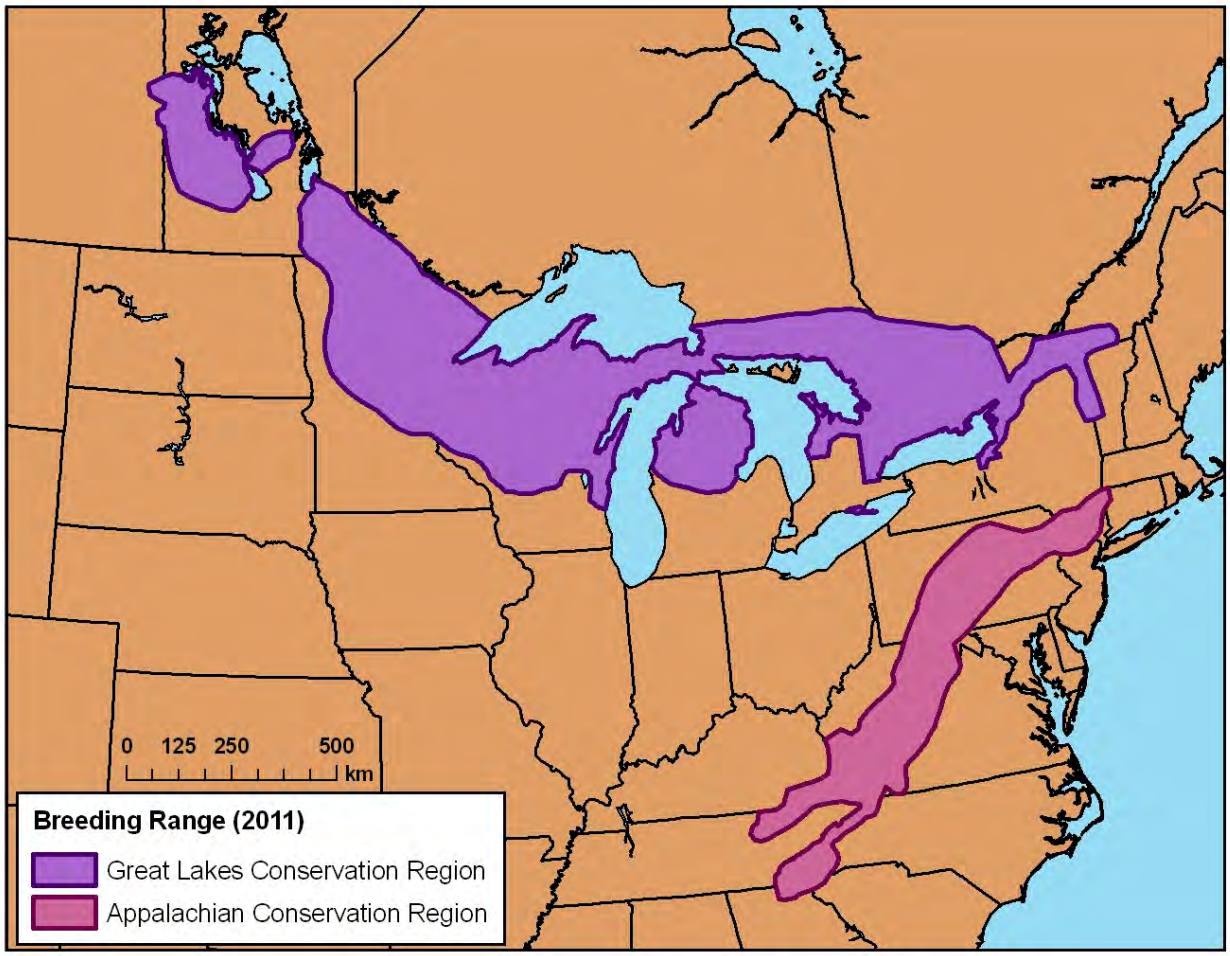


Figure 3–1. Golden-winged Warbler conservation regions based on 2011 breeding range and disjunct population segments.

DEFINITION OF REGIONS AND FOCAL AREAS

Conservation Regions

Each conservation region represents a subset of the current breeding range that is ecologically similar with respect to broad habitat characteristics deemed important to Golden-winged Warbler, and populations with similar demographics and spatial (continuous versus patchy) characteristics. The geographic extents of these two regions represent the Golden-winged Warbler's core breeding population. That is, breeding pairs can be consistently found in these regions from year to year. It is likely that sporadic breeding in other areas, such as central New York State, occurs, but does not measurably contribute to maintenance of the global population.

The Golden-winged Warbler breeding range is segmented into two populations that have considerable overlap with several Bird Conservation Regions ((BCR); Figures 3–1 and 3–2):

1. **Great Lakes** is within BCR 6 (Boreal Taiga Plains–southeast), 12 (Boreal Hardwood Transition–south), 13 (Lower Great Lakes/St. Lawrence Plains–north), and 23 (Prairie Hardwood Transition–north)

2. **Appalachian Mountains** is primarily in BCR 28 (Appalachian Mountains)

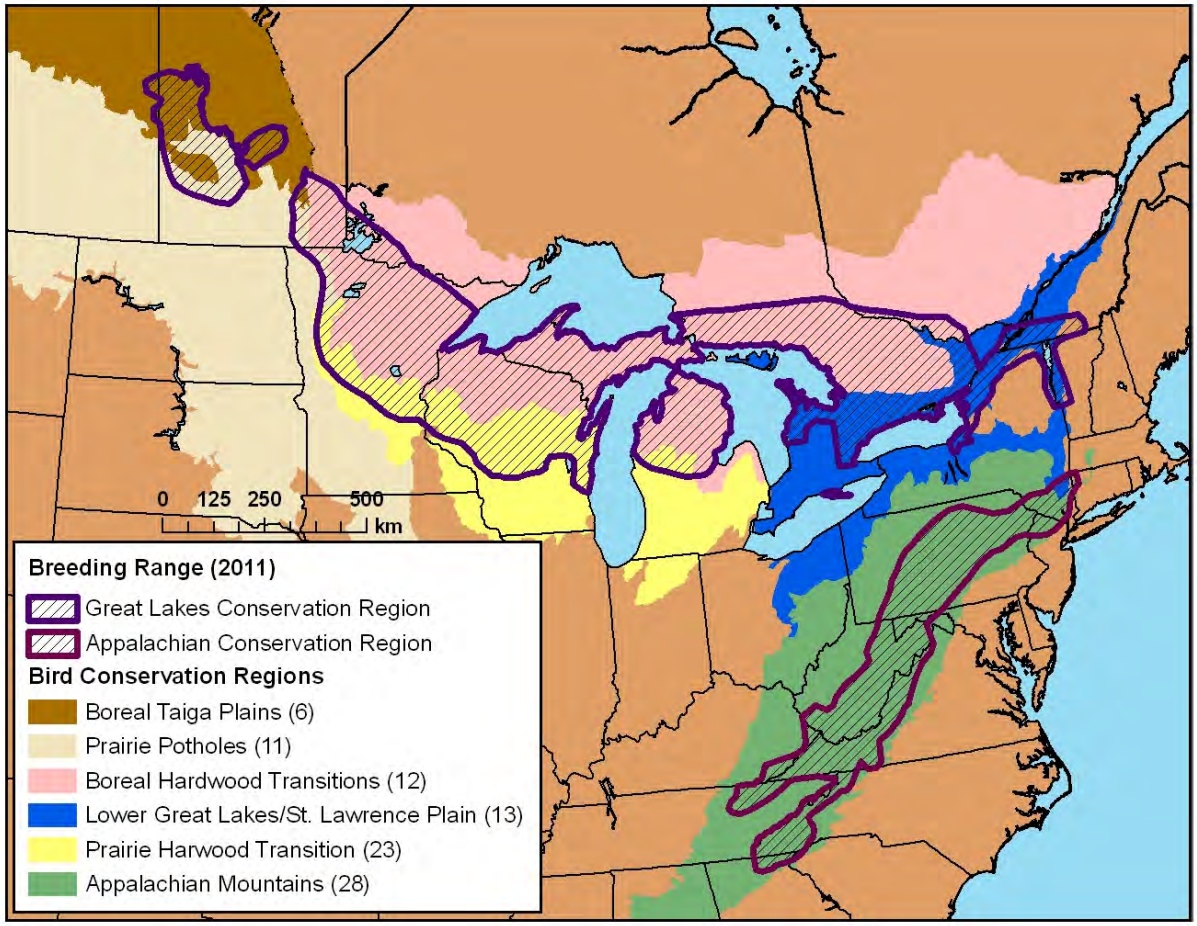


Figure 3–2. Golden-winged Warbler breeding range and boundaries of Bird Conservation Regions

Focal Areas and Priorities

Geographic focal areas, as defined by the Golden-winged Warbler Working Group, are places where the maintenance of core populations will be important for sustaining and growing the current distribution (Figure 3–3). Further, focal areas with greater than 20 breeding pairs will be particularly important for expanding the population into adjacent areas. Eight of the 34 total focal areas contain 20 or fewer pairs and the goal of these areas is to increase the population to sustain the current breeding season distribution.

Not all parts of a focal area are appropriate for habitat management. Places within focal areas where applying the management guidelines from this plan should be **avoided** include: 1) places where management and protection of other rare or imperiled resources are higher priority (e.g., national forest wilderness areas) or have conflicting management needs, and 2) places where Blue-winged Warbler populations co-occur and management for Golden-winged Warbler might hasten Blue-winged Warbler invasion of Golden-winged Warbler territories, increasing the probability for hybridization.

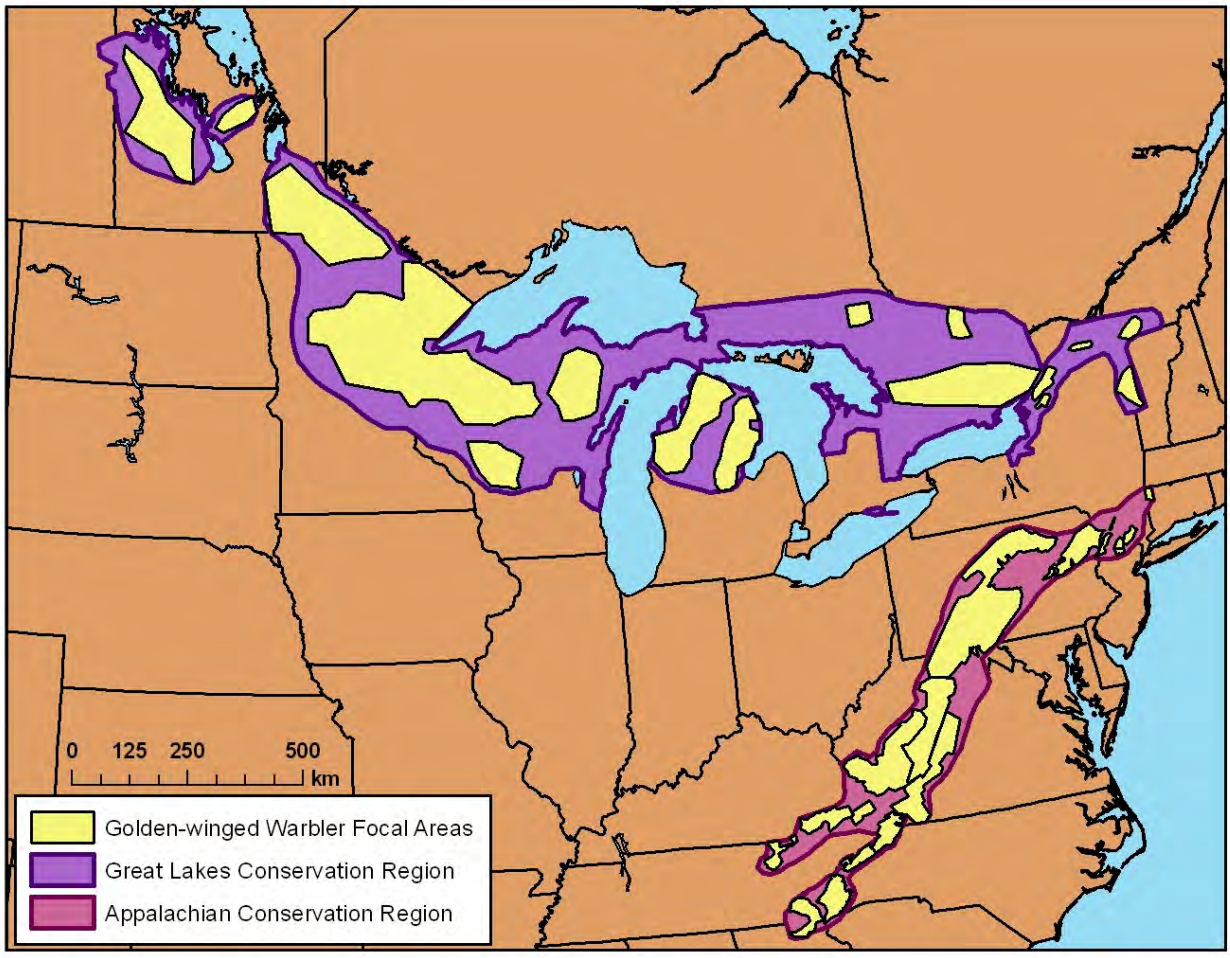


Figure 3–3. Geographic extent of the Appalachian Mountains and Great Lakes conservation regions containing defined Golden-winged Warbler focal areas (yellow).

POPULATION AND HABITAT GOALS

The rangewide population goal for Golden-winged Warbler, established by the Golden-winged Warbler Working Group, is to restore the current estimated population of approximately 414,000 breeding individuals to approximately 620,000 birds (similar to population in 1980s), through habitat management and conservation at locations used by Golden-winged Warblers during their annual life cycle (Table 3–1) (see Part II Focal Area Reference Guide, page 3–46). The timeline for achieving this goal will require stabilizing the global population (stop present declines) within 10 years and then increasing the population by 50% in the following 30 years.

Estimating the population size of any widely dispersed bird species is extremely difficult and requires a set of clearly articulated assumptions. Our Golden-winged Warbler population estimates are based on a procedure developed by Partners in Flight, which uses extrapolation of North American Breeding Bird Survey (BBS) data (Rich et al. 2004, Rosenberg and Blancher 2005). The most recently available population estimates (PIF Landbird Populations Estimation Database http://rmbo.org/pif_db/laped/) represent an update from Rich et al. (2004), based on newer BBS data (1999–2008) and revised correction factors agreed to by the Golden-winged Warbler Working Group (June 2011 workshop). These estimates should not be viewed as absolute; rather they present an order-of-magnitude estimate of abundance relative to other bird species in North America, and for comparison among regions. Golden-winged Warbler has one of the lowest estimated population sizes for any species not protected under the Endangered Species Act; most other migratory songbird species have populations in the millions or tens of millions.

Currently the Great Lakes Golden-winged Warbler population is estimated to represent 95% of the global breeding population, leaving only 5% of the global population in the Appalachian Conservation Region. This imbalance is growing more extreme as Appalachian populations continue to decline at much sharper rates than populations in the Great Lakes region.

"We already have a lot of early successional habitat so why do we need more?"

Not all early successional habitats are suitable for Golden-winged Warblers. High quality breeding habitat provides optimal conditions for reproduction and survival. For example in the Great Lakes region, where aspen forest and shrub wetlands are abundant, high quality breeding habitat can be identified by:

- Landscapes with 50–70% deciduous forest and less than 20% coniferous forest.
- Aspen clearcuts that are 2–10 years old with 10–15 residual live trees/ac (25–37 trees/ha).
- Shrub wetlands with appropriate habitat components. NOTE: many shrub wetlands are unoccupied for unknown reasons, perhaps because they lack an important habitat component such as the proper ratio of herbaceous to woody vegetation, scattered trees, adjacent forest for foraging, or dry nest sites.
- Close proximity to other breeding populations; isolated patches have higher likelihood of being unoccupied.

Closer examination of existing ESH may reveal that there is not as much high quality Golden-winged Warbler habitat as initially thought. Where ESH does not meet these guidelines, there is an opportunity to convert low quality into high quality habitat. Even where ESH acreage in general is trending downward, by enhancing the quality of ESH for Golden-winged Warbler, we can increase the acreage of high quality habitat.

Thus to reach the 40-year goal of increasing the global population by 50%, a majority of this increase will need to be realized in the Great Lakes region. However, an important goal is to prevent extirpation of the Golden-winged Warbler in the Appalachians with the more aggressive goal of doubling the regional population within 40 years.

Restoring Appalachian populations of Golden-winged Warbler is important for two reasons: 1) these represent historic strongholds for the species that until recently supported a larger proportion of the global population; and 2) these populations have a longer history of interactions with hybridizing Blue-winged Warblers, and therefore the potential to establish long-term co-existence, which is still uncertain in the larger Great Lakes population.

Breeding habitat goals are based on current estimates of available habitat area at the landscape-scale within focal areas and conservation regions. To estimate breeding habitat acreage, a habitat multiplier (1 territorial pair/10 ac (4 ha)) was estimated based on mean territory densities at eight study areas across the breeding range, representing a broad range of community types and management regimes. We assumed that increasing acreage of habitat would result in a 10:1 proportional increase in Golden-winged Warbler populations. In other words, 10 acres would support one new breeding pair. We further assumed that future creation, maintenance, and restoration of breeding habitat will produce high quality sites based on implementation of the habitat management guidelines in this plan, with the result of producing a roughly average territory density. Habitat goals may include habitat generated or maintained through natural disturbance processes, not necessarily solely attained by active management. Note that an explicit assumption, based on current knowledge, is that establishment of high quality breeding habitat will favor genetically pure Golden-winged Warbler in areas where Blue-winged Warbler co-occur; specific management guidelines may need to be adjusted as this assumption is continually tested and evaluated. Finally there is the implicit

Table 3–1. Golden-winged Warbler population estimates and breeding habitat area estimates for 2010 and goals for 2020 and 2050. The annual or decadal net gain in suitable breeding habitat that is needed to attain a goal is shown in parentheses.

	Great Lakes Conservation Region	**Appalachian Conservation Region**	**Rangewide**
Population (individuals)			
Estimated Population (2010)	392,000	22,000	414,000
Population Goal (2020)	441,000	27,000	466,000
Population Goal (2050)	588,000	44,000	621,000
Breeding Habitat			
Estimated Breeding Habitat (2010)	1,960,000 ac (793,000 ha)	110,000 ac (45,000 ha)	2,070,000 ac (838,000 ha)
Breeding Habitat Goal (2020)	2,205,000 ac (+25,000 ac/yr) 892,000 ha (+10,000 ha/yr)	137,000 ac (+3000 ac/yr) 55,000 ha (+1200 ha/yr)	2,330,000 ac (+26,000 ac/yr) 943,000 ha (+11,000 ha/yr)
Breeding Habitat Goal (2050)	2,940,000 ac (+245,000 ac/decade) 1,190,000 ha (+99,000 ha/decade)	220,000 ac (+27,000 ac/decade) 89,000 ha (+11,000 ha/decade)	3,105,000 ac (+259,000 ac/decade) 1,257,000 ha (+105,000 ha/decade)

assumption that habitat that is created or restored will indeed be occupied by breeding Golden-winged Warblers; however, this might not be the case in some areas.

Regional and focal area population and habitat goals need to be stepped down to the state and management site scales, as well. Land managers should assess current and potential habitat management options and estimate acreages. A site-level plan should be developed that includes goals, management practices, and a monitoring schedule. See the Example Management Plan (page 3–18) for how to set goals at the site level.

MANAGEMENT GUIDELINES

The management guidelines portion of this plan is divided into three parts. The first is a **Quick Start Guide for Land Managers**. The Quick Start Guide is meant to get land managers started quickly without having to wade through a prohibitive amount of background information. It is a summary of information presented in Part I: Comprehensive Management Guide for Creating and Maintaining Breeding Habitat and contains only the basic knowledge required for understanding the Golden-winged Warbler's landscape-scale habitat requirements and manipulating habitat at the scales of the management site and patch.

Information presented in the Quick Start Guide is repeated in other parts of this plan. For ease of use and to set the Quick Start Guide apart from the remainder of the plan, it is set in a box with a green background on multiple pages.

Part I: Comprehensive Management Guide for Creating and Maintaining Breeding Habitat provides additional technical detail for managing Golden-winged Warbler habitat at the site scale, and discusses management techniques that can be used to achieve the desired habitat conditions.

Part II: Focal Area Reference Guide provides spatially explicit overviews of habitat-use patterns within each of the plan's 34 focal areas, and gives population and habitat goals for each focal area.

With their high level of detail and georeferencing, Parts I and II can be used to answer conceptual questions about habitat management and guide large-scale conservation planning.

Quick Start Guide for Land Managers

Breeding Golden-winged Warblers require a complex structure of habitat components that occur within a variety of ephemeral, young forest, and other ESHs that result from disturbances, like timber harvesting (Figure 3–4) or fire, and more permanent ecological conditions, such as alder swamps and oak barrens. Regardless of the habitat's origin or degree of permanency, the basic conditions required by Golden-winged Warblers are approximately the same:

Shrubby, young forest with limited canopy cover that is frequently interspersed with herbaceous areas of grasses and forbs, and includes widely spaced overstory trees for song perches (Figures 3–4 and 3–5). This basic patch-level configuration often borders more mature forest and is usually set within a landscape matrix of deciduous forest.

Figure 3–4. This newly harvested aspen forest has a moderate density of residual canopy trees with a high proportion that are hardwoods (northern red oaks) dispersed throughout the stand. In a couple of years, when the understory has regrown, this site should provide excellent nesting habitat for Golden-winged Warblers. Photo by Laurie Smaglick Johnson.

We highly recommend working within the pre-defined focal areas for your region and in places with limited co-occurrence of Blue-winged Warbler (Figures 3–6 to 3–10). See Part II (page 3–46) for maps and detailed descriptions of each focal area.

We use four guiding principles to describe habitat associations and provide management guidelines:

1. **Context**—what is the landscape-scale context of the management site?
2. **Configuration**—how are the major habitat components configured at the scales of the management site and patch?
3. **Content**—what are the major habitat components within a patch or stand?
4. **Composition**—what are the key species or plant community associations within the region and habitat type?

Context is discussed at the landscape scale, while Configuration, Content, and Composition are considered at the scales of the management site and patch or stand.

Determining Appropriate Landscape Context

Below we describe the landscape-scale conditions necessary when considering the most productive places to establish Golden-winged Warbler management sites. With the exception of elevation, these metrics apply to both the Appalachian and Great Lakes regions. Parts I and II provide more detail on landscape-scale habitat associations.

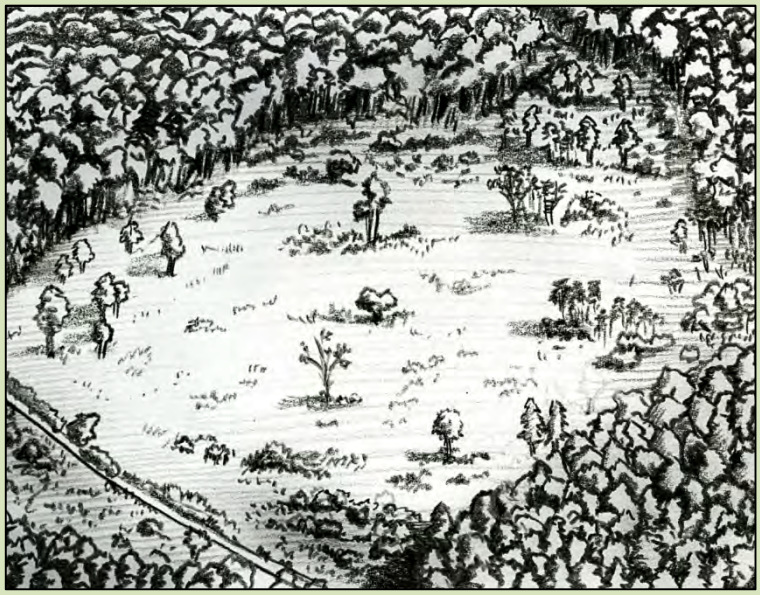


Figure 3–5. Sketch of early successional habitat patch as viewed from overhead. Illustration by Ann-Kathrin Wirth.

Macro Landscape Context (within 1.5 mi (2.5 km) of management site):

- **Elevation**:
  Southern Appalachians (GA, KY, NC, TN, VA, WV)—generally above 2000 ft (610 m), varies with site-specific context
  Northern Appalachians (NJ, PA, MD, WV)—generally above 1300 ft (400 m), lower in heavily forested areas
  Great Lakes—no association with elevation
- **Forest Cover**: 50–75%
- **Forest Type**: primarily deciduous; limited Golden-winged Warbler occurrence in landscapes containing greater than 25% coniferous forest
- **Tree Communities:** yellow poplar-red oak; sugar maple-beech-yellow birch; aspen-paper birch; mixed-oak
- **Introgression Risk**: In Great Lakes region avoid landscapes with greater than 30% coniferous forest and in Appalachians avoid valleys and lower slopes at lower elevations with areas of known co-occurrence with Blue-winged Warbler.

Micro Landscape Context (within 800 ft (250 m) of management site):

- **Primary Habitat Types:** 60–80% forest and 15–55% shrub-herbaceous; negative associations with human development and cropland
- **Secondary Habitat Types:** shrub-forest wetlands and pasture-hay fields
- **Forest Type:** deciduous, no more than 20% coniferous
- **Distance Association:** Golden-winged Warblers tend to be further from rivers and streams than Blue-winged Warblers.

Developing Habitat at Management Sites and Patches

Within appropriate landscape contexts, identify management sites to create, maintain, or restore Golden-winged Warbler habitat. The management site (see sidebar to right) includes the local area that is receiving active habitat management and will ultimately provide primary habitat for breeding territories and nest sites, and the contextual habitat that will potentially receive management action in the future. Management sites can range in size from a few acres or hectares to hundreds of acres or hectares. In some cases, management sites might be part of a larger habitat complex that is collectively being managed for Golden-winged Warbler and other associated species. In large, heavily forested areas, try to maintain 15–20% of forestland in early successional stages appropriate for Golden-winged Warbler breeding.

The management site can further be divided into smaller, more logistically manageable units. These units are often referred to as patches or stands. In this plan, we use the term patch (see sidebar to right) to refer to the smaller units residing within a management site. If there is no other suitable habitat within 1 mi (1.5 km) of the proposed management site, then a minimum of 25 ac (10 ha) should be created as one or more patches of breeding habitat. If other suitable breeding habitat is adjacent (within approximately 1000 ft (300 m)) to the proposed area, then a patch of new habitat can be as small as 5 ac (2 ha).

Habitat Configuration

Decreasing spatial scale

Management site- area where management prescriptions are focused as defined by a management plan.

Patch- an area of uniform habitat type or successional stage and defined by a habitat edge.

Habitat Edge- distinct boundary between different habitat types or the same habitat but in distinctly different successional stages.

Clump- area of distinctly associated vegetation at a fine scale and separated from habitat patch by a micro-edge.

Microedge- readily perceived change in vegetation type or height, such as where grasses change to sedge at the border of a wet area or where an herbaceous opening is bordered by dogwood or *Rubus* shrubs. Note: Due to scale not all microedges are shown.

Illustration by Ann-Kathrin Wirth.

Appalachian Region

Most common habitat types used:

- Upland shrub communities (abandoned farmland, shrubby fields, lightly grazed pastures)
- Successional forest (regenerating young forest resulting from forest management or other disturbance)
- Forest-shrub wetland (alder wetland, beaver wetland, hardwood swamp)
- Reclaimed surface mine
- Utility rights-of-way

Configuration within Management Sites:

- Patches of young forest or other ESH with feathered edges (see sidebar, page 3–15) leading up to mature forest boundary.
- Patches ≤ 1000 ft (300 m) from existing, suitable habitat should be ≥ 5 ac (2 ha), while those ≥ 1000 ft (300 m) from existing habitat should be ≥ 25 ac (10 ha).
- Within large management complexes, at any given time, 15–20% of area should be maintained in early successional or young forest habitat.

Content within Patches:

- Overstory trees (>9 in (>23 cm) DBH), saplings, shrubs, herbaceous openings, bare ground, and sometimes surface water

Configuration within Patches:

- Tall shrubs and saplings 3–13 ft (1–4 m) unevenly distributed as clumps (see sidebar, page 3–15) should make up 30–70% of patch.
- Shrub and sapling clumps should be interspersed with herbaceous openings that are primarily composed of forbs with lesser proportions of grasses.
- Low woody vegetation (< 3 ft (1 m)), leaf litter, and bare ground can occur in openings but should occupy less than 25% of the opening's space.
- Overstory trees should be infrequent (5–8/ac (10–15/ha)) and widely spaced (or retained in clusters) resulting in 10–30% canopy cover throughout the patch. At least 50% of overstory trees should be deciduous.
- Average distance to microedge (see sidebar, page 3–15) should be less than 20 ft (6 m) from any point within the patch.

Composition within Patches – common plant species include:

Note: Below we list numerous species that are commonly found within Golden-winged Warbler territories; however, it's likely that many species not contained in this list will provide the structure that Golden-winged Warblers need. Additionally, several plant species listed are exotic and/or invasive and should not be planted or encouraged to disperse. We list them here only to show possible habitat associations as derived from analyses of empirical data. They potentially can be substituted with native species that provide the same structural attributes.

- *Forbs*: goldenrod (*Solidago* spp.), bracken fern (*Pteridium aquilinium*), wild strawberry (*Fragaria virginiana*), large-leaved aster (*Eurybia macrophyllus*), stinging nettle (*Urtica dioica*), milkweed (*Asclepias* spp.), asters (multiple genuses), common cinquefoil (*Potentilla simplex*), sericea lespedeza (*Lespedeza cuneata*), mountain mint (*Pycnanthemum* spp.), yarrow (*Achillea millefolium*)

- *Grasses/Sedges:* timothy (*Phleum* spp.), sweet vernalgrass (*Anthoxanthum odoratum*), grove bluegrass (*Poa alsodes*), Pennsylvania sedge (*Carex pensylvanica*), wild rye (*Elymus* spp.), smooth brome (*Bromus inermis*), velvet grass (*Holcus lanatus*), orchard grass (*Dactylis glomerata*), panicgrass (*Panicum* spp.)

- *Shrubs:* raspberry/blackberry (*Rubus* spp.), blueberry (*Vaccinium* spp.), beaked hazelnut (*Corylus cornuta*), American hazelnut (*Corylus americana*), hawthorn (*Crataegus* spp.), multiflora rose

(*Rosa multiflora*), sweetfern (*Comptonia peregrina*), autumn olive (*Elaeagnus umbellata*), maple (*Acer* spp.), honeysuckle (*Lonicera* spp.)

- *Trees:* black cherry (*Prunus serotina*), white ash (*Fraxinus americana*), black locust (*Robinia pseudoacacia*), pin cherry (*Prunus pensylvanica*), white oak (*Qurecus alba*), eastern white pine (*Pinus strobus*), American elm (*Ulmus americana*), black walnut (*Juglans nigra*)**,** apple (*Malus spp*.) sugar maple (*Acer saccharum*), tulip poplar (*Liriodendron tulipifera*), American beech (*Fagus grandifolia*), paulownia (*Paulownia tomentosa*), hickories (*Carya* spp), maples (*Acer* spp.)

Great Lakes Region

Most common habitat types used:

- Forest or shrub wetlands (alder/willow wetlands, beaver wetland)
- Aspen clearcuts
- Successional forest (regenerating young forest from forest management or other disturbance)
- Tamarack bog
- Upland shrub communities (abandoned farmland, shrubby fields)

Configuration within Management Sites:

- Patches of young forest or other ESH with feathered edges (see sidebar, page 3–15) leading up to mature forest boundary.
- Patches $\leq$ 1000 ft (300 m) from existing, suitable habitat should be $\geq$ 5 ac (2 ha), while those > 1000 ft (300 m) from existing habitat should be > 25 ac (10 ha).
- Within large management complexes, at any given time, 15–20% of area should be maintained in early successional or young forest habitat.

Content within Patches:

- Overstory trees (> 9 in or > 23 cm dbh), saplings, shrubs, herbaceous openings, bare ground, and sometimes surface water

Configuration within Patches:

- Tall shrubs and saplings 3–13 ft (1–4 m) unevenly distributed as clumps (see sidebar, page 3–15) should make up 30–70% of patch.
- Shrub and sapling clumps should be interspersed with herbaceous openings that are primarily composed of forbs with lesser proportions of grasses.
- Low woody vegetation (< 3 ft (1 m)), leaf litter, and bare ground can occur in openings but should occupy less than 25% of opening's space.
- Overstory trees should be infrequent (5–8/ac (10–15/ha)) and widely spaced (or clustered), resulting in 10–30% canopy cover. At least 50% of overstory trees should be deciduous.
- Average distance to microedge (see sidebar, page 3–15) should be less than 20 ft (6 m) from any point within the patch.

Composition within Patches – common plant species include:

Note: Below we list numerous species that are commonly found within Golden-winged Warbler territories; however, it's likely that many species not contained in this list will provide the structure that Golden-winged Warblers need. Additionally, several plant species listed are exotic and/or invasive and should not be planted or encouraged to disperse. We list them here only to show possible habitat associations as derived from analyses of empirical data. They potentially can be substituted with native species that provide the same structural attributes.

- *Forbs:* goldenrod, bracken fern, wild strawberry, large-leaved aster, stinging nettle, milkweed, asters
- *Grasses/Sedges:* timothy, sweet vernalgrass, grove bluegrass, Pennsylvania sedge, wild rye, smooth brome, orchard grass, panicgrass, fescue (*Festuca Spp.*)
- *Shrubs:* raspberry/blackberry, blueberry, beaked hazelnut, American hazelnut, hawthorn, multiflora rose, sweetfern, autumn olive, serviceberry (*Amelanchier* spp.)
- *Trees:* quaking aspen (*Populus tremuloides*), big-tooth aspen (*Populus grandidentata*), balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*), red maple (*Acer rubrum*), northern red oak (*Quercus rubra*), bur oak (*Quercus macrocarpa*), black cherry, tamarack (*Larix laricina*), balsam fir (*Abies balsamea*), eastern white Pine (*Pinus strobus*), red pine (*Pinus resinosa*), jack pine (*Pinus banksiana*), white spruce (*Picea alba*)

Example Management Plan

A land manager has a small population of Golden-winged Warblers with at least five breeding pairs in a forested landscape dominated by deciduous forest. This site falls in an existing forest management site that is 1000 ac (400 ha) and within one of the defined Golden-winged Warbler focal areas (see Part II, page 3–46). The manager assesses the plant composition and structure at the management site and determines that the following distribution of habitat types currently exists (see table below).

The manager wants to generate suitable Golden-winged Warbler habitat on 20% of the area, or 200 ac (80 ha), and sets this as the long-term goal for the management site. Currently 12% of the area, or 120 ac (48 ha), is suitable habitat so the manager needs to add 80 ac (32 ha). The manager consults with the local forester and determines that 50 ac (20 ha) of aspen forest can be harvested in the next two years to generate young forest and that 100 ac (40 ha) could be harvested about every 10 years. In addition, there is suitable habitat around the edge of two openings and pairs are breeding in an area of young aspen forest that grades into an alder wetland.

Habitat Type	Current Distribution in acres (ha)	Current Suitable in acres (ha)
Aspen Forest (50%)	500 (200)	50 (20)
Non-aspen Deciduous or Mixed Forest (20%)	200 (80)	0
Conifer Forest (10%)	100 (40)	0
Alder Wetland (15%)	150 (60)	50 (20)
Abandoned Field (5%)	50 (20)	20 (8)
Total (100%)	1000 (400)	120 (48)

Based on current management opportunities, the manager develops the following plan:

Habitat Type	Current Distribution in acres (ha)	Current Suitable Habitat in acres (ha)	Two-year Habitat Goal in acres (ha)	Long-term Planned Action
Aspen Forest (50%)	500 (200)	50 (20)	100 (40)	Harvest 100 ac (40 ha) every 10 years.
Non-aspen Deciduous or Mixed Forest (20%)	200 (80)	0	0	Continue uneven-aged management but remove more volume along boundaries adjacent to shrubby or sapling dominated patches.
Conifer Forest (10%)	100 (40)	0	0	No change.
Alder Wetland (15%)	150 (60)	50 (20)	50 (20)	Maintain; experimental enhancement harvest of 5 ac (2 ha) in an area of upland alder to increase patchiness of herbaceous cover.
Abandoned Field (5%)	50 (20)	20 (8)	50 (20)	Mow herbaceous areas less frequently to encourage more small woody cover; remove pine regeneration from openings and mow periodically to control new invasions.
Total (100%)	1000 (400)	120 (48)	200 (80)	

The plan uses timber harvests to increase the acreage of young aspen forest and increase use of edges of other deciduous forest types adjacent to existing suitable habitat. For old fields, the mowing schedule is changed to encourage small-diameter woody cover and to remove pine regeneration from openings. An experimental harvest in upland alder is scheduled to try to improve habitat quality as indicated by an increase in territory density and use of this community type by increasing the patchiness of the mature alder and encouraging regeneration of herbaceous vegetation and young alder. The result is that 20% of the management site is suitable breeding habitat, an increase from 12%. The managed areas will be monitored before and after treatment to evaluate Golden-winged Warbler response.

Part I: Comprehensive Management Guide for Creating and Maintaining Breeding Habitat

Most bird species use just one habitat type, such as forest or prairie. However, the habitat conditions that Golden-winged Warblers rely on can be met within numerous habitat types, ranging from forests to abandoned fields to wetlands. Fortunately, the basic requirements—a patchy mixture of shrubs, saplings, herbaceous openings, and widely spaced tall trees within a primarily forested landscape—are similar regardless of habitat type. The difference lies in the management techniques used to create and maintain these conditions across habitat types. Under natural disturbance regimes, the Golden-winged Warbler was likely restricted to wetland areas impacted by periodic flooding, such as beaver meadows, edges of tamarack bogs, hardwood swamp forests, alder and willow swamps; or upland areas that were frequently disturbed by fire, insect outbreaks, and wind. Periodic wind events creating medium to large-scale forest openings were likely important in some areas. After European settlement, early-successional habitat was created as forests were cleared for settlement and agriculture. Habitat availability probably peaked as farms were abandoned and forests regenerated during the first half of the 20th century.

Given the Golden-winged Warbler's consistent population decline during the past 45 years, it is likely that contemporary land-use patterns are not generating adequate amounts of habitat to sustain stable populations. This trend appears to be especially true in the Appalachian Region where populations are declining most rapidly. Furthermore, these land-use patterns might promote contact between Golden-winged Warbler and Blue-winged Warbler, which is a contributing factor of the Golden-winged Warbler's precipitous decline. Suppression of natural disturbance regimes such as wildfires and flooding has further contributed to the loss of suitable habitat. Without a proactive effort to manage for ESH, continuing declines will likely cause Golden-winged Warbler extirpations at local and regional scales. Reversing population declines will require restoring natural disturbance regimes in appropriate habitats and implementing broad-scale forest management and other management strategies that mimic natural disturbances elsewhere.

The following sections provide detailed information on how to identify and manage Golden-winged Warbler habitat. The content is organized by geographic scale, starting at the landscape level and drilling down to the breeding territory and nest scales. The raw data and

Incidental Take and Timing of Habitat Management Activities

Because of its threatened status in Canada and threatened or endangered status in selected U.S. states, the Golden-winged Warbler is afforded certain legal protections. These protections can sometimes complicate the timing of management activities. Whenever possible, habitat management should be conducted during the non-breeding season (mid-August to mid-April), as disturbance during the nesting season potentially can result in "incidental take" of nests, eggs, and young birds.

In cases where habitat objectives can only be achieved during the nesting season, we recommend following guidelines for your agency or organization that address potential take of protected bird nests, eggs, and young as a result of habitat management practices. Please note that these recommendations are solely intended to avoid significant adverse impacts on migratory birds and do not provide any authorization for incidental take of birds and their eggs or for the disturbance, destruction or taking of nests.

synthesized results used to develop these guidelines were derived from the following sources:

- Golden-winged Warbler Atlas Project (1999–2005)
- Golden-winged Warbler Conservation Initiative (2007–2011)
- Golden-winged Warbler Conservation Workshop (Ithaca, NY August 2010)
- Golden-winged Warbler Habitat Best Management Practices for Forestlands in Maryland and Pennsylvania (Bakermans et al. 2011)
- The primary scientific literature.

Landscape Scale—Selecting Management Sites

Below we discuss landscape-scale habitat requirements of breeding Golden-winged Warblers in the context of selecting management sites that have the greatest probability of attracting breeding pairs and contributing to population level recovery through adequate reproductive success. In some cases, we provide information that, to the extent possible, may reduce the probability of contact and introgression with Blue-winged Warblers.

In general, the management site includes the local area that is receiving active management and will ultimately provide primary habitat for breeding territories and nest sites. Management sites can range in size from a few acres/hectares

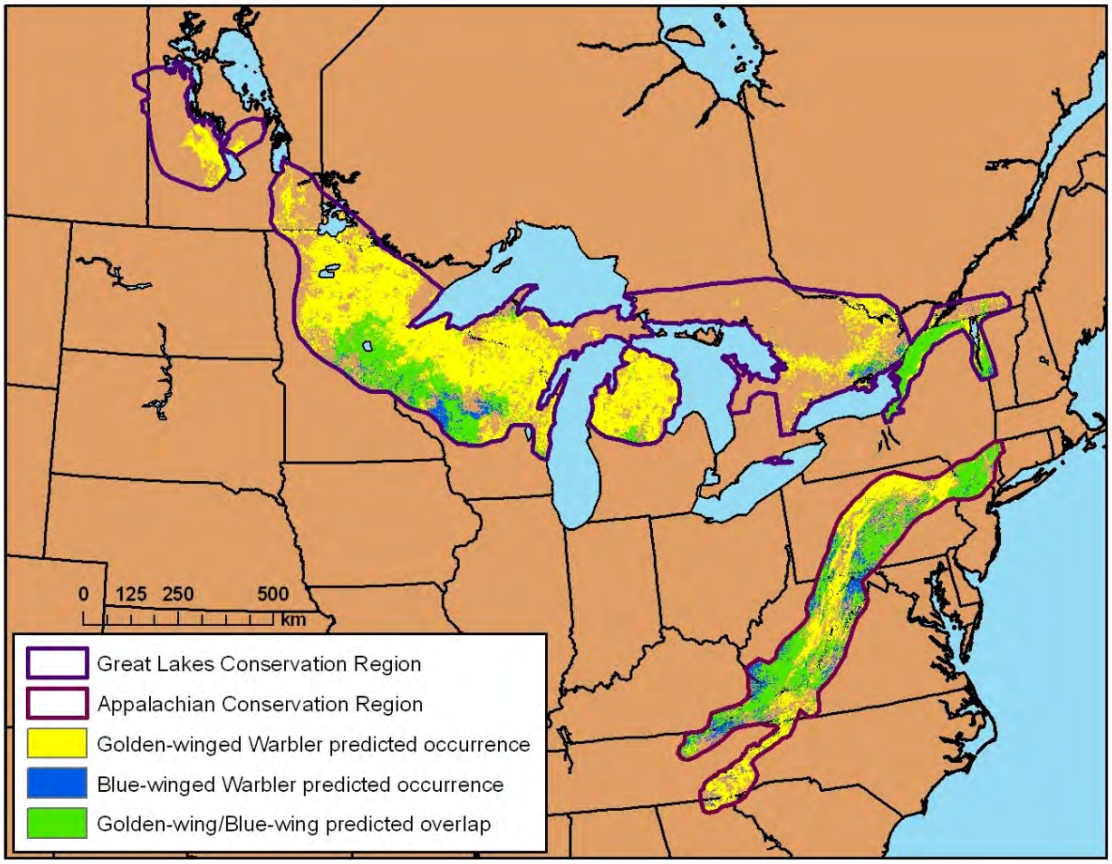


Figure 3–6. Model results showing the current predicted distribution of Golden-winged and Blue-winged warblers with areas of overlap. A smaller number of ecological variables were available to model the estimated warbler distribution in Canada, and thus estimates for some areas within the Great Lakes Conservation region are preliminary. Blue-winged Warbler occurrence may be lesser or greater than depicted in some areas.

to hundreds of acres/hectares. Not all habitat within the management site will receive active manipulation. Management sites might be part of a larger habitat complex that is collectively being managed for Golden-winged Warbler, other associated young forest species, and species that rely on more mature forest.

In most cases, management sites should be selected from within defined focal areas (see Part II, page 3–46) to maintain and grow existing populations. However, management outside of focal areas should be considered if the proposed site is within 1 mi (1.5 km) of a known breeding population. In future years, management outside of focal areas will become increasingly important to grow the numerical size and geographic extent of regional populations as focal-area populations increase and young birds disperse to new habitat outside of focal area boundaries.

Generally, the Golden-winged Warbler is associated with landscapes (within 1.5 mi (2.5 km)) that include 50–75% forest cover that is composed of 75% deciduous forest types, such as mixed hardwoods, mixed oak, northern hardwoods, oak-hickory, and aspen. Golden-winged Warbler is very rarely found in landscapes with more than 25% coniferous forest.

Management sites should be placed where there is limited co-occurrence with Blue-winged Warblers to minimize the probability for introgression between the species (Figure 3–6). Where Golden-winged Warbler does not co-occur with Blue-winged Warbler, there is less risk of attracting Blue-winged Warbler to newly managed sites. However, to achieve rangewide

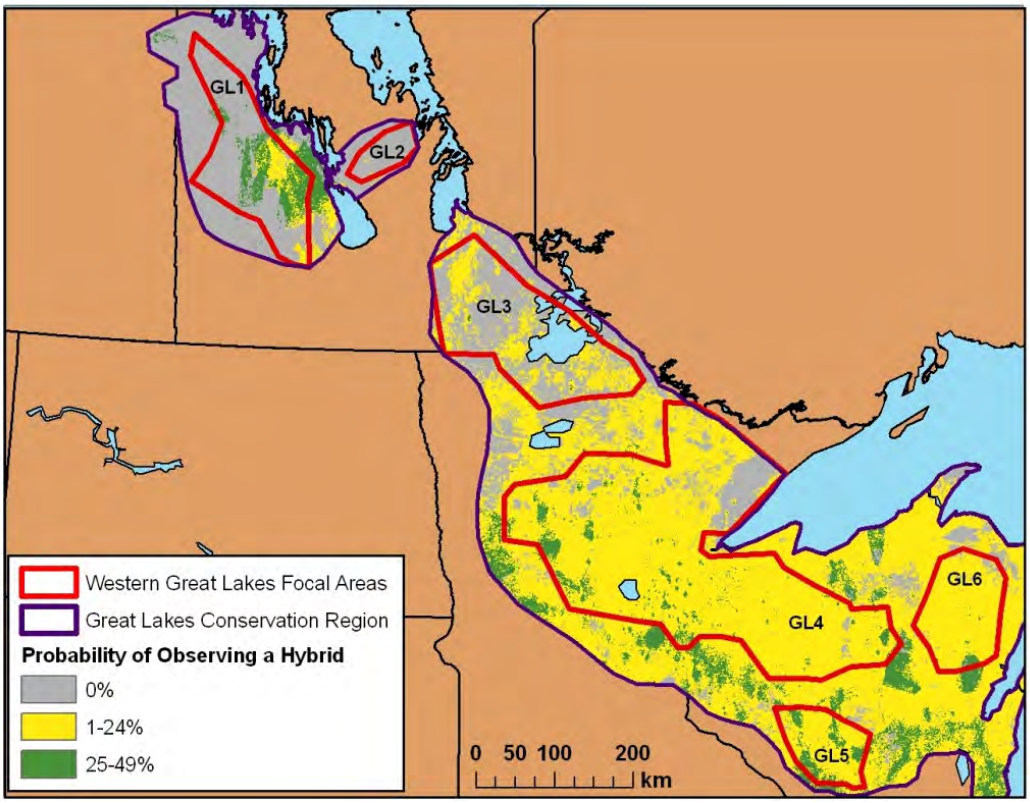


Figure 3–7. Model results showing the current probability of detecting a phenotypic or genotypic hybrid Golden-winged Warbler x Blue-winged Warbler in the western Great Lakes Region based on the probability of both Golden-winged and Blue-winged warbler being present, elevation, forest type, and climate. Areas defined as having 0% hybrid probability lacked the appropriate environmental conditions to support both species, thus pushing the likelihood of hybridization to near zero. While no hybrid or Blue-winged Warbler individuals have been documented in GL1, the model predicts that environmental conditions are suitable for hybridization to occur. Future monitoring in this focal area should emphasize detection and documentation of Blue-winged Warbler and hybrids to help shape management decisions.

population recovery, it is likely that some management will need to take place in areas where the two species co-occur. In these areas, landscape-scale site selection must be undertaken carefully to minimize the attraction of Blue-winged Warbler to newly managed sites.

The probability of finding a genetically pure Golden-winged Warbler, Blue-winged Warbler, or a hybrid varies with geographic location and habitat conditions. It is important to understand this variation when making decisions about where to invest in Golden-winged Warbler conservation. In general, the greatest investments should be made in those places with the lowest probability of facilitating further hybridization. Figures 3–7 to 3–10 display the predicted probability of a given focal area to support hybrid Golden-winged Warblers based on habitat and climatic conditions. These maps can be used to help guide initial, large-scale decisions about where to work. **However, they are not substitutes for empirical knowledge about the presence and distribution of Blue-winged Warblers and hybrids in your local area.** For example, we know there are differences between where Blue-winged Warblers are predicted to occur and where they are known to occur based on a variety of survey data sources. In these circumstances, empirical knowledge should be used to help select and prioritize management sites. When a choice of management sites is available from within a focal area, and field-based data on Blue-winged Warblers and hybrids are unavailable or unreliable, we recommend using the maps to first select areas with < 25% probability of supporting hybrids (gray and yellow shaded areas) and then

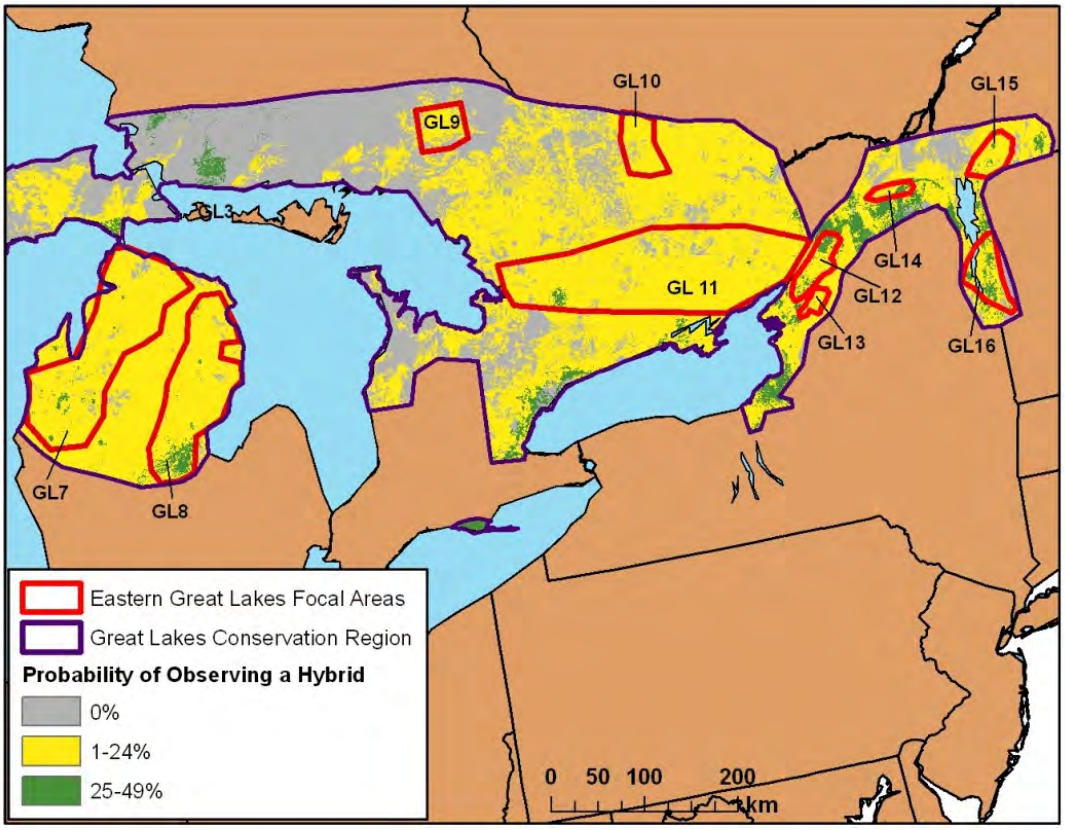


Figure 3–8. Model results showing the current probability of detecting a phenotypic or genotypic hybrid Golden-winged Warbler x Blue-winged Warbler in the eastern Great Lakes Region based on the probability of both Golden-winged and Blue-winged warbler being present, elevation, forest type, and climate. Areas defined as having 0% hybrid probability lacked the appropriate environmental conditions to support both species, thus pushing the likelihood of hybridization to near zero.

follow elevation and habitat recommendations for your region to select specific management sites.

When there are few management site options or when all locations within your focal area have > 25% probability of supporting hybrids (green and pink shaded areas), we recommend learning as much as possible about the local presence and distribution of Blue-winged Warblers and hybrids, and following elevation and habitat recommendations for your region to select specific management sites with the greatest chance of supporting pure Golden-winged Warbler populations.

In the Appalachian Region, the probability for hybridization to occur is greater than 25% at elevations below 1500 ft (460 m). We recommend selecting management sites at elevations above the "Blue-winged Warbler zone" (i.e., above 1300 ft (400 m) in the northern Appalachians (NJ, PA, MD, WV) and above 2000 ft (610 m) in the southern Appalachians (GA, KY, NC, TN, VA, WV). However, elevation should not be used exclusively in deciding where to work. Heavily forested areas at lower elevations throughout the Appalachian Region can provide excellent Golden-winged Warbler habitat, as other landscape scale factors can mitigate hybridization. The probability of hybridization between Golden-winged and Blue-winged warbler is positively correlated with the percent coniferous forest in the macro landscape (within 1.5 mi (2.5 km) of management site). This is especially true in the Great Lakes Region where there was a 25% greater chance of detecting a hybrid in landscapes with more than 30% coniferous forest. This result is consistent with the habitat affinities we observed for Golden-

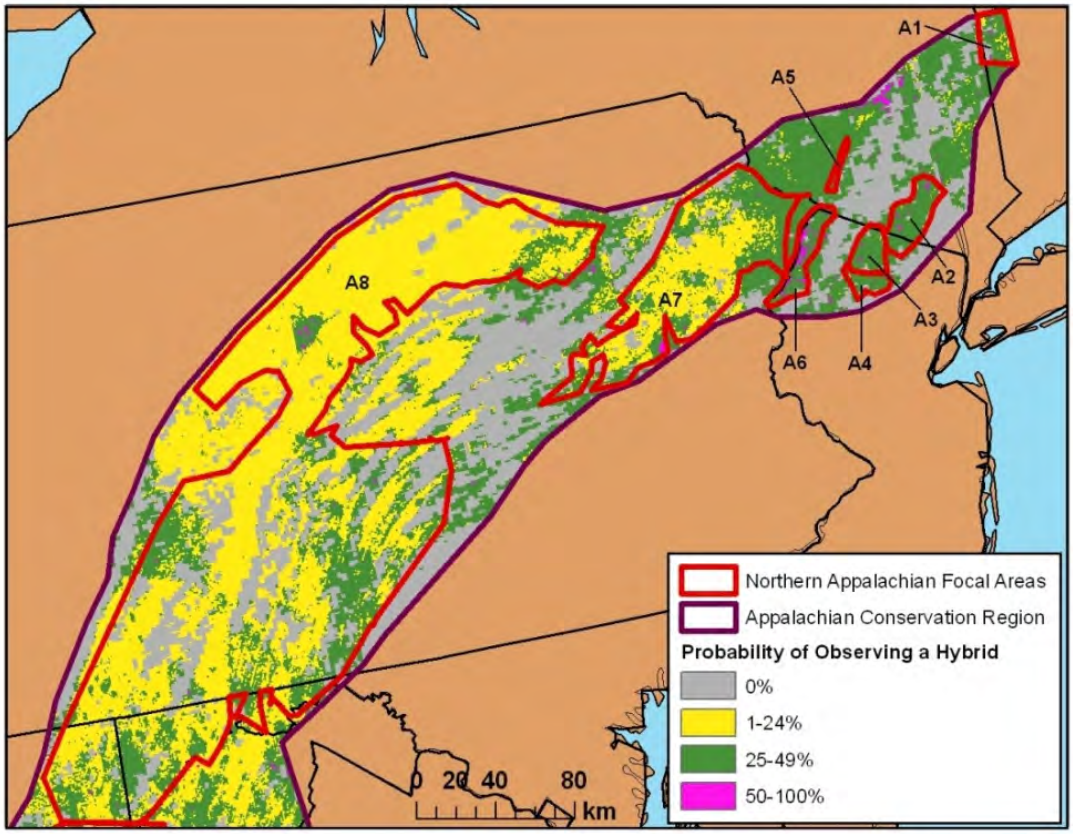


Figure 3–9. Model results showing the current probability of detecting a phenotypic or genotypic hybrid Golden-winged Warbler x Blue-winged Warbler in the northern Appalachian Region based on the probability of both Golden-winged and Blue-winged warbler being present, elevation, forest type, and climate. Areas defined as having 0% hybrid probability lacked the appropriate environmental conditions to support both species, thus pushing the likelihood of hybridization to near zero.

winged and Blue-winged warbler, where Golden-winged Warbler rarely occurs in landscapes with more than 25% coniferous forest, while Blue-winged Warbler does not appear to show a negative relationship with conifers. This suggests that landscapes with 25% or more coniferous cover might represent marginal habitat for Golden-winged Warblers. If so, these marginal conditions might serve to facilitate hybridization.

It is important to know whether breeding Golden-winged Warbler populations occur within or are nearby to a proposed management site (Figure 3–11). Though little is known about how juveniles disperse or how new habitat is colonized, we recommend creating habitat within 1 mi (1.5 km) of known breeding populations. Small, isolated patches of new habitat that are disassociated with existing breeding populations may have lower likelihood of being occupied. The minimum habitat area required to attract and support a functional sub-population of Golden-winged Warblers is unknown and likely highly correlated with the landscape context. However, in the interest of providing basic information to inform spatially explicit conservation designs, we make the following recommendations. In extensively forested management sites, we recommend maintaining 15–20% of the area in suitable Golden-winged Warbler habitat. This can be done by creating single patches of at least 5 ac (2 ha) or clusters of smaller patches that are no more than 300 yards (275 m) apart and add up to at least 10 ac (4 ha).

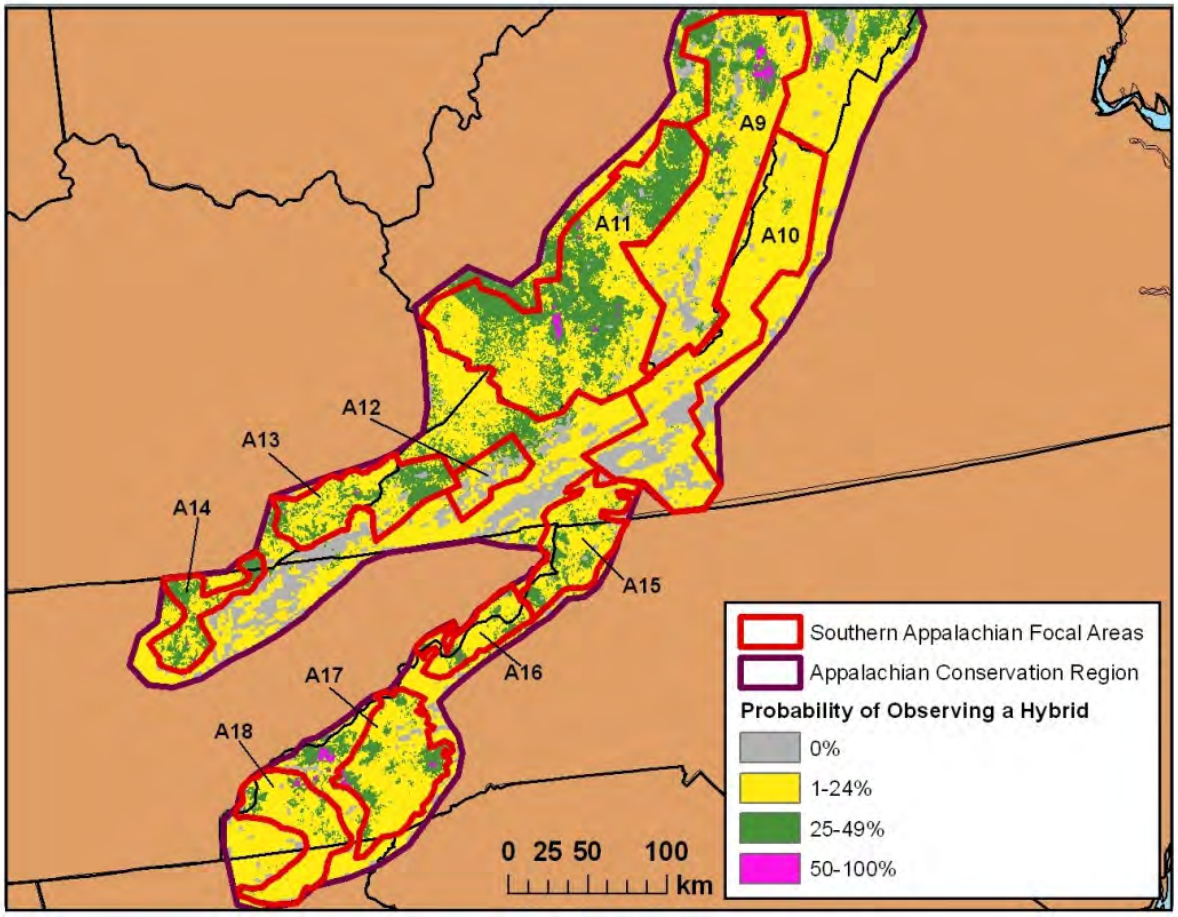


Figure 3–10. Model results showing the current probability of detecting a phenotypic or genotypic hybrid Golden-winged Warbler x Blue-winged Warbler in the southern Appalachian Region based on the probability of both Golden-winged and Blue-winged warbler being present, elevation, forest type, and climate. Areas defined as having 0% hybrid probability lacked the appropriate environmental conditions to support both species, thus pushing the likelihood of hybridization to near zero.

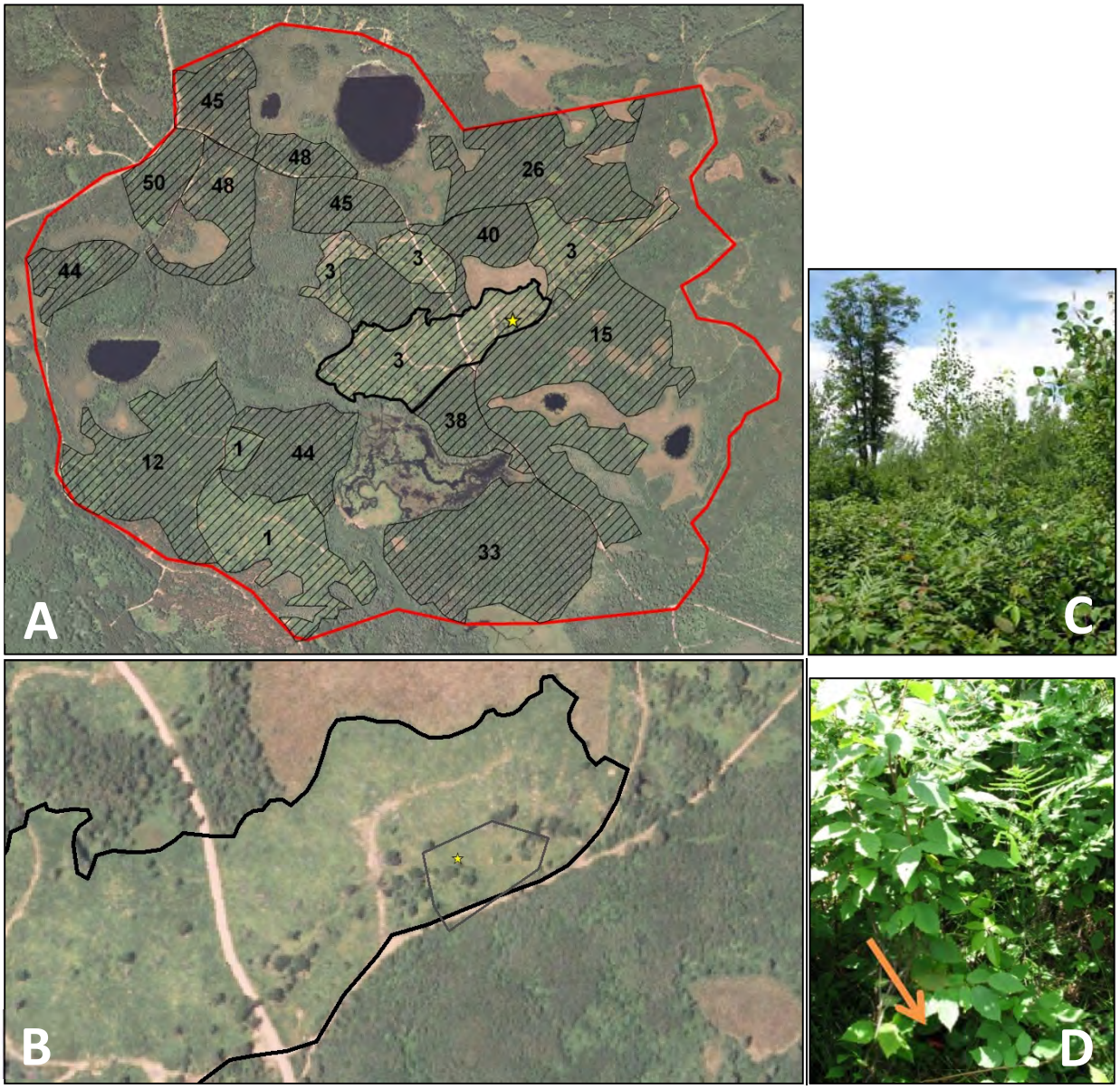


Figure 3–11. Golden-winged Warbler habitat in northern Wisconsin. (A) The yellow star indicates a Golden-winged Warbler nest site within a young aspen forest stand (heavy black boundary line). The management site outlined in red represents 1,100 acres (445 ha) of forest and wetlands. Hatched aspen patchs are labeled with their age since they were clearcut. Aspen is rotationally clearcut on a 50 year cycle such that several aspen stands are harvested approximately every five years to maintain some 1-10 year old aspen in this management area at all times. (B-C) The breeding territory (narrow gray boundary line) contains numerous residual canopy oak trees that are important for song perches. (D) The nest site (orange arrow points to the nest location) is along an over-grown logging trail with a cluster of residual oak trees in the background (C). Photo by Amber Roth.

Management Site Scale

Creating and Maintaining Habitat within Management Sites

After management sites have been selected from within the larger landscape, it is time to develop site level plans and begin creating and maintaining ESH. The management site can be further divided into smaller, more logistically manageable units (Figure 3–11). These units are often referred to as patches or stands. In this plan, we use the term patch to refer to the smaller units residing within a management site.

Some Associated Species Require Large Management Sites

Sharp-tailed Grouse is an area-sensitive species that requires large areas (1000 ac (400 ha) or more) of very young vegetation in open forested and brushland landscapes that are harvested regularly or managed with a combination of timber harvesting, prescribed burning, and mowing to control succession.

Management sites for American Woodcock should be at least 500 ac (200 ha) to support a viable population and to encompass the diverse habitat components needed during the course of the breeding season, including young forest for nesting and brood-rearing, shrub wetlands for foraging, and roosting fields.

Golden-winged Warbler, and other associated songbirds with relatively small territories, may occupy patches within woodcock and grouse management sites. The creative land manager will envision new ways to create Golden-winged Warbler habitat within the context of management for other species.

Golden-winged Warbler habitat occurs across a variety of habitat types that are either naturally disturbed or managed. Though we don't provide management guidelines for how to restore natural disturbance regimes, especially those that historically created ESH (e.g. flooding and lightning-ignited fire), the role of natural disturbances should be considered when developing management plans.

For the sake of discussion, we can divide managed, patch-level Golden-winged Warbler habitat into two categories:

1. Silviculturally-derived habitats: forests that will be managed through timber harvesting to produce habitat where none previously existed.
2. Non-forested habitats: abandoned fields, lightly grazed pastures, surface mines, and pre-existing wetlands that will be improved through non-commercial management and restoration techniques.

Silviculturally-derived habitats, such as clearcuts, shelterwood harvests, or other even-aged harvest prescriptions, will typically be generated proactively by defining a management site, delineating patches within the site, and then prescribing appropriate timber management within those patches.

In non-forested habitats, management is likely to be more opportunistic and focused on discrete, pre-existing habitat patches that are being improved through management. For example, overgrown abandoned fields and surface mines can be brush-hogged, burned, or grazed to promote herbaceous openings and set back succession. Wetland habitats can be improved by creating new habitat in adjacent upland areas or restored by removing deleterious conditions, such as high densities of invasive Phragmites (*Phragmites australis*).

It is important to keep these differences in habitat type and starting point (creating new habitat versus managing existing habitat) in mind as you consider patch-level management.

Patch Area and Configuration

The required patch area for adequate Golden-winged Warbler reproduction is context dependent and will be dictated by the habitat within and around the management site. The following guidelines should be treated as general recommendations and not hard and fast rules. If there is no other suitable habitat within 1 mi (1.5 km) of the proposed patch, then a minimum of 25 ac (10 ha) should be created as one or more patches of habitat. If there is suitable breeding habitat adjacent to the proposed patch (within 300 yards (275 m)), then a patch of new habitat can be as small as 5 ac (2 ha) and might be thought of as an enhancement or expansion of existing suitable habitat especially if already occupied by Golden-winged Warblers.

Patch shape will influence the amount of edge by altering the perimeter to area ratio. Long narrow patches or patches with wandering boundaries create a higher edge to perimeter area ratio than square or round patches. When scattered residual trees are not available for retention, or where this practice is not preferred, then the edge where ESH meets more mature forest will influence Golden-winged Warbler territory placement and the amount of edge will determine the number of pairs supported within the patch. In this case, more edge generally equals more territories per patch. The majority of territories will be found along the edge of the patch and, for large patches, the middle of the patch might not be used. Primary edges should be "feathered" so they transition from younger or more open habitat to older or more closed canopy forest. Even when clearcutting a stand, useable habitat can be enhanced by thinning or conducting a selection harvest along the edge of the stand in adjacent forest.

Configuration of habitat patches within a management site is important, as it helps provide connectivity for young birds dispersing from a nest and for returning adult birds that will be breeding for the first time. Furthermore, ESHs by definition are temporary. Depending on site conditions and habitat type, any given habitat patch will age out of suitability in a relatively short period of time. Generally speaking, suitable habitat can persist from 2–20 years depending on the rate of natural succession. Reestablishing a population is more difficult (and may not happen if a persistent population isn't nearby) than maintaining an existing one. For this reason, management plans for large, heavily forested areas should strive to create a shifting mosaic of habitat ages that consistently maintains 15–20% of the area in ESH while still allowing the full spectrum of age classes to occur across the management site. In most cases, site conditions will dictate the configuration of management activities. When possible, we suggest interspersing the 15–20% of managed habitat across the management site to create a shifting mosaic of young and more mature forest habitats.

This approach will promote regular colonization and abandonment of patches within a management site, as habitat suitability shifts from patch to patch. Similar strategies have been successfully applied on the Nantahala National Forest in North Carolina (Klaus and Buehler 2001) and commercially-managed aspen forests in the Upper Midwest (Roth and Lutz 2004). The Pennsylvania Game Commission is currently managing their State Game Lands in this fashion by using the Golden-winged Warbler Habitat Best Management Practices for Forestlands in Maryland and Pennsylvania (Bakermans et al. 2011) to guide interspersion of young forest stands on State Game Lands within Golden-winged Warbler Focal Areas.

Management sites on the Cherokee National Forest in Tennessee retained suitable habitat conditions for approximately 10 years (Klaus 1999) after harvest, but were not suitable for commercial harvest for another 50–60 years. Given a 1235-acre (500-ha) management site, if 15% of the area is harvested every 10 years (a 70-

year rotation), 185 ac (75 ha) of habitat will be available for Golden-winged Warbler use at any point in time. This same strategy can be applied to non-commercial areas such as surface mines or scrub oak barrens, where fire takes the place of timber harvest and serves to set back succession. Fire frequency within a patch will be dependent on site quality (typically 4–10 years), but the goal of 15–20% habitat availability at any given time is still the same.

Suitable habitat may be created as single patch (Figure 3–11) or multiple clustered patches. For example, if overstory trees cannot be retained, multiple small patches that maximize edge might be preferred over one or two very large patches. Providing habitat in clusters allows for contact of individuals among patches (i.e., conspecific attraction) and increases patch occupancy and densities in the management site. Ultimately, patch size and shape will be driven by context dependent silvicultural needs and topographic constraints, particularly in the rugged terrain of the Appalachian Region.

Managing Habitat within Patches

Do I Need to Micro-manage for Territories and Nest Sites?

The simple answer is probably not. Commercial timber management and other management techniques should be implemented to produce heterogeneity in the regenerating vegetation. Before creating an elaborate management prescription, evaluate the current prescription to determine if Golden-winged Warblers are responding as desired. If they are not responding to your satisfaction, then the prescription might need to be modified to better produce the desired ratio of habitat components. An adaptive management strategy should be employed to work toward a more effective prescription but also one that remains relatively simple to apply.

The following sections provide detailed information on within patch habitat requirements of Golden-winged Warbler and basic guidance on how to create these conditions. At the patch scale there are two units of measure that are important for nesting pairs: the breeding **territory** and the **nest site**. The breeding territory is generally defined as the defended area containing the nest site and should not be confused with home range, which also includes undefended areas used for foraging or post-fledging activities. Territory size varies with habitat quality and type, but a good frame of reference for management purposes is 2–5 ac (1–2 ha). The nest site can be thought of as the area immediately around the nest itself (within a 33 ft (10 m) radius). Because nests are naturally located within territories, in many cases the differences in habitat composition and configuration between the two are subtle.

The general idea is to manage habitat in large patches (> 5 ac (2 ha)) in a way that will meet the overall ecological needs of nesting pairs, including providing territories that contain secure nest-site locations. While the patch remains the primary management unit, we present guidelines for both the territory and nest site, as some habitat conditions can effect nest survival.

Breeding Territories

Proportion of Habitat Components —

The primary habitat components found within Golden-winged Warbler territories include:

1. Tall woody cover (shrubs, saplings [<4 in (10 cm) DBH]), up to 13 ft (4 m) tall.
2. Short woody cover (shrubs, seedlings) less than 3 ft (1 m) tall.
3. Herbaceous cover composed of forbs, grasses, and sedges generally less than 3 ft (1 m) tall.
4. Ground cover, including leaf litter, surface water, and exposed soil/rock.
5. Tree canopy cover.
6. Canopy tree density.

The key to creating suitable Golden-winged Warbler habitat is to produce the appropriate proportion of habitat components that are patchily distributed throughout the patch. Depending on habitat type, there are some variations to the targets provided in Table 3–2. For instance, *Rubus* (considered short woody cover) seems to be tolerated at greater proportions in eastern deciduous forest of Pennsylvania than in other habitat types. In aspen forests, eastern deciduous forest, and surface mines, suitable habitat is characterized by greater amounts of grass cover, whereas forb cover tends to be greater in abandoned farmland.

In many places, the suitability of a site is limited by the abundance and distribution of the scarcest habitat element. For example, in aspen clearcuts, grass and sedge cover may be the scarcest element as opposed to an old field where it may be woody cover (shrubs and saplings). Increasing the scarcest element can increase suitability of a larger proportion of a patch.

Table 3–2. Recommended habitat management targets for Golden-winged Warbler territories in silviculturally derived and non-forested habitat types.

Primary Habitat Component	**Management Target**	
	Silviculturally Derived Habitats	Non-forested Habitats
Tall Woody Cover > 3 ft (1 m)	5–35%, definitely < 50%	5–25%, definitely < 40%
Short Woody Cover < 3 ft (1 m)	10–30%	5–15%, definitely < 25%
Herbaceous Cover	5–25%	10–30%
Ground Cover	10–15%	10–15%
Tree Canopy Cover	10–30%, definitely > 10%	10–30%, definitely > 10%
Canopy Tree Density (or Basal Area)	5–8/ac (10–15/ha); basal area = 10–35 ft^2/ac (2.3–8.0 m^2/ha); definitely < 50 ft^2/ac (11.5 m^2/ha)	5–8/ac (10–15/ha); basal area = 10–35 ft^2/ac (2.3–8.0 m^2/ha); definitely < 50 ft^2/ac (11.5 m^2/ha)

Habitat Interspersion —

A high degree of within-patch habitat interspersion and heterogeneity is important for Golden-winged Warblers. To get a sense of this, as a rule of thumb, one should be able to stand anywhere within an appropriately managed patch and be within 20 ft (6 m) of a microedge (see sidebar, page 3–15 and Figure 3–12). A microedge is any readily perceived change in vegetation type or height, such as where grasses change to sedge at the border of a wet area or where an herbaceous opening is bordered by dogwood or *Rubus* shrubs. Shrubs should be scattered and clumped, with herbaceous openings and ground cover separating the clumps.

Bulluck and Harding 2010 developed a "clumpiness index" for sites in Virginia to describe the spatial configuration of woody vegetation (shrubs and saplings) and the relationship to Golden-winged Warbler habitat use. Shrubs that were spaced < 7 ft (2 m) apart were classified as clumped and shrubs spaced > 7 ft (2 m) apart were classified as scattered (Figure 3–12). The majority of sites occupied by Golden-winged Warblers had 50% or more of their shrubs and saplings in a contiguous clump.

Figure 3–12. The left photo shows a site with a high clumpiness index value (i.e., contiguous patches of shrubs),and presence of adequate microedge indicating high quality habitat for Golden-winged Warblers, and the right shows a site with a low clumpiness index value (i.e., scattered shrubs) and limited microedge that indicates low quality habitat for Golden-winged Warblers (from Bulluck and Harding (2010)).

Plant composition –

Providing the appropriate vegetation structure is likely more important than providing specific plant species. Certain species; however, may more likely produce the structure that Golden-winged Warblers finds attractive. For example, a combination of *Rubus* and goldenrod might serve as indicators of Golden-winged Warbler habitat in the eastern Great Lakes and the Appalachians as these plants are almost universally found on Golden-winged Warbler territories in these areas.

Some other species or species groups that are frequently found within Golden-winged Warbler territories include, but aren't limited to the following:

Note: Below we list numerous species that are commonly found within Golden-winged Warbler territories; however, it's likely that many species not contained in this list will provide the structure that Golden-winged Warblers need. Additionally, several plant species listed are exotic and/or invasive and should not be planted or encouraged to disperse. We list them here only to show possible habitat associations as derived from analyses of empirical data. They potentially can be substituted with native species that provide the same structural attributes.

- *Forbs*: goldenrod, bracken fern, wild strawberry, large-leaved aster, stinging nettle, milkweed, asters, common cinquefoil, sericea lespedeza, mountain mint, yarrow

- *Grasses/Sedges:* timothy, sweet vernalgrass, grove bluegrass, Pennsylvania sedge, wild rye, smooth brome, velvet grass, orchard grass, panicgrass, fescue

- *Shrubs:* raspberry/blackberry, blueberry, beaked hazelnut, American hazelnut, hawthorn, multiflora rose, sweetfern, autumn olive, maple, honeysuckle, serviceberry

- *Trees: (Appalachian Region)* black cherry, white ash, black locust, pin cherry, white oak, eastern white pine, American elm, black walnut**,** apple, sugar maple, tulip poplar, American beech, paulownia, hickories, maples; *(Great Lakes Region)* quaking aspen, big-tooth aspen, balsam poplar, paper birch, red maple, northern red oak, bur oak, black cherry, tamarack, balsam fir, eastern white pine, red pine, jack pine, white spruce

Nest Sites

Nest-site Selection –

The area within 33 ft (10 m) of nest sites is typically composed of 50% herbaceous cover, 30% woody vegetation, 13% open ground, and 7% scattered canopy trees (Table 3–3). These are approximate percentages and some suitable habitats might have different proportions such

Table 3–3. Recommended habitat management targets for Golden-winged Warbler nest sites.

Habitat Component	Desired Habitat Conditions
Woody Cover	5–50%, definitely < 70%
Forb Cover (silviculturally derived sites)	45–100%
Forb Cover (non-forest sites)	5–45%
Rubus Cover (where it occurs)	5–40%
Grass/Sedge Cover	5–25%, definitely < 45%
Vegetation Density (as viewed horizontally)	10–30%, definitely < 40%

that one category could become the limiting element. In our analyses, woody cover was a primary driver of nest-site selection. All nest sites included some wood component, but rarely did woody cover exceed 70%. While herbaceous cover at the nest site is clearly important, the response to forbs versus grasses is somewhat different and dependent on habitat type (Figure 3–13). In silviculturally-derived management sites, most nest sites contain > 50% forbs, while non-forested sites, such as abandoned fields generally contain < 50% forb cover. In all habitat types; however, there seems to be a general selection pressure against high amounts of grass cover, as few sites contain > 45% grass cover. Given this, we recommend using woody cover and grass cover as indicators of when sites are becoming too shrubby versus too open. Where it occurs, relatively small amounts of *Rubus* spp. can be an important indicator of high quality nest sites, but it should not exceed 40% cover.

Figure 3–13. Golden-winged Warbler nest (orange arrow) in an aspen clearcut in northern Wisconsin. Live and dead grasses, sedges, and bracken fern are important components at nest locations on these sites. Photo by Amber Roth.

Nest Survival –

Vegetation Density and Woody Cover: Golden-winged Warbler nest survival is lowest where vegetation density is scant and optimal where vegetation density is in the moderate to dense range (10–40% as viewed horizontally from 33 ft (10 m) away). As the proportion of woody cover exceeds 50%, the effect on nest survival is negative. This relationship is also reflected in nest-site selection by Golden-winged Warblers where it has an affinity for small-to-moderate amounts of woody cover but avoid sites with excessive cover. Therefore, when vegetation density and woody cover approach these high proportions, management should set back succession to favor forbs and grasses. This can be accomplished by a variety of means such as prescribed burning, brush hogging, or grazing (Table 3–4).

Grass Cover: Nest survival is consistently high when grass cover is < 40%, but as the percentage of grass cover within 33 ft (10 m) of the nest exceeds this amount survival begins to decrease. This result is consistent with nest-site selection where breeding pairs avoided sites with > 45% grass cover. Given its importance to nest site selection and survival, the overall proportion of grass cover within patches should be monitored carefully and used as an indicator of suitable Golden-winged Warbler habitat. When grass becomes too extensive (> 40% cover), management is needed to reduce its proportion relative to other cover types. Typical management of grasses includes mechanical and/or chemical treatments. Dormant season burns or dormant season soil disturbance (disking) promote forbs and reduce grasses. Likewise, high frequency (annual) burns may promote grasses where less frequent burning will yield more shrub-dominated habitats.

Management Techniques

A variety of management techniques are available to create and maintain suitable habitat for Golden-winged Warblers. These techniques can be used to influence the proportion of each habitat component relative to the others. This can include substantially retarding or advancing succession, or making smaller manipulations to favor or disfavor a given set of conditions (Table 3–4).

Table 3–4. Suggested management techniques to manipulate habitat conditions.

Symptom	Timber Management	Mechanical Clearing	Prescribed Burning or Grazing	Restore Natural Disturbances	Plant Desired Species
Excessive canopy cover	Commercial or non-commercial harvest to remove canopy trees and promote shrub growth		Periodic burning can kill fire intolerant trees and reduce canopy cover	Restore hydrology on wetland sites to kill non-wetland adapted canopy trees	
Shrubs too evenly distributed		Mow in patches to create large shrub clumps interspersed with herbaceous openings	Conduct micro-burns to selectively remove shrubs; graze cattle to reduce shrub density	Restore hydrology on wetland sites to kill shrubs and retard re-growth	
Too little herbaceous cover	Harvest canopy trees to create gaps and allow greater sun penetration	Cut or mow to remove woody cover, such as shrubs and saplings; apply herbicide to prevent re-growth	Use late, growing season burns to promote grass and forb growth. Frequent (annual) burning will reduce shrub cover		
Too little edge (when residual canopy trees not present)	Create irregular patch margin through timber harvesting	Mowing can be used to feather edges by cutting some shrubs and small trees			
Too few canopy trees	Create feathered edge through thinning operation; retain select saplings and poles of desirable species as future residual trees				Plant fast growing hardwood trees
High herbaceous cover but low woody cover		Reduce frequency and/or intensity of mowing	Reduce frequency and/or intensity of burning/grazing		Plant appropriate shrub species

Promote natural disturbance regimes

Suppression of fire, beaver activity, flooding, and native insect/disease outbreaks have increased the necessity for active management to provide habitat for Golden-winged Warblers and other ESH associates. Where and when possible, natural disturbance regimes that create habitat should be promoted or restored (Figure 3–14). Careful consideration should be given to the timing of the activities and to possible effects on human habitation and safety, commercially valuable resources (e.g. trees), cold-water fisheries, and other issues that could result in conflicting management needs and priorities.

Figure 3–14. This sedge meadow occupied by Golden-winged Warblers in New York is maintained by beaver activity. Photo by John Confer.

Reclamation and Restoration of Degraded Sites

To reclaim or restore heavily disturbed sites such as surface mines and gravel pits, plant native warm and cool season grasses with forbs and a woody shrub component (Figure 3–15). Plant hardwood tree species known to be important as song perches and forage trees and allow these to reach maturity; these should be retained as scattered, residual trees in future disturbance treatments. The shrubs and trees should be planted in clumps, rather than dispersed evenly across the site. Important residual tree species include red oaks (*Quercus rubra*) in the Upper Great Lakes (Roth et al. unpubl. data), black locust (*Robinia pseudoacacia*) in the Appalachians (Patton et al. 2010), and apple (*Malus sylvestris*), black cherry (*Prunus serotina*), and hawthorn (*Crataegus* spp.) in New York (Ficken and Ficken 1968), though specific species may be less important than having hardwood species that provide critical structure.

Figure 3–15. Not all reclaimed mine areas have appropriate nesting habitat for Golden-winged Warblers, as illustrated at these sites in the Cumberland Mountains, Tennessee. The site in the left photo does not contain the necessary woody structure, while the site in the right photo does. Photo by Katie Percy.

Utility Rights-of-Way (ROW)

Utility ROWs occur extensively throughout the range of the Golden-winged Warbler and are often cited as a potential source of habitat. Kubel and Yahner (2008) compared Golden-winged Warbler density and nest success along ROWs in Pennsylvania to 2.5 ac (1 ha) patch clearcuts. Use of wide ROWs (200 ft (60 m) wide) for nesting was similar to use of clearcuts, although nest success was much lower and narrow ROWs (66 ft (20 m) wide) received no Golden-winged Warbler use. Thus, the suitability of utility ROWs as Golden-winged Warbler habitat is likely to vary extensively depending on width and habitat management. When woody vegetation is controlled aggressively, ROWs are generally unsuitable as Golden-winged Warbler habitat. ROWs that are at least 160 ft (50 m) wide with the potential to manage adjacent vegetation as habitat provide the greatest management opportunities for the species. In forested areas, for example, ROWs often lack a transition zone (soft edge) from adjacent woodlands because utility managers actively control woody growth. Incorporating timber harvests in forest stands adjacent to utility ROW is being used in Pennsylvania and New Jersey to create Golden-winged Warbler breeding habitat.

Managing areas for nesting habitat adjacent to the corridors may be one way to reduce the linearity of the habitat and to provide missing structural components such as saplings, scattered canopy trees, and dense shrubs. The ROW itself then provides the herbaceous and shrub cover needed for nesting. In this way, where possible, two adjacent areas can be managed with different prescriptions that provide habitat characteristics that are complementary. This type of management strategy has not been evaluated for effects on annual reproduction, especially in relation to traditional, linear corridors. In general, source/sink dynamics are not well understood under different corridor management scenarios thus caution is advised when including utility ROWs as part of a local or regional conservation strategy (Figure 3–16).

Figure 3–16. A managed utility ROW in Sterling Forest State Park, New York. This habitat has supported Golden-winged Warbler, Blue-winged Warbler, and various hybrid pairings. With the loss of genetic purity for both species and high nest predation due to eastern chipmunks (Tamias striatus) and black rat snakes (Elaphe obsolete obsolete), the habitat at this location is likely a genetic and population sink. Photo by John Confer.

Timber Management

Even-aged and two-aged silviculture treatments, such as clearcutting, seed tree harvests, green-tree retention, and shelterwood harvests, can provide the proper structural conditions that Golden-winged Warblers prefer. Group and single-tree selection characteristic of uneven-aged harvest prescriptions produce small gaps that are infrequently occupied by Golden-winged Warblers. **Rotate management between adjacent sites such that at least 15–20% of a management area is available as breeding habitat in any one year.** Refer to the Golden-winged Warbler Forestland Best Management Practices in Pennsylvania and Maryland (Bakermans et al. 2011) for a complete set of guidelines for creating and maintaining Golden-winged Warbler breeding habitat via timber harvests.

Ruffed Grouse Habitat is Golden-winged Warbler Habitat

For species that depend on young forests and shrublands, most timber management practices that create ESH for one species will benefit a broad suite of associated species. Ruffed Grouse management is a good example. From the Ruffed Grouse Conservation Plan, recommendations that are compatible with Golden-winged Warbler habitat needs include:

- Maintain a mosaic of young forest (< 20 years old) interspersed with mature stands (> 40 years old).
- Target management along upland-lowland forest ecotones where topography is relatively flat.
- Within a management site, create 2.5–10 ac (1–4 ha) clearcut patches.
- In aspen clearcuts, retain up to 15 ft^2/ac (3.4 m^2/ha) of basal area for residual trees.
- In oak or maple clearcuts, retain up to 25 ft^2/ac (5.7 m^2/ha) of basal area for residual trees.

To see the Ruffed Grouse Conservation Plan, visit www.ruffedgrousesociety.org/

Retention of residual canopy trees is an important characteristic of aspen clearcuts supporting breeding pairs of Golden-winged Warblers in northern Wisconsin (Roth et al. unpubl. data, Figure 3–17). Retention of these healthy canopy trees (and snags) provides foraging opportunities and song perches for territorial males (Figure 3–19). Absence of residual trees is correlated with low male densities and poor mating success.

A minimum of five to six large residual canopy trees should be retained per acre (12-14 trees/ha) with at least four (10 trees/ha) of these being hardwood species (Figure 3–18). This equates roughly to a minimum of 5 ft^2/ac (1 m^2/ha) basal area of residual trees with at least 3 ft^2/ac (0.6 m^2/ha) as hardwoods. Mean diameter at breast height (DBH) for residual trees varied between 8–13 in (20–33 cm), and a maximum of 38 in (97 cm) was recorded. Residual basal areas

Figure 3–17. This newly harvested aspen forest has a moderate density of residual canopy trees with a high proportion of hardwoods (northern red oaks) dispersed throughout the stand. In a couple years, when the understory has regrown, this site should provide excellent nesting habitat for Golden-winged Warblers. Photo by Laurie Smaglick Johnson.

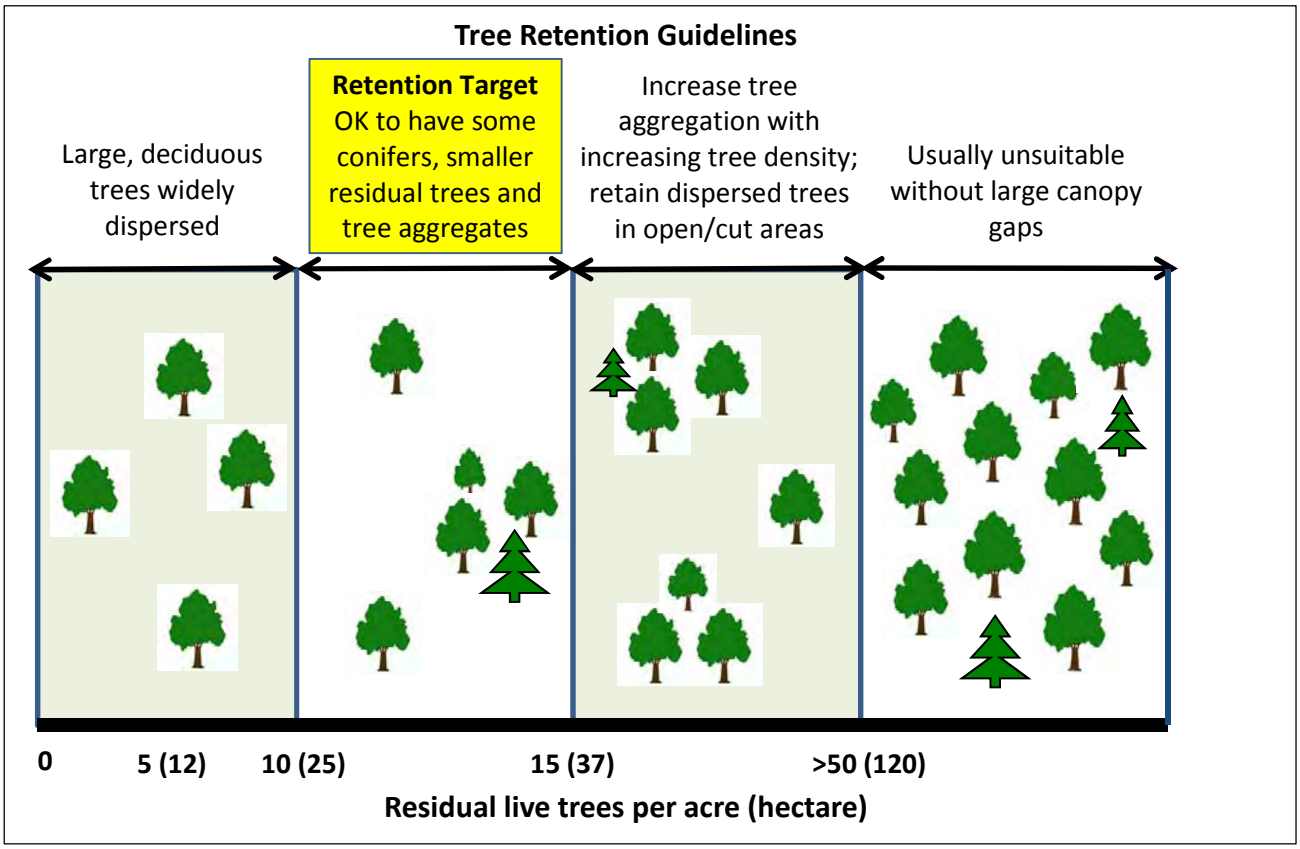


Figure 3–18. Harvest of a forest stand to generate Golden-winged Warbler breeding habitat must take into consideration the size and shape of the harvest area and canopy tree retention options. If retention is not desirable or when there are no canopy trees to retain, then harvest areas should be relatively small (5–10 ac (2–4 ha)) with irregular edges. Adjacent older forest will be used as song perches and to define territory boundaries. If retention is possible, the recommended target is 10–15 trees/ac (25–37 trees/ha). At low retention levels (<10 trees/ac (<25 trees/ha)), a dispersed pattern of retention is important. At or above the retention target level, harvest areas should be relatively large (>25 ac (>10 ha)) and minimize edge; retained trees should be increasingly aggregated as retained tree density increases. At all retention densities, at least 4 trees/ac (10 trees/ha) should be large deciduous trees.

*Figure 3–19. Silvicultural practices such as clearcutting with retention of snags and live cavity trees in clearcuts will benefit high priority cavity nesters such as Northern Flicker (*Colaptes auratus*) and Yellow-bellied Sapsucker (*Sphyrapicus varius*). Golden-winged Warbler will also use snags for song perches. Photo by Laurie Smaglick Johnson.*

up to 47 ft^2/ac (10.8m^2/ha) attracted high densities of males. In Minnesota, Huffman et al. (1997) recommended a residual basal area of 20 ft^2/ac (4.6 m^2/ha) or approximately 20% residual canopy cover in aspen forest; at around 40 ft^2/ac (9.2 m^2/ha) or approximately 40% residual canopy cover.

Similarly, in Pennsylvania, Golden-winged Warblers were detected in stands with a residual basal area of 10–50 ft^2/ac (2.3–11.5 m^2/ha); hence Bakermans et al. (2011) recommended retaining 10–15 residual trees per acre (25–37/ha). Large-diameter residual trees (> 9 in (23 cm) DBH) are preferred over smaller trees. Timber stands in Pennsylvania with Golden-winged Warblers had the following size class distribution of residuals: 42% were > 15 in (38 cm) DBH, 39% and 19% were 4–9 in (10–23 cm) DBH. If no large-diameter trees are present, retain trees that have the

potential to become large-diameter in future rotations or retain clusters of small trees to provide some structural diversity. For basal areas less than 10 ft^2/ac (2.3 m^2/ha), residual trees should be dispersed throughout the stand or retained in clumps embedded within the harvest. At basal areas >35 ft^2/ac (8.0 m^2/ha), up to half of the residual trees should be spatially aggregated in patches and the remainder dispersed throughout the stand.

In the Appalachians, use of timber harvesting followed by burning extends the habitat availability of forest stands for Golden-winged Warblers by sustaining herbaceous cover (Brose and Van Lear 1998). This practice has been used in the Midwest to promote Sharp-tailed Grouse habitat, particularly in diverse barrens (a combination of herbaceous prairie and brush prairie with 30–60% woody cover) that attract low densities of Golden-winged Warbler (Mossman et al. 1991). When these areas are burned on longer rotations, succession leads to more woody vegetation dominated by aspen, oak, and jack pine and an associated increase in Golden-winged Warbler abundance.

Figure 3—20. This area was mechanically treated in Bald Eagle State Park, Pennsylvania to create breeding habitat for Golden-winged Warbler and American Woodcock. Note residual canopy trees and clumpiness of uncut saplings and shrubs. Photo by Jeffrey Larkin.

Mechanical Clearing

Mowing and brush-hogging during the non-breeding period is another method to reduce woody growth to maintain Golden-winged Warbler habitat. Cutting of woody brush stems; however, tends to stimulate woody re-growth from the established roots, which may limit the subsequent period of habitat availability. Following the cutting with a selective herbicide application will often be necessary to reduce re-sprouting. Cutting should be conducted in patches to maintain the patchy woody structure that Golden-winged Warblers prefer. Cuttings in Minnesota brushlands may reduce quality of breeding habitat for at least three years relative to unmanaged areas though no mention was made about the size and configuration of the cut areas (Hanowski et al. 1999). Thus, where the effect of mechanical cutting is not well understood, it is advised to incrementally increase the ratio of brush cleared and to evaluate Golden-winged Warbler response at each cutting interval. Residual canopy trees or clusters of shrubs and saplings should be retained when present (Figure 3—20). On wet sites and sensitive soils, heavy equipment should be used only when the ground is frozen.

Mechanical cutting is generally a non-commercial treatment though the number of bioenergy and biofuel plants capable of utilizing woody biomass is increasing such that this may be a commercially viable option in some regions. Mowing may also be necessary to reduce vegetation height in shrubland habitats where fire has been excluded (Figure 3—21). Mechanically lowering this vegetative fuel load may allow managers to reintroduce fire as a disturbance factor in Golden-winged Warbler habitats.

Figure 3—21. Mechanical clearing or "brush-hogging" can diversify structure, as shown just following management in the top photo and after two growing seasons in the bottom photo. Golden-winged Warbler often don't respond positively to this type of management for two to three growing years until the vegetation has recovered. Photos by Top Photo—Cathy Johnson, Bottom Photo—Kyle Aldinger.

Prescribed Burning

Fire has played an important role in creating and maintaining habitat for Golden-winged Warbler across many parts of its range. Over the past five decades; however, fire suppression has resulted in widespread forest succession and loss of early-successional habitats. In the absence of wildfires, prescribed burns are the likely management tool for both creating and maintaining Golden-winged Warbler habitat today, particularly in upland sites. For example, experimental burns conducted in 2003 appear to have created and maintained suitable habitat that has enabled a population of Golden-winged Warblers to persist and expand in Georgia. The breeding population increased from three territories in 2002 to 12 territories in 2003 (N. Klaus, GA DNR, pers. comm.). Prescribed burning in Tennessee on reclaimed surface mine sites demonstrated that fire is an effective management tool for restoring Golden-winged Warbler habitat on overgrown mine sites, with breeding pairs increasing from 5 to 25 pairs with repeated burns over 5 years (Figure 3–22 and 3–23, David Buehler, unpubl. data).

Figure 3–22. Prescribed burn on a reclaimed mine site in Tennessee. Photo by Kelly Caruso.

Importance of Burns

Allowing natural disturbance or mimicking the natural disturbance regime can increase suitable ephemeral sites for a host of species. For example, forested sites burned by wildfires or prescribed burning have attracted Kirtland's Warbler (*Setophaga kirtlandii*), Spruce Grouse (*Falcipennis Canadensis*), Black-backed Woodpecker (*Picoides arcticus*), and Golden-winged Warbler. Fire-created structures such as "stringers", or lines of unburned live residual trees, may be important for attracting species dependent on residual trees in regenerating forests such as Golden-winged Warbler (Kashian et. al 2012). Fire-killed trees will attract nesting and foraging woodpeckers, most notably Black-backed Woodpecker in the northern Great Lakes.

The frequency of burning required to maintain Golden-winged Warbler habitat varies by community type and location. Based on research in the southern Appalachians, an initial burn cycle of two to four years is necessary for restoring herbaceous cover and suppressing woody growth. Once the desired herbaceous cover is in place, a less frequent burn cycle (five to ten years) may be sufficient to maintain Golden-winged habitat (N. Klaus, GA DNR, pers. comm.). In areas where woody growth and development are slower, longer burn cycles may be used from the onset. In Minnesota brushlands, Golden-winged Warblers preferred to nest in unmanaged areas than in zero to three-year-old burned areas, thus longer burn cycles are likely needed in this vegetation community and location (Hanowski et al. 1999).

Burn intensity and timing will depend on whether you need to promote or suppress woody vegetation growth. Late-summer (late August-September) or fall burns may be more intense and most effective at suppressing woody growth, thus prolonging suitability of Golden-winged Warbler habitat, while having the least effect on

annual reproduction (Brose and Van Lear 1998). However, if herbaceous cover is abundant and woody vegetation is scarce but you need to control invasive plants, a spring burn prior to the nesting season might be preferred. Some habitat objectives can only be met with prescribed burns that occur during the spring growing season (i.e., invasive plants control, promoting oak regeneration) (see Sidebar on Incidental Take, page 3–20). Spring burning; however, will likely reduce nesting in the burned area for that breeding season (K. Percy and D. Buehler, unpubl. data).

Frequency of burning should be dictated by desired vegetation response, and fire intensity should be used to control vegetation as desired. Fire return interval (i.e. burning regime) will determine the composition and structure of the subsequent plant community. Annual prescribed fire has a tendency to shift the plant community to a more grass-forb-dominated composition, whereas a two- to three-year burning regime generally will yield an herbaceous community with scattered shrubs and saplings. A three- to four-year burning regime will create a mixed grass and forb community with a substantial shrub-sapling component; burning regimes beyond a four year interval typically allow an area to quickly become encroached by mid- and over-story canopy trees. Though Frost (1995) recommended a return interval of 7–25 years, in many cases, an intermediate return interval (7–12 year) may provide the appropriate mix of structural characteristics for nesting habitat. The optimal return interval will ultimately depend on the vegetation response and the rate of woody plant invasion and growth that will need to be evaluated on a site-by-site basis.

Figure 3–23. This reclaimed mine site in Tennessee was previously burned resulting in maintenance of Golden-winged Warbler nesting habitat. Photo by Katie Percy.

Grazing

Grazing can maintain pastures and old fields, in an early-successional condition suitable for Golden-winged Warblers by reducing growth of woody vegetation (Figure 3–24). In the Appalachians, graze one animal unit/5–10 ac (2–4 ha) during the growing season. Greater intensity grazing (up to one animal unit per acre) is acceptable during the summer for short periods of time (i.e., less than two months). On high elevation sites, winter and early spring grazing can help set-back woody vegetation.

Figure 3–24. As this West Virginia site demonstrates, moderate to light cattle grazing can help maintain Golden-winged Warbler habitat. Photo by Kyle Aldinger.

Figure 3–25. American Woodcock are frequently associated with Golden-winged Warbler breeding habitat. Photo by Eric Dresser.

Herbicide Application

Herbicides that selectively target woody plant growth can be used effectively, especially in combination with other management tools, such as fire, grazing, or mowing to retard plant succession and prolong the period of habitat suitability for Golden-winged Warblers. Chemicals should be target specific and applied by a certified applicator (where required). When working in or near surface water or wetlands, use only chemicals appropriate for aquatic systems.

Managing Shrub Wetlands

Harvesting wetland or upland shrubs as patches perpendicular to open water is commonly used to improve feeding habitat for American Woodcock (Figure 3–25). Strips should be 50–100 ft (15–30 m) wide and cross a moisture gradient when possible; this is important for providing good woodcock foraging conditions through wet and dry weather cycles. Strips or patches should be cut every 20 years with 25% of the area rotationally harvested every five years.

Modifications for Golden-winged Warbler – If strip mowing is used, periodic clumps of shrubs and scattered trees should be retained in each strip. In all cases, edges should be irregular.

For more information on American Woodcock ecology and habitat management guidelines, visit www.timberdoodle.org/

Other Habitat Management Considerations

Invasive plant prevention and management

Anytime habitat is manipulated, especially when using heavy machinery, there is a risk of introducing and spreading exotic, invasive plant species. Prior to management action, target sites should be surveyed for problematic species. When working in an area where invasive species are present, special actions may be necessary and clearly outlined in a management plan. Consultation with an invasive species control expert is advised. Targeted removal of invasive plants by mechanical and/or chemical means may be necessary immediately before and/or after management actions are implemented. Equipment should be cleaned before moving it from one site to another. Winter cutting can reduce spread of these species and the likelihood of mud and seeds sticking to the equipment. In highly degraded sites infested with Phragmites or other invasive plants, we recommend following the guidelines that have been developed for restoration of bog turtle (*Glyptemys muhlenbergii*) habitat by conservation organizations and state agencies. In the northeastern US, Golden-winged Warbler and bog turtles sometimes co-occur in swamp and shrubland habitats, thus these guidelines may also be useful for Golden-winged Warbler habitat restoration though they have not been evaluated specifically for this application (Figure 3–26). The guidelines provide sound information on using grazing to manage habitat in wetland situations.

A stocking density of 0.75 animal units per acre of open habitat is recommended, though 1 animal unit can be used for control of woody invasive species (Tesauro 2006). This equates to 5–10 mature sheep or goats per acre. Duration of grazing should not exceed 5 consecutive months for 1–5 years (Tesauro 2006). Given that this is a

Figure 3–26. Goats (left photo) are one option for controlling Phragmites or other invasive plants in Golden-winged Warbler habitat. Though this technique is untested in Golden-winged Warbler habitat, it has been effective for bog turtle habitat restoration as pictured before (top right) and after (bottom right) grazing on this transmission line right-of-way in New Jersey. The bottom right photo depicts the habitat improvement after two years of grazing treatments. Photos by Jason Tesauro.

higher rate of grazing pressure than we recommend for upland habitat maintenance, care should be taken to monitor effects of grazers on vegetation such that suitable habitat is generated for Golden-winged Warblers. If the goal is herbaceous plant control with minimal effect on shrubs, then sheep are preferred. If shrub control is also needed, then goats or a mix of sheep and goats is preferred. Guidelines for other restoration techniques such as chemical application, mechanical removal, and prescribed burning are also available. Information on these techniques as applied to bog turtle habitat restoration can be obtained by contacting the US Fish & Wildlife Service Northeastern Regional Office in Hadley, Massachusetts, www.fws.gov/northeast/ma/ro.html.

Cowbird parasitism

Landscape context is important to consider when planning and performing habitat management for Golden-winged Warblers. Cowbird parasitism is likely to be a problem in agricultural landscapes or where forested sites are within 5 km of agricultural areas (Figure 3–27). Cowbird parasitism tends to not have a population effect in forested landscapes.

Figure 3–27. This Golden-winged Warbler nest in Wisconsin contains two Golden-winged Warbler eggs and one Brown-headed Cowbird (Molothrus ater) egg (the largest of the three). The female Golden-winged Warbler abandoned this nest after the cowbird egg was laid. Photo by Amber Roth.

Part II: Reference Guide to Focal Areas

This section provides detailed information on each of the 34 focal areas in the two conservation regions. For ecological relevance and ease of discussion, similar focal areas were grouped by using a principal components analysis to form subregions (see Appendix C).

A set of 12 independent variables was initially identified as significant predictors of Golden-winged Warbler habitat selection at the 0.6 mi (1 km) scale. A principal components analysis was conducted to examine how variation among the independent variables was distributed among focal areas. Results demonstrated that > 92% of the variation was explained by elevation, percent forest cover, forest height, and forest type (deciduous versus coniferous). The principal components analysis reduced the 34 focal areas to 11 ecologically distinct subregions (Figures 3–28 and 3–39).

The Appalachian Conservation Region

The Appalachian Mountains Conservation Region is divided into five subregions, containing one or more focal areas each.

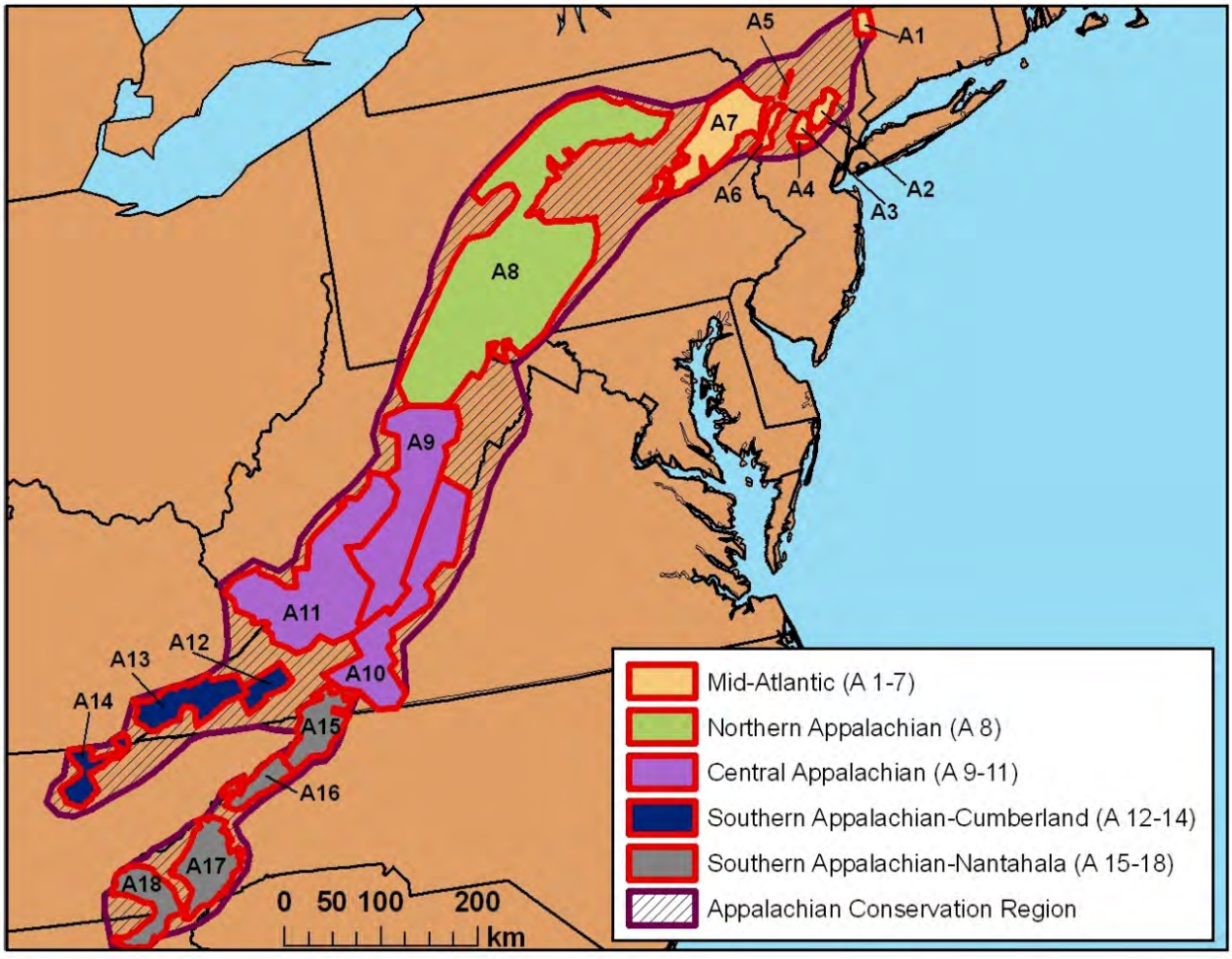


Figure 3–28. Golden-winged Warbler subregions and focal areas in the Appalachian Mountains Conservation Region.

Mid-Atlantic Subregion (Focal areas A1–A7; Figures 3–29 and 3–30; Table 3–5)

General Description

The focal areas in this subregion support approximately 13% of the region's (and 0.7% of the world's) Golden-winged Warblers. This subregion has a couple of large populations and several small, remnant populations. Managed successional forests and scrub barrens are the primary habitats in the Poconos where 51% of surveyed timber harvests had Golden-winged Warbler present. The largest, estimated Golden-winged Warbler population occurs in the Hudson Highlands, which supports mixed populations of Golden-winged and Blue-winged warblers in abandoned fields and shrub-swamp, and nearly pure Golden-winged Warbler populations in hardwood swamp forests where reproductive success is particularly high and elevations relatively low. The hardwood swamp forests of the Hudson Highlands provide habitat segregation between Golden-winged Warblers and Blue-winged Warblers at elevations below 1300 ft (400 m). The swamp forests that support Golden-winged Warblers have 30-70% canopy cover with extensive understory. Control of the invasive plant Phragmites is necessary to sustain Golden-winged Warbler populations in the hardwood swamps (Confer et al. 2010).

Macro Landscape Context (within 1.5 mi (2.5 km) of management site)

Golden-winged Warblers are generally associated with landscapes containing:

- Elevations that range from 750–1180 ft (230–360 m), but habitat management in uplands should be above 1300 ft (400 m) to exclude Blue-winged Warblers. Presence of Golden-winged Warbler in hardwood swamp forests of Hudson Highlands seems to be unrelated to elevation.
- Forests that are 33–82 ft (10–25 m) in height (i.e. large sapling to small sawtimber sized trees).
- A relatively open forest canopy, more so than in other subregions (except in Hudson Highlands).
- Relatively high coniferous forest cover (14–25%) with a ratio of 70:30 deciduous:coniferous trees in the landscape (expect nearly pure deciduous forest in Hudson Highlands).

Micro Landscape Context (within 0.15 mi (0.25 km) of management site)

Sites where Golden-winged Warblers are found generally:

- Have a lower ratio of deciduous:coniferous trees (85:15) relative to the central and southern Appalachians (expect hardwood swamps of Hudson Highlands, which are 100% deciduous).
- Have less herbaceous cover (32%) than elsewhere in region (40%).
- Contain the following primary land cover types: deciduous forest (45%); woody wetlands (11%); mixed forest (5%). Blue-winged Warblers have similar occurrence in all land cover types except hardwood swamps of Hudson Highlands.

*Table 3–5. Population and habitat goals for focal areas in the Mid-Atlantic subregion.**

Focal Area Map ID	Focal Area Name	Estimated Population for 2010 (individuals)	Population Goal for 2050 (individuals)	Estimated Breeding Habitat for 2010 in acres (ha)	Breeding Habitat Goal for 2050 in acres (ha)
A1	Northwest Connecticut	8	16	40 (16)	80 (32)
A2	Hudson Highlands	1500	3000	7500 (3040)	15,000 (6100)
A3	Newark Watershed/ Wawayanda	40	80	200 (80)	400 (160)
A4	Picatinny/Sparta/Wildcat	8	16	40 (16)	80 (32)
A5	Bashakill	14	28	70 (28)	140 (57)
A6	Delaware Water Gap	26	52	130 (53)	260 (105)
A7	Pennsylvania Poconos	1250	2500	6250 (2530)	12,500 (5060)

**Population estimates are based on expert knowledge and Golden-winged Warbler Atlas Project data.*

Potential Partners and Priority Sites

National/Regional – Appalachian Mountains Joint Venture, Atlantic Coast Joint Venture, National Park Service (Delaware Water Gap National Recreational Area), Natural Resources Conservation Service, Palisades Interstate Park Commission, US Department of Defense (Picatinny Arsenal, West Point), US Fish and Wildlife Service (Migratory Bird Program, Partners for Fish and Wildlife, Wallkill River National Wildlife Refuge)

State – Connecticut Department of Energy and Environmental Protection, Morris County Park Commission (NJ), New Jersey Department of Environmental Protection-Division of Fish and Wildlife (Bureau of Land Management), New Jersey Department of Environmental Protection-Division of Parks and Forestry (High Point State Park, Stokes State Forest), New Jersey Highlands Council, New York Natural Heritage Program, New York State Office of Parks, Recreation and Historic Preservation (Sterling Forest State Park), Newark Watershed Conservation and Development Corporation (NJ), Pennsylvania Department of Conservation and Natural Resources-Bureau of Forestry (Delaware State Forest), Pennsylvania Game Commission, East Stroudsburg University, Indiana University of Pennsylvania, Cornell Cooperative Extension, University of Connecticut Cooperative Extension System, Penn State Cooperative Extension, Rutgers Cooperative Extension, county conservation districts

NGOs – Appalachian Fire Learning Network, Audubon, Audubon New York, Audubon Pennsylvania, Black Rock Forest Consortium, Conserve Wildlife Foundation of New Jersey, Cornell Lab of Ornithology, Hawk Mountain Sanctuary, Highlands Environmental Research Institute, land trusts (Orange County Land Trust, Ridge and Valley Conservancy), native plant societies, local forest owners associations (contact extension service for information), The Nature Conservancy, New Jersey Audubon, New Jersey Conservation Foundation, The New York-New Jersey Trail Conference, Pennsylvania Forestry Association, Pennsylvania Society for Ornithology, Sterling Forest Partnership, Wildlife Management Institute, Quality Deer Management Association, Ruffed Grouse Society, Wild Turkey Federation, Woodcock Limited of Pennsylvania

Industry – Jersey Central Power & Light, Public Service Electric & Gas, The Wagner Companies, Pike County Light & Power Company, Pennsylvania Power & Light, UGI Utilities Inc.

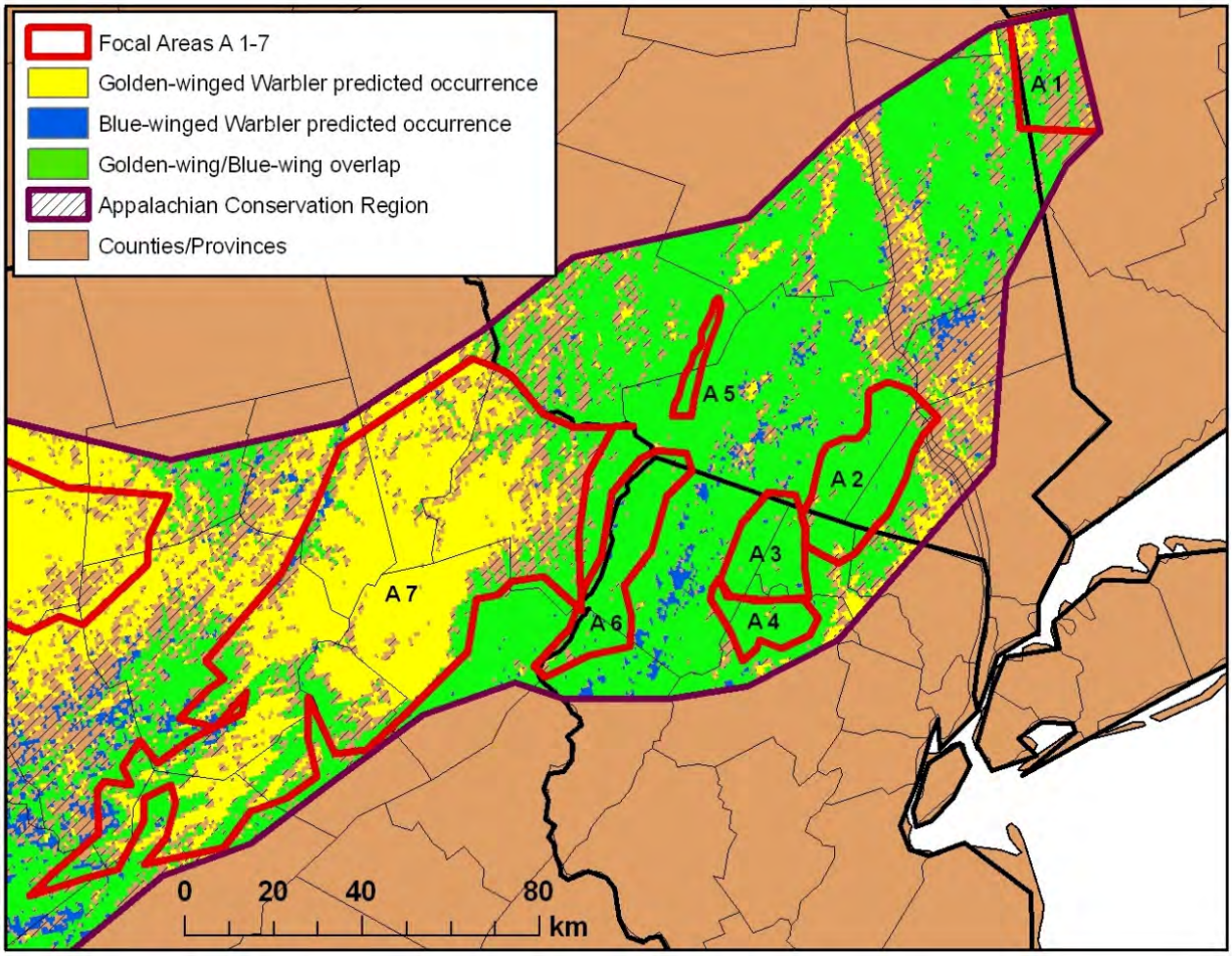


Figure 3–29. Model results showing the current predicted distribution of Golden-winged and Blue-winged warbler in Mid-Atlantic. Locations inside focal areas and without Blue-winged Warbler should receive highest priority for conservation and management actions.

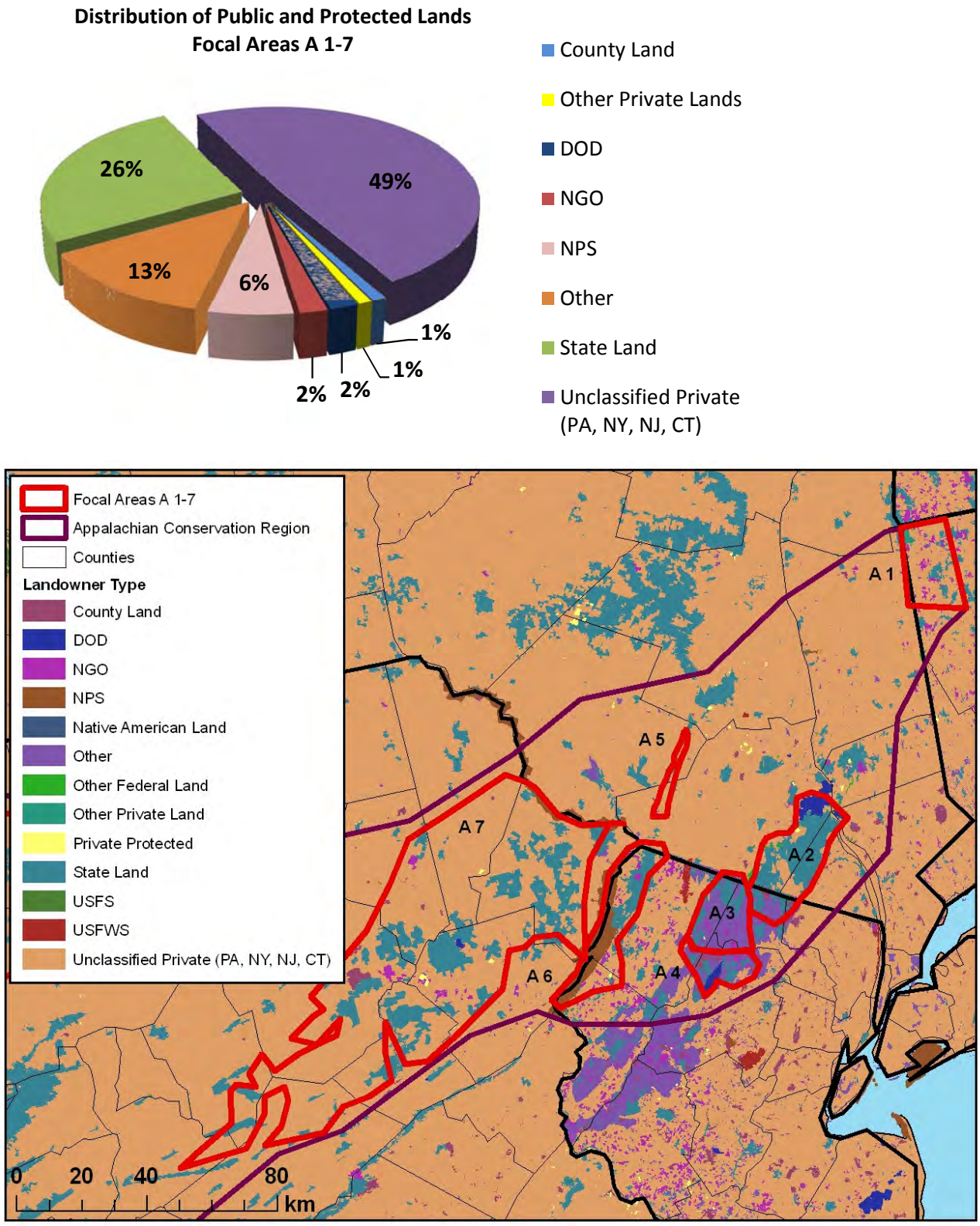


Figure 3–30. Percentage of landowner types and spatial layout of public and protected areas in the Mid-Atlantic focal areas (USGS Protected Areas Database of the USA, version 1.2, www.protectedlands.net/padus/).

Northern Appalachian Subregion (Focal Area A8; Figures 3–31 and 3–32; Table 3–6)

General Description

This subregion supports approximately 27% of the region's (and 1% of the world's) Golden-winged Warblers. The primary habitats in this area are managed successional forest, abandoned farmland, scrub barrens, utility rights-of-way, and reclaimed surface mines. Major threats in this area are lack of active timber harvesting, energy extraction, and Blue-winged Warbler encroachment. With appropriate site-scale reclamation, energy extraction may also create additional Golden-winged Warbler habitat.

Macro Landscape Context (within 1.5 mi (2.5 km) of management site):

Golden-winged Warblers are generally associated with landscapes containing:

- Elevations ranging from 1200–2300 ft (370–700 m) but habitat management to exclude Blue-winged Warblers should be above 1575 ft (480 m).
- 60–95% forest cover that is widely dispersed and more open than in the southern Appalachians.
- Forests that are 33–82 ft (10–25 m) in height (i.e. large sapling to small sawtimber sized trees).
- The following land cover types: mixed deciduous-coniferous forests and open woodlands (e.g. savannah, pine and oak barrens, forest-grassland ecotones). Some Golden-winged Warblers are associated with upland red maple forests, an association not found elsewhere in the region.

Micro Landscape Context (within 0.15 mi (0.25 km) of management site)

Sites where Golden-winged Warblers are found generally:

- Have a slightly higher herbaceous cover (mean of 45%) than region-wide (mean of 40%).
- Have a lower ratio of deciduous:coniferous trees (85:15) relative to farther south.
- Contain the following primary land cover types: deciduous forest (46%); pasture-hay (12%); and evergreen and mixed forests (6%). Very few Golden-winged Warblers are associated with shrub-scrub or wetland habitats at this scale. Compared to Golden-winged Warblers, Blue-winged Warblers were more frequently associated with urban landscapes (11%, compared with 3% for Golden-winged Warbler).

*Table 3–6. Population and habitat goals for focal areas in the Northern Appalachian subregion.**

Focal Area Map ID	Focal Area Name	Estimated Population for 2010 (individuals)	Population Goal for 2050 (individuals)	Estimated Breeding Habitat for 2010 in acres (ha)	Breeding Habitat Goal for 2050 in acres (ha)
A8	Northern Appalachians	6000	12,000	30,000 (12,000)	60,000 (24,000)

**Population estimates are based on expert knowledge and Golden-winged Warbler Atlas Project data.*

Potential Partners and Priority Sites

National/Regional – Appalachian Mountains Joint Venture, US Army Corps of Engineers, USDA Forest Service (Northern Forest Research Station)

State – Maryland Department of Natural Resources, Pennsylvania Department of Conservation and Natural Resources: Bureau of Forestry (Buchanan, Elk, Forbes, Gallitzin, Loyalsock, Moshannon, Rothrock, Sproul, and Tiadaghton State Forests) and State Parks (Bald Eagle, Canoe Creek, and Ohiopyle State Parks), Pennsylvania Department of Environmental Protection (Ebensburg), Pennsylvania Game Commission, West Virginia Division of Natural Resources, Garrett College, University of Maryland Extension, Indiana University of Pennsylvania, Penn State Cooperative Extension, West Virginia University Extension Service, county conservation districts

NGOs – Appalachian Fire Learning Network, Audubon Pennsylvania, local bird clubs (State College and Three Rivers Birding Clubs), Maryland Ornithological Society, Mountaineer Audubon Society, The Nature Conservancy, Pennsylvania Society for Ornithology, Powdermill Avian Research Center, Western Pennsylvania Conservancy, Quality Deer Management Association, local forest owners associations (contact extension service for information), Ruffed Grouse Society, Woodcock Limited of Pennsylvania, Appalachian Mountain Young Forest Initiative (Wildlife Management Institute)

Industry – The Wagner Companies, Pennsylvania Power & Light, Peoples Natural Gas, Dominion, Equitable Gas, Columbia Gas of Pennsylvania, UGI Utilities Inc.

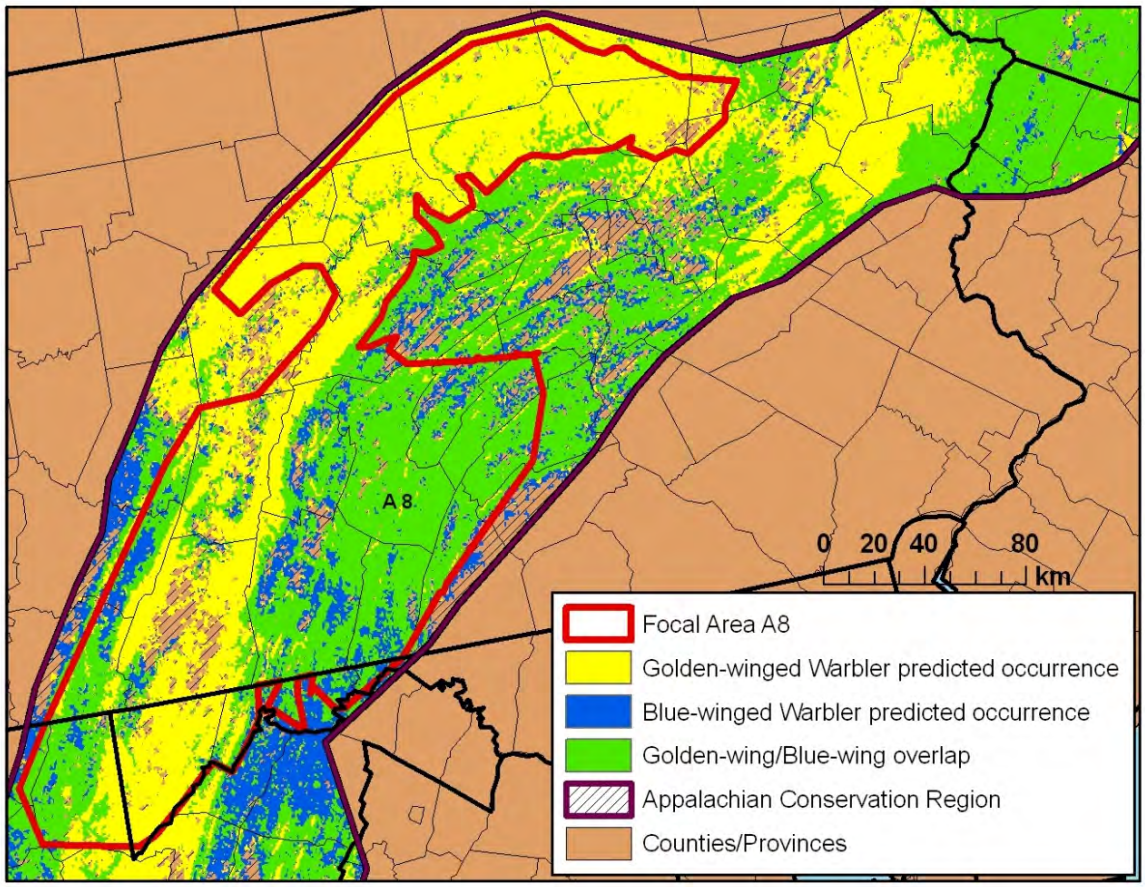
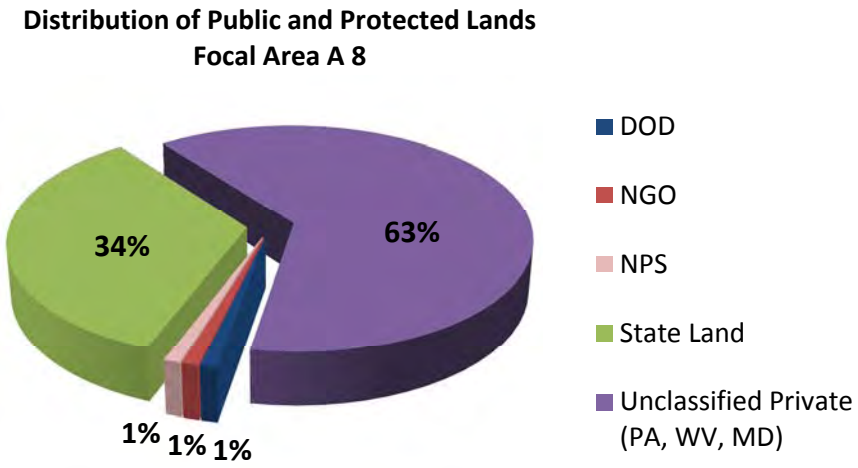


Figure 3–31. Model results showing the current predicted distribution of Golden-winged and Blue-winged warbler in Northern Appalachians. Locations inside focal areas and without Blue-winged Warbler should receive highest priority for conservation and management actions.



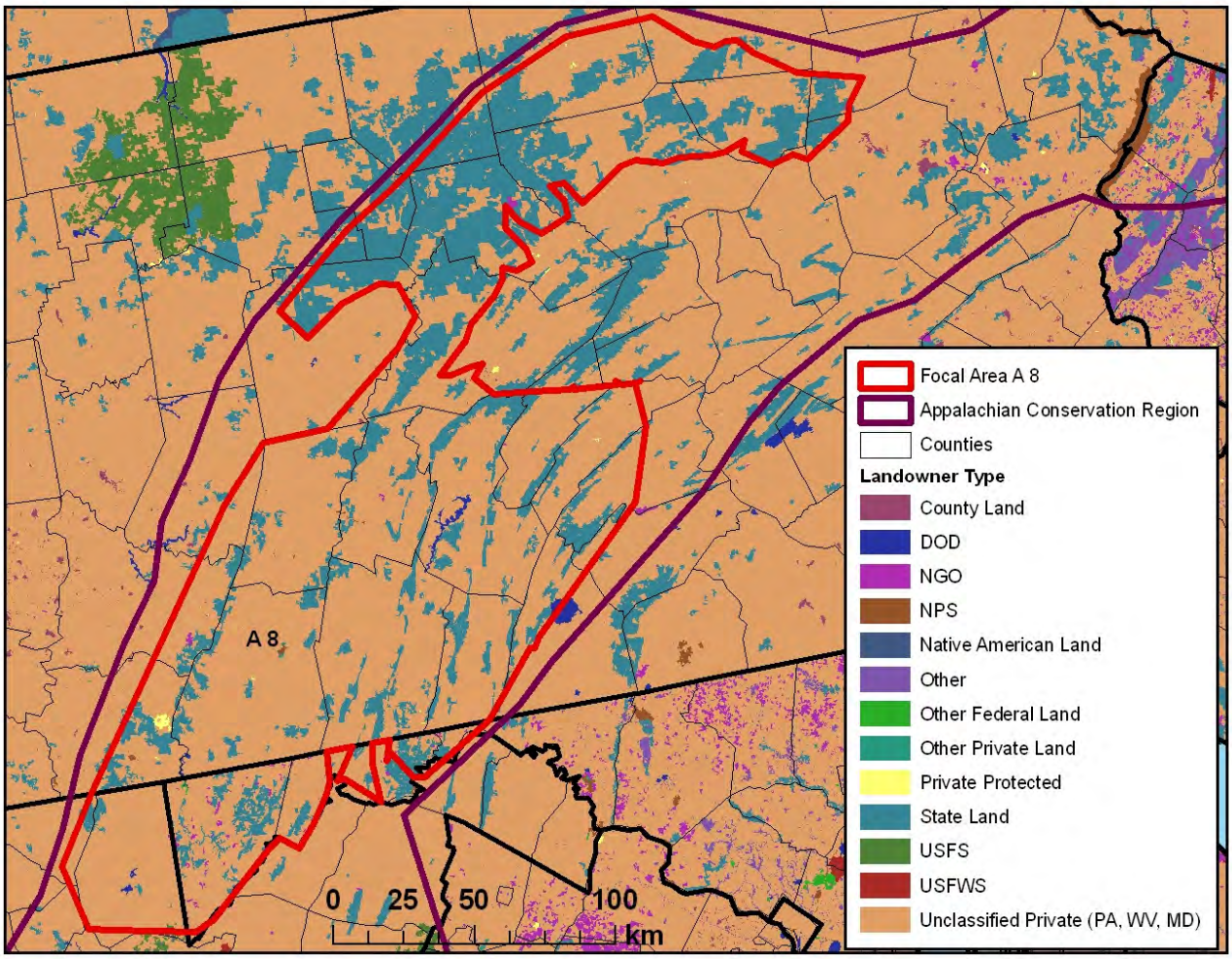


Figure 3–32. Percentage of landowner types and spatial layout of public and protected areas in the Northern Appalachian focal area (USGS Protected Areas Database of the USA, version 1.2, www.protectedlands.net/padus/).

Central Appalachian Subregion (Focal Areas A9–A11; Figures 3–33 and 3–34; Table 3–7)

General Description

The focal areas in this subregion support approximately 21% of the region's (and 1% of the world's) Golden-winged Warblers. The primary habitats for Golden-winged Warblers in these areas are abandoned contour mines and pasturelands in West Virginia, and abandoned farmland and pasturelands in Virginia. There is ample opportunity in this subregion to create Golden-winged Warbler habitat through forest management, management of pasturelands, and reforestation of minelands. Major threats in these areas are restricted access for monitoring, lack of timber management to create new habitat, Blue-winged Warbler encroachment, and succession and mountaintop mining of contour mines.

Macro Landscape Context (within 1.5 mi (2.5 km) of management site)

Golden-winged Warblers are generally associated with landscapes containing:

- Elevations ranging from 1975–2650 ft (600–800 m) but habitat management to exclude Blue-winged Warblers should be above 2035 ft (620 m).
- A higher ratio of deciduous trees in the landscape (90:10; deciduous:coniferous trees) than in the rest of the region.
- Forests that are 33–82 ft (10–25 m) in height (i.e. large sapling to small sawtimber sized trees).
- Sugar maple-beech-yellow birch and yellow poplar (sometimes with red oak) forests.

Micro Landscape Context (within 0.15 mi (0.25 km) of management site)

Sites where Golden-winged Warblers are found generally:

- Contain the following primary land cover types: deciduous forest (47%); pasture/hay (8%); and grassland/herbaceous (4%). Very few Golden-winged Warblers are in emergent wetlands and none are in woody wetlands. Blue-winged Warbler are more frequently associated grassland-herbaceous and evergreen and mixed forests and less in pasture-hay.

*Table 3–7. Population and habitat goals for focal areas in the Central Appalachian subregion.**

Focal Area Map ID	Focal Area Name	Estimated Population for 2010 (individuals)	Population Goal for 2050 (individuals)	Estimated Breeding Habitat for 2010 in acres (ha)	Breeding Habitat Goal for 2050 in acres (ha)
A9	Eastern West Virginia	2500	5000	12,500 (5060)	25,000 (10,100)
A10	Virginian Appalachians	600	1200	3000 (1200)	6000 (2400)
A11	Southern West Virginia	1500	3000	7500 (3040)	15,000 (6100)

**Population estimates are based on expert knowledge and Golden-winged Warbler Atlas Project data.*

Potential Partners and Priority Sites

National/Regional – Appalachian Mountains Joint Venture, Appalachian Regional Reforestation Initiative, National Park Service, Natural Resources Conservation Service, USDA Forest Service (George Washington and Jefferson National Forests, Monongahela National Forest), US Office of Surface Mining Reclamation and Enforcement

State – Virginia Department of Game and Inland Fisheries, , Virginia Department of Forestry, Virginia Department of Conservation and Recreation, West Virginia Division of Forestry, West Virginia Division of Natural Resources, Virginia Commonwealth University, Virginia Cooperative Extension, West Virginia University Extension Service

NGOs – Appalachian Fire Learning Network, local bird clubs (Bath-Highland Bird Club, Brooks Bird Club, New River Valley Bird Club), Canaan Valley Institute, local watershed groups, The Mountain Institute, The Nature Conservancy, private landowners, Virginia Important Bird Areas Program, Virginia Society of Ornithology, Ruffed Grouse Society, Wild Turkey Federation, Appalachian Mountain Young Forest Initiative (Wildlife Management Institute), local forest owners associations (contact extension service for information)

Industry – Equitable Gas, Nicholas Energy, Trinity Coal, Raw Coal Mining Inc., Columbia Gas of Virginia, Bluefield Gas Company, Appalachian Natural Gas Distribution Company

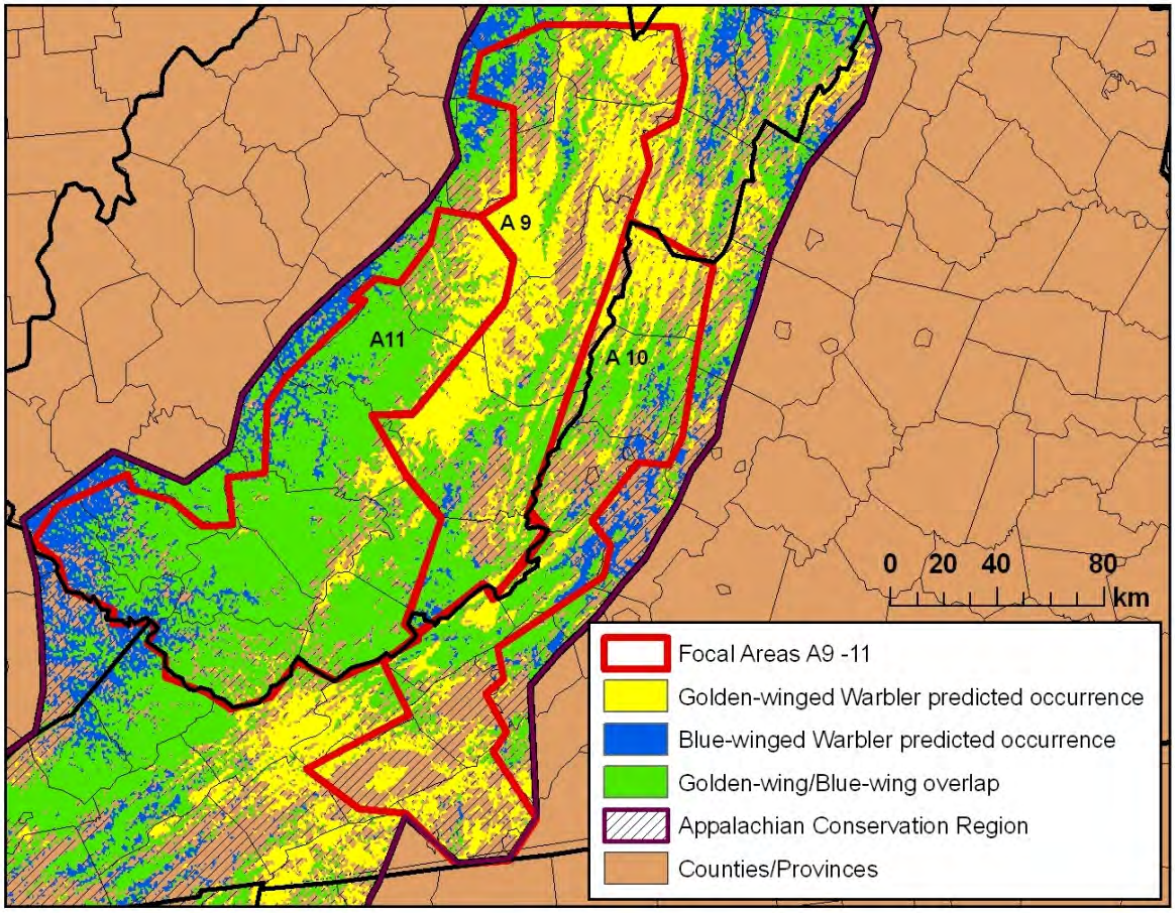
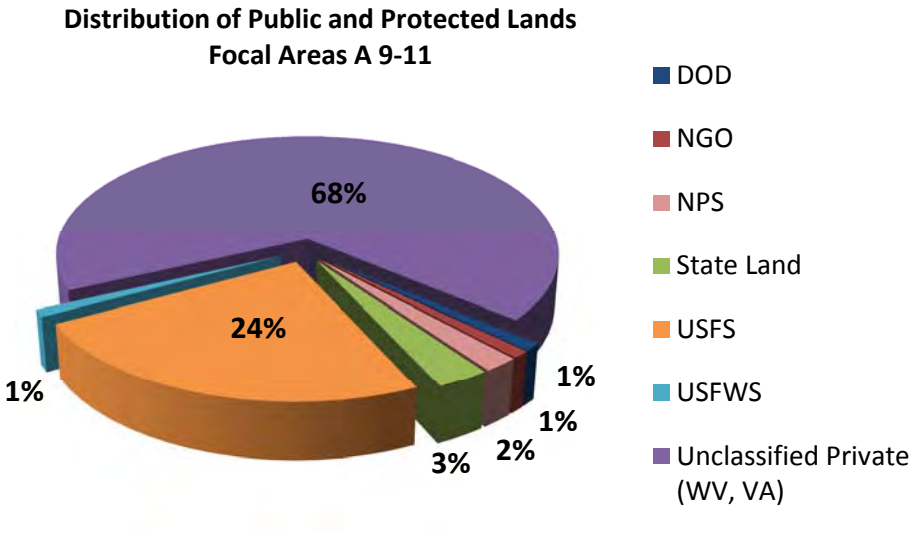


Figure 3–33. Model results showing the current predicted distribution of Golden-winged and Blue-winged warbler in Central Appalachians. Locations inside focal areas and without Blue-winged Warbler should receive highest priority for conservation and management actions.



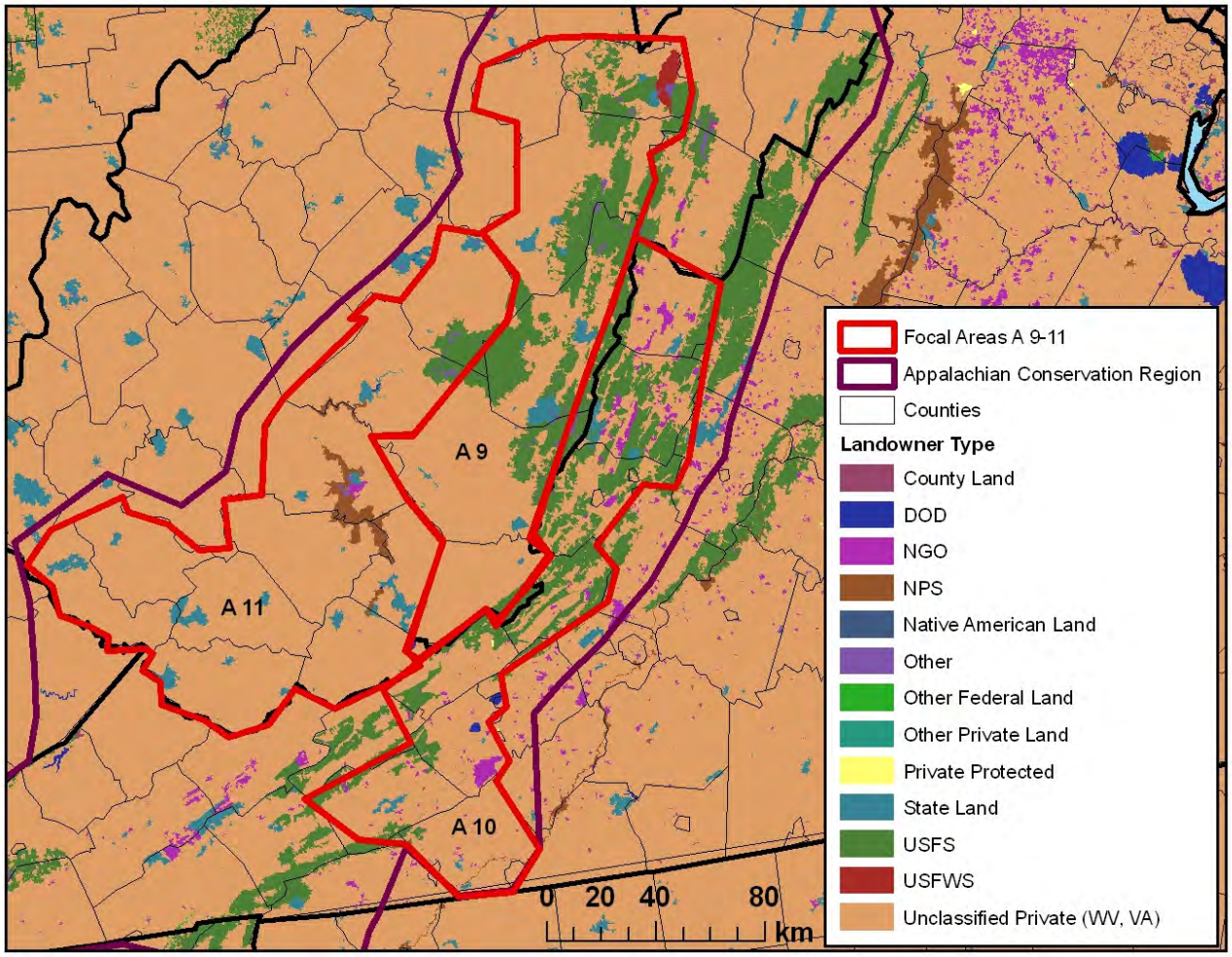


Figure 3–34. Percentage of landowner types and spatial layout of public and protected areas in the Central Appalachian focal areas (USGS Protected Areas Database of the USA, version 1.2, www.protectedlands.net/padus/).

Southern Appalachian-Cumberland Subregion (Focal Areas A12–A14; Figures 3–35 and 3–36; Table 3–8)

General Description

This subregion supports approximately 3% of the region's (and 0.1% of the world's) Golden-winged Warblers. The areas are characterized by small but often high-density local populations primarily on reclaimed surface mine sites. Significant management opportunities exist with forest management but require additional post-harvest treatments of prescribed burning and use of herbicides to control woody growth. Major threats in these areas are succession and the re-mining of previously-mined and abandoned surface mines.

Macro Landscape Context (within 1.5 mi (2.5 km) of management site)

Golden-winged Warblers are generally associated with landscapes containing:

- Elevations ranging from 1975–3000 ft (600–800 m) but habitat management to exclude Blue-winged Warblers should be above 2000 ft (620 m).
- A high proportion of contiguous forest (100% forest cover) which is unique to the southern Appalachians. In contrast, around 25% of Golden-winged Warblers are found in landscapes where herbaceous cover is between 70–90%.

Micro Landscape Context (within 0.15 mi (0.25 km) of management site)

Sites where Golden-winged Warblers are found generally:

- Contain the following primary land cover types: deciduous forest (48%), grassland-herbaceous cover (14%), and barren cover (8%). Barren cover is uniquely important in this subregion and may include glacial debris, surface mines, and gravel pits. Also the absence of wetland cover types is a notable difference for Golden-winged Warbler sites in this subregion as compared to elsewhere in the range.

*Table 3–8. Population and habitat goals for focal areas in the Southern Appalachian-Cumberland subregion.**

Focal Area Map ID	Focal Area Name	Estimated Population for 2010 (individuals)	Population Goal for 2050 (individuals)	Estimated Breeding Habitat for 2010 in acres (ha)	Breeding Habitat Goal for 2050 in acres (ha)
A12	Virginia Clinch Valley	100	200	500 (200)	1000 (400)
A13	Black and Little Black Mountains	120	240	600 (240)	1200 (490)
A14	Cumberland Mountains	370	740	1850 (750)	3700 (1500)

**Population estimates are based on expert knowledge and Golden-winged Warbler Atlas Project data.*

Potential Partners and Priority Sites

National/Regional – Appalachian Mountains Joint Venture, Natural Resources Conservation Service, USDA Forest Service (Jefferson National Forests: Clinch Ranger District), US Office of Surface Mining Reclamation and Enforcement

State – Kentucky Department of Fish and Wildlife Resources, Tennessee State Parks, Tennessee Wildlife Resources Agency, Virginia Department of Conservation and Recreation-Natural Heritage Program, Virginia Department of Game and Inland Fisheries, University of Kentucky, Kentucky Cooperative Extension Service, University of Tennessee, University of Tennessee Extension, Virginia Cooperative Extension, Virginia Commonwealth University, Virginia Tech, Indiana University of Pennsylvania

NGOs – Appalachian Fire Learning Network, local bird clubs (e.g. Russell County Bird Club), The Nature Conservancy, private landowners, Virginia Society of Ornithology, Tennessee Ornithological Society, Ruffed Grouse Society, Wild Turkey Federation, local forest owners associations (contact extension service for information), Wildlife Management Institute, The Nature Conservancy, Bristol Bird Club, New River Valley Bird Club, Virginia Audubon Important Bird Areas Program

Industry – coal companies, Lyme Timber Company, Fountain Forestry, state surface mining (KY)

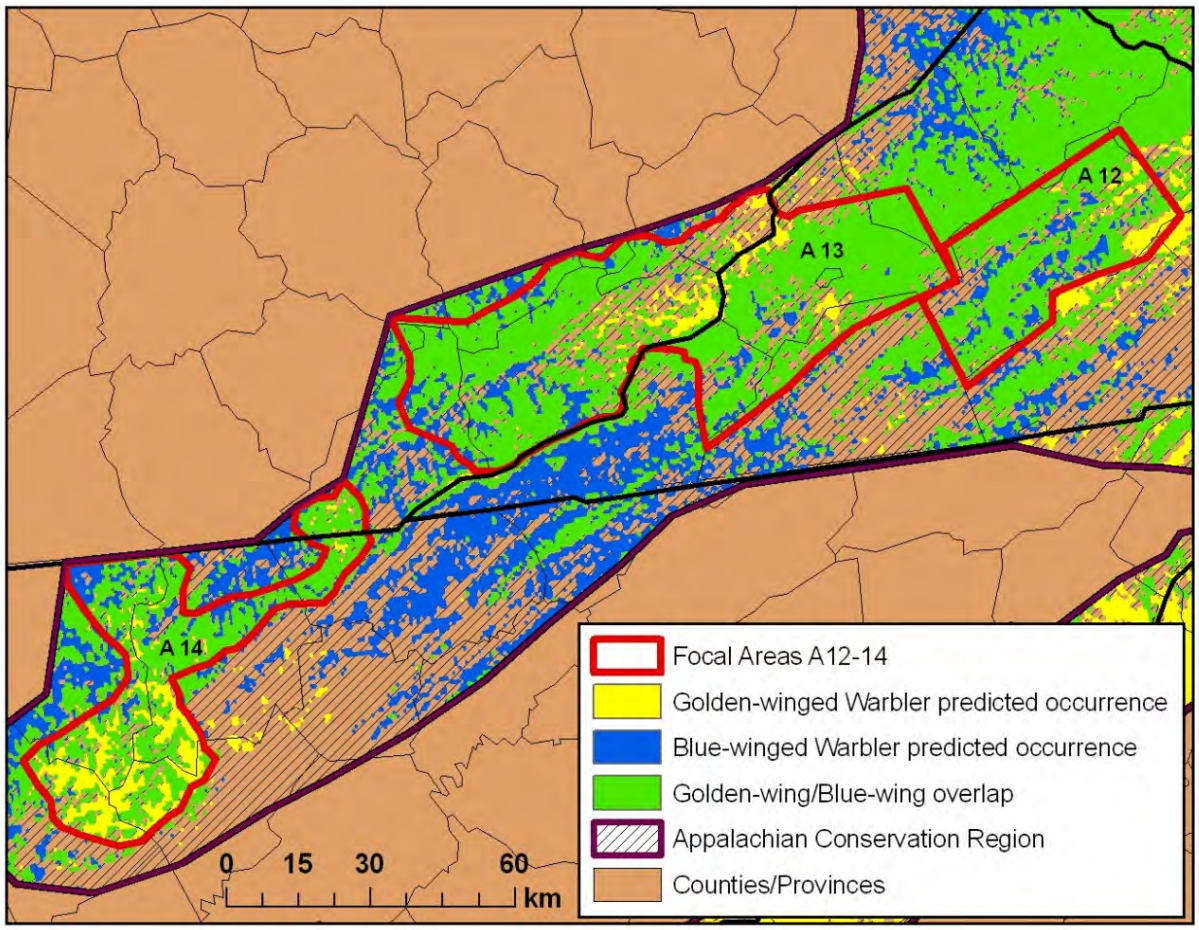
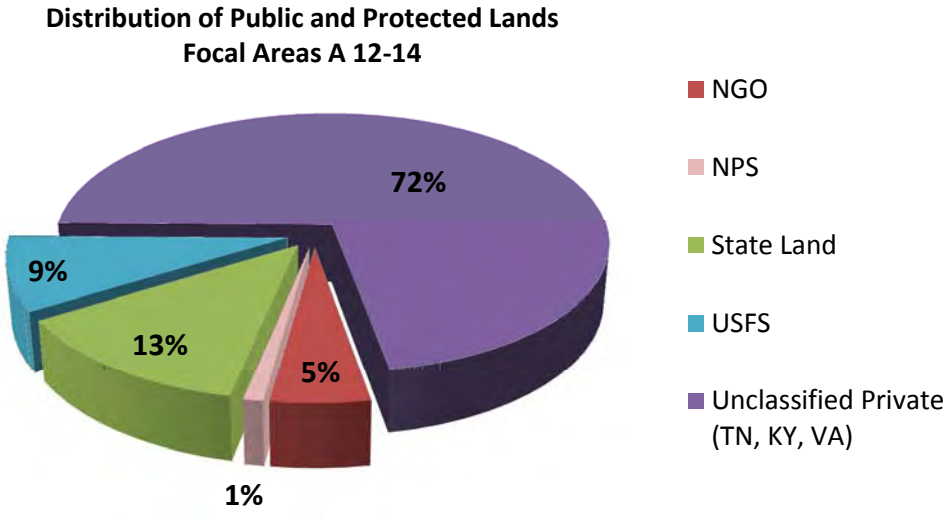


Figure 3–35. Model results showing the current predicted distribution of Golden-winged and Blue-winged warbler in Southern Appalachians–Cumberlands, Locations inside focal areas and without Blue-winged Warbler should receive highest priority for conservation and management actions.



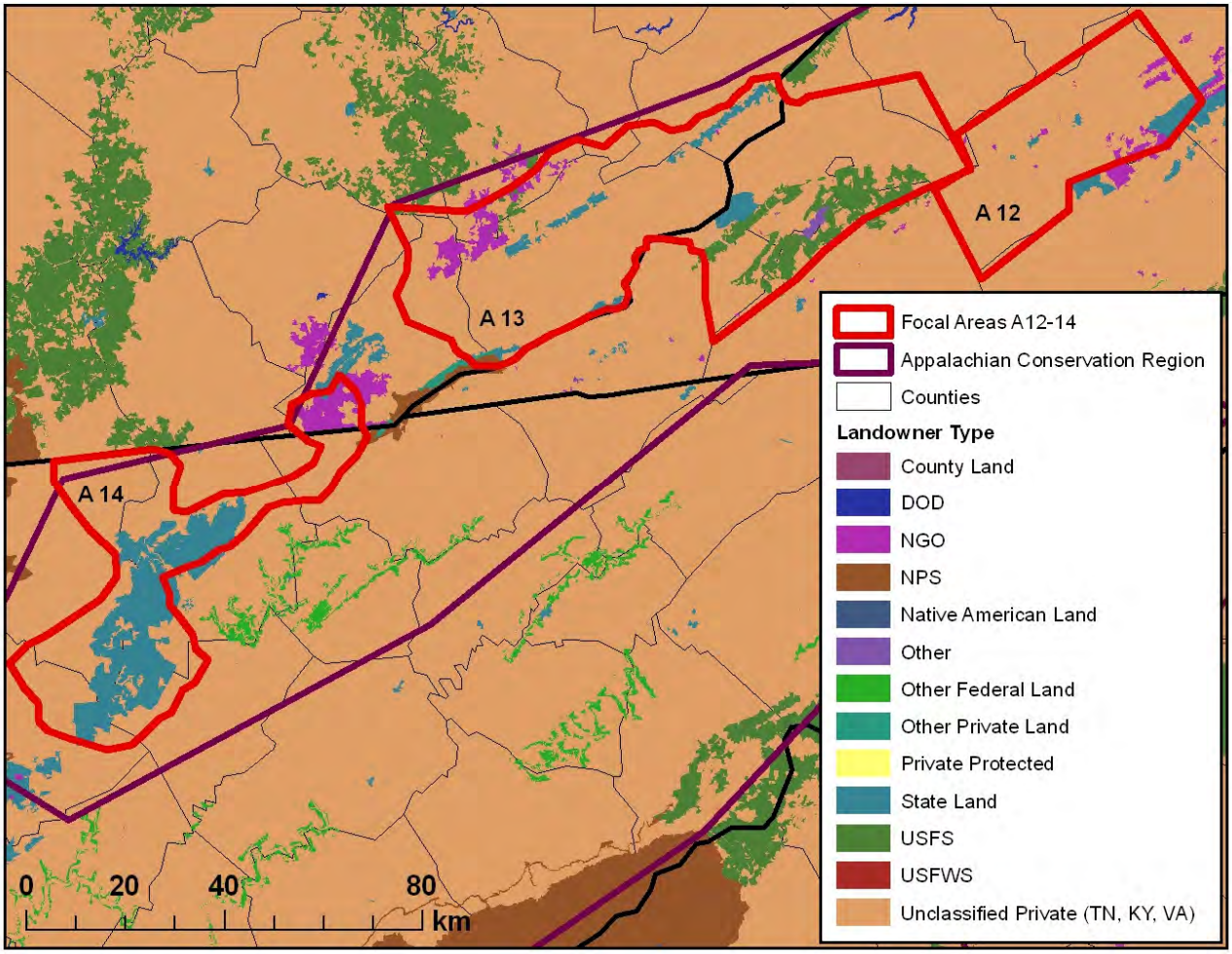


Figure 3–36. Percentage of landowner types and spatial layout of public and protected areas in the Southern Appalachian-Cumberland focal areas (USGS Protected Areas Database of the USA, version 1.2, www.protectedlands.net/padus/).

Southern Appalachian-Nantahala Subregion (Focal Areas A15–A18; Figures 3–37 and 3–38; Table 3—9)

General Description

This subregion supports approximately 5% of the region's (and 0.2% of the world's) Golden-winged Warblers. The focal areas are characterized by small but often high-density local populations frequently found in upland successional forests and on grazing lands. Major threats in these areas are succession, development, and reduced cutting of timber.

Macro Landscape Context (within 1.5 mi (2.5 km) of management site)

Golden-winged Warblers are generally associated with landscapes containing:

- Elevations ranging from 2800–4600 ft (850–1100 m) and habitat management at these elevations should exclude Blue-winged Warblers.
- A high proportion of contiguous forest (100% forest cover), which is unique to the southern Appalachians.

Micro Landscape Context (within 0.15 mi (0.25 km) of management site)

Sites where Golden-winged Warblers are found generally:

- Contain the following primary land cover types: deciduous forest (48%); pasture/hay (14%); and coniferous and mixed forests (2%). Very few Golden-winged Warblers are associated with shrub-scrub or wetland habitats.

*Table 3–9. Population and habitat goals for focal areas in the Southern Appalachian-Nantahala subregion.**

Focal Area Map ID	Focal Area Name	Estimated Population for 2010 (individuals)	Population Goal for 2050 (individuals)	Estimated Breeding Habitat for 2010 in acres (ha)	Breeding Habitat Goal for 2050 in acres (ha)
A15	Northern Peaks	300	600	1500 (600)	3000 (1200)
A16	Roan-Unaka	200	400	1000 (400)	2000 (800)
A17	Nantahala North	200	400	1000 (400)	2000 (800)
A18	Nantahala South	300	600	1500 (600)	3000 (1200)

**Population estimates are based on expert knowledge and Golden-winged Warbler Atlas Project data.*

Potential Partners and Priority Sites

National/Regional – Appalachian Mountains Joint Venture, Natural Resources Conservation Service, USDA Forest Service (Nantahala National Forest, Pisgah National Forest), Cherokee National Forest, Chattahoochee National Forest, George Washington National Forest, and Jefferson National Forest)

State – North Carolina Forestry, North Carolina Wildlife Resources Commission (Division of Wildlife Management), University of Georgia Cooperative Extension, North Carolina Cooperative Extension, North Carolina State University, University of Tennessee Extension, Virginia Cooperative Extension, Tennessee Wildlife Resources Agency, Tennessee Department of Environment and Conservation, University of Tennessee, Georgia Department of Natural Resources, Virginia Department of Conservation and Recreation, Grayson Highlands State Park, Virginia Department of Game and Inland Fisheries

NGOs – Audubon North Carolina, Blue Ridge Conservancy, Southern Appalachian Highlands Conservancy, Wildlife Management Institute, Bristol Bird Club, Virginia Audubon Important Bird Areas

Industry – Dunaway Timber Company, Heartland Timber Company

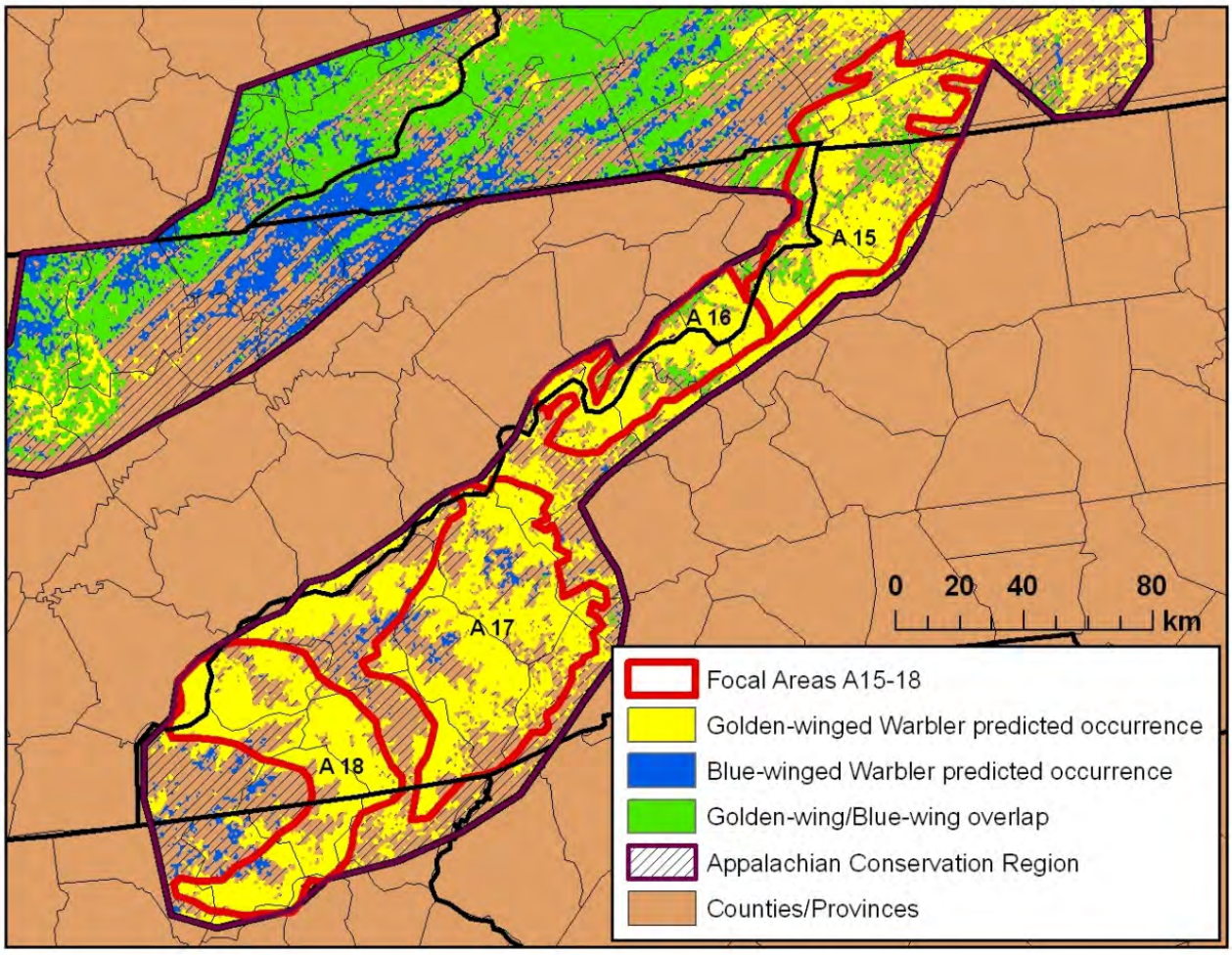
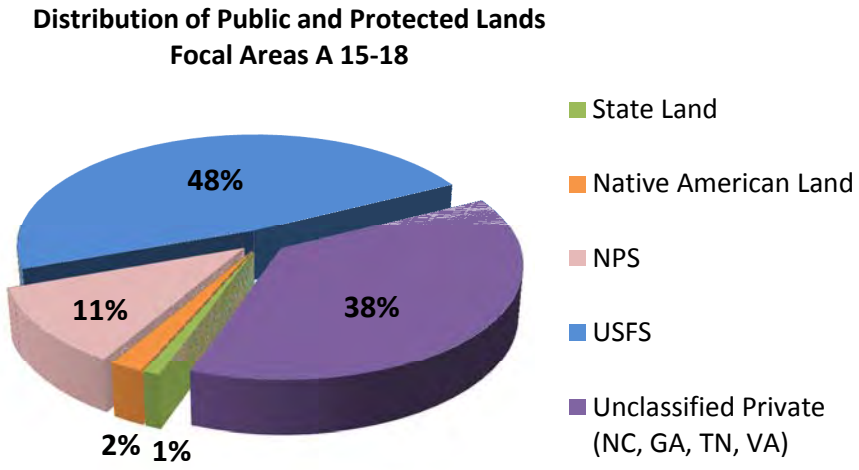


Figure 3–37. Model results showing the current predicted distribution of Golden-winged and Blue-winged warbler in Southern Appalachian-Nantahala. Locations inside focal areas and without Blue-winged Warbler should receive highest priority for conservation and management actions.



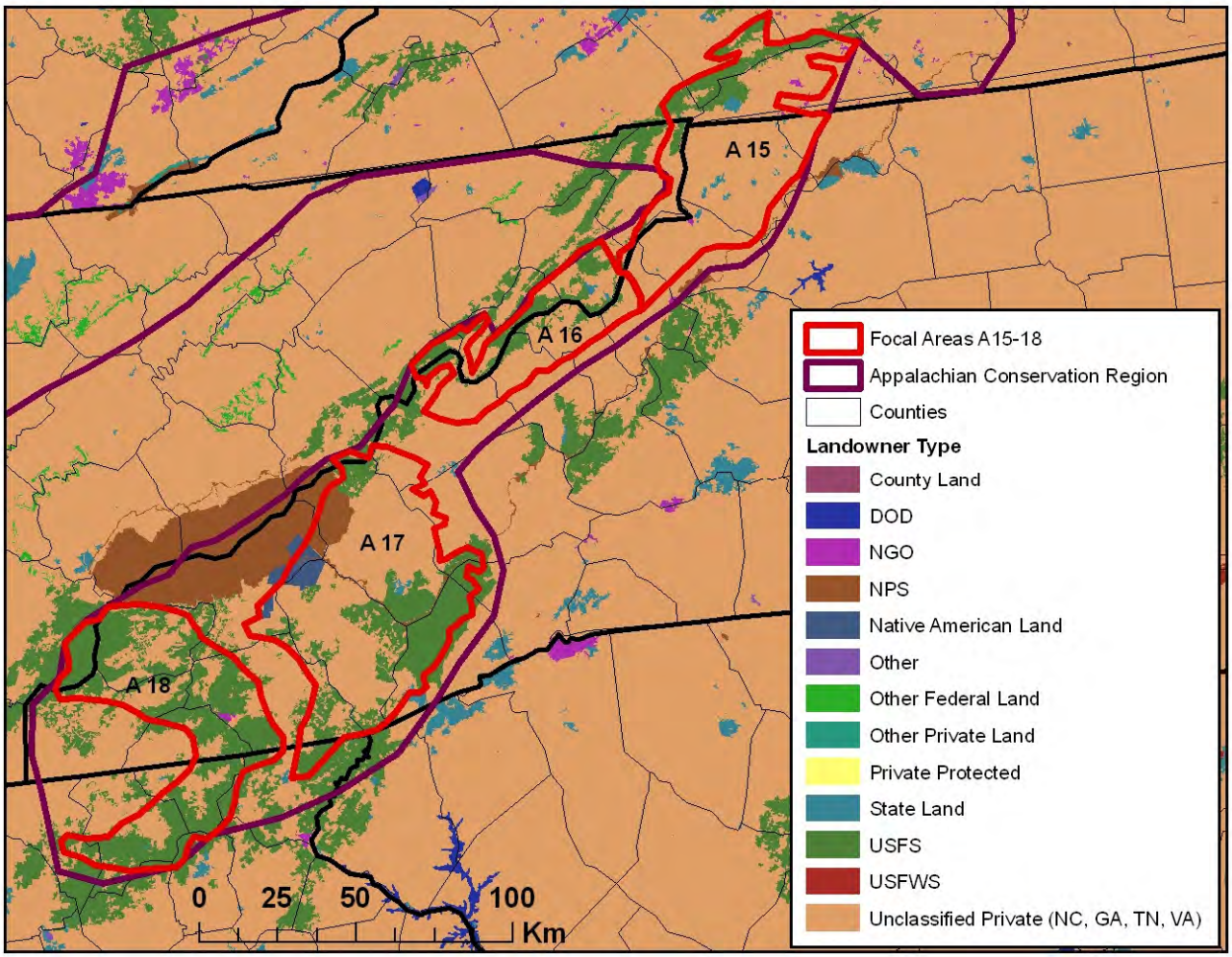


Figure 3–38. Percentage of landowner types and spatial layout of public and protected areas in the Southern Appalachian-Nantahala focal areas (USGS Protected Areas Database of the USA, version 1.2, www.protectedlands.net/padus/).

The Great Lakes Conservation Region

The Great Lakes Conservation Region is divided into six subregions containing one or more focal areas each (Figure 3–39). The following accounts give detailed information specific to those focal areas and subregions.

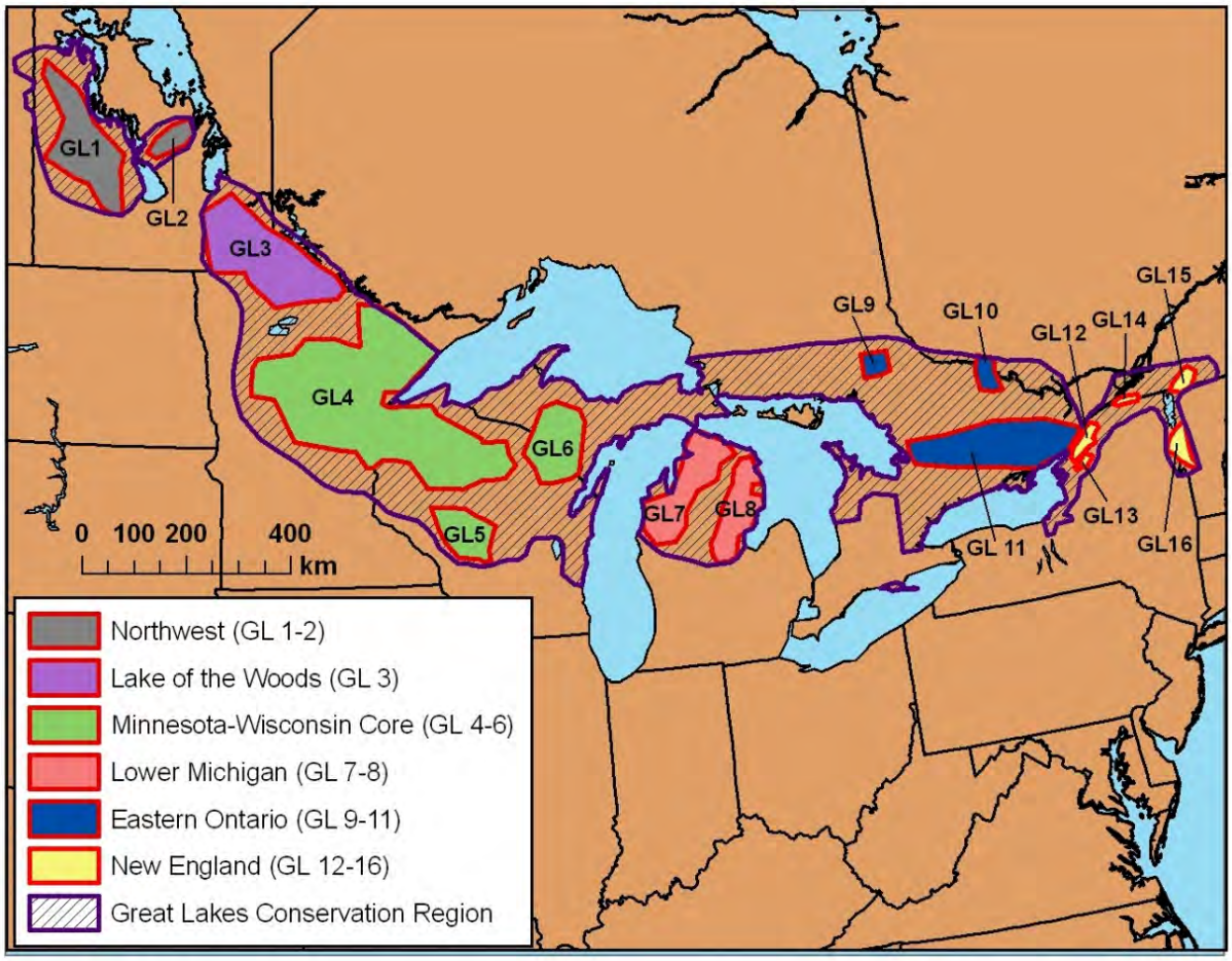


Figure 3–39. Golden-winged Warbler subregions and focal areas in the Great Lakes Conservation Region.

Northwest Subregion (Focal Areas GL1–GL2; Figures 3–40 and 3–41; Table 3–10)

General Description

This subregion supports approximately 1% of the region's and world's Golden-winged Warblers. The primary habitats for Golden-winged Warblers in these focal areas are young aspen forests, aspen parkland, and open oak/shrub savannah. It is notable that Golden-winged Warblers occupy mature aspen forests where gap dynamics provide suitable nesting habitat (i.e. aspen parkland). This ecology is unique to this subregion because aspen forest is the climax community unlike in other parts of the range where it is succeeded by hardwood forest or other forest types. Blue-winged Warblers have not been observed here and no Golden-winged Warbler cryptic hybrids have been detected, so this is one of the last strongholds for pure Golden-winged Warblers. There is high potential for creating suitable habitat via aspen harvesting and prescribed burning.

Note: there was insufficient remotely sensed data to model Golden-winged Warbler habitat associations in this subregion.

*Table 3–10. Population and habitat goals for focal areas in the Northwest subregion.**

Focal Area Map ID	Focal Area Name	Estimated Population for 2010 (individuals)	Population Goal for 2050 (individuals)	Estimated Breeding Habitat for 2010 in acres (ha)	Breeding Habitat Goal for 2050 in acres (ha)
GL1	Manitoba Escarpment	2500	3750	12,500 (5060)	18,750 (7590)
GL2	Manitoba Interlakes	500	750	2500 (1000)	3750 (1520)

**Population estimates are based on expert knowledge and Golden-winged Warbler Atlas Project data.*

Potential Partners and Priority Sties

National/Regional – Environment Canada (Golden-winged Warbler Recovery Team), Riding Mountain National Park, Riding Mountain Biosphere Reserve

Provincial – Manitoba Conservation

NGOs – Bird Studies Canada, The Nature Conservancy Canada, Nature Manitoba (Manitoba Naturalists Society), local forest owners associations (contact extension service for information)

Industry – Louisiana-Pacific Canada

Tribal – First Nations in Manitoba

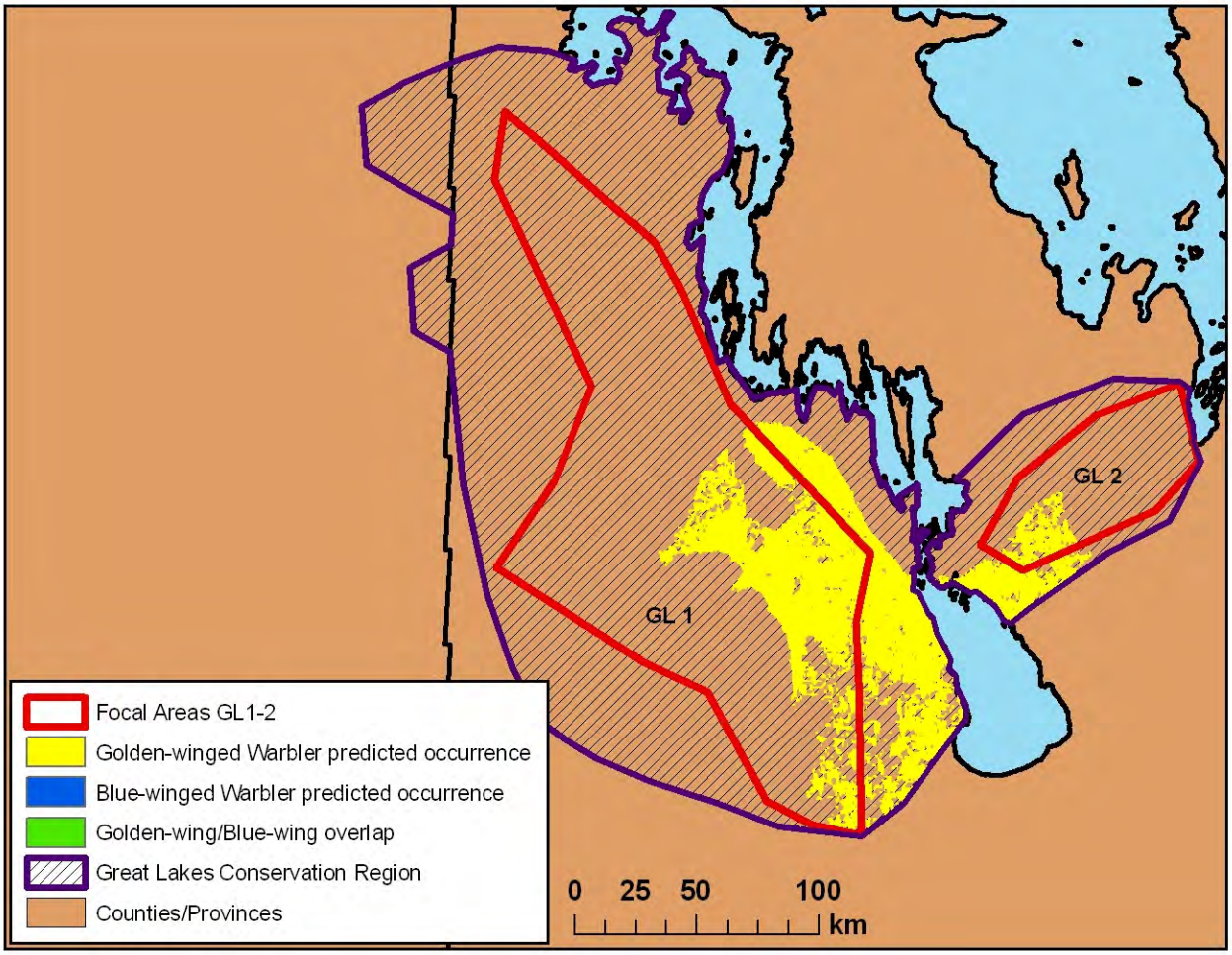
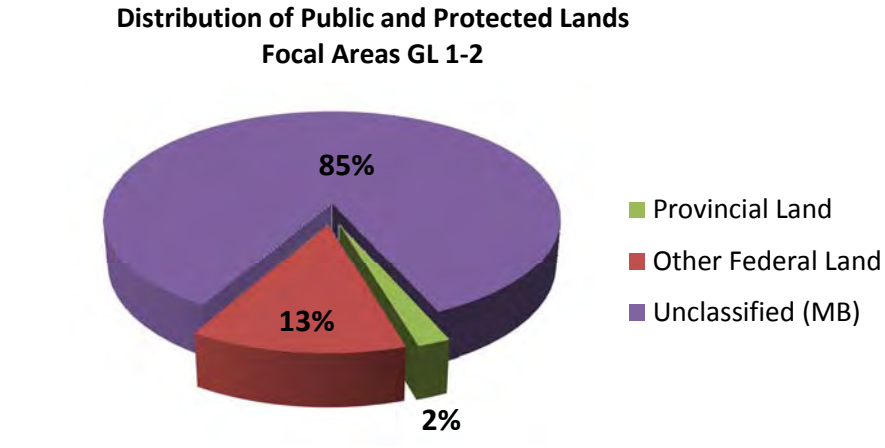


Figure 3–40. Model results showing the current predicted distribution of Golden-winged and Blue-winged warblers the Northwest. Locations inside focal areas and without Blue-winged Warbler should receive highest priority for conservation and management actions. A smaller number of ecological variables were available to model the estimated warbler distribution in Canada, and thus estimates for some areas within the Great Lakes Conservation region are preliminary. However, model predictions for these focal areas demonstrated relatively good support.



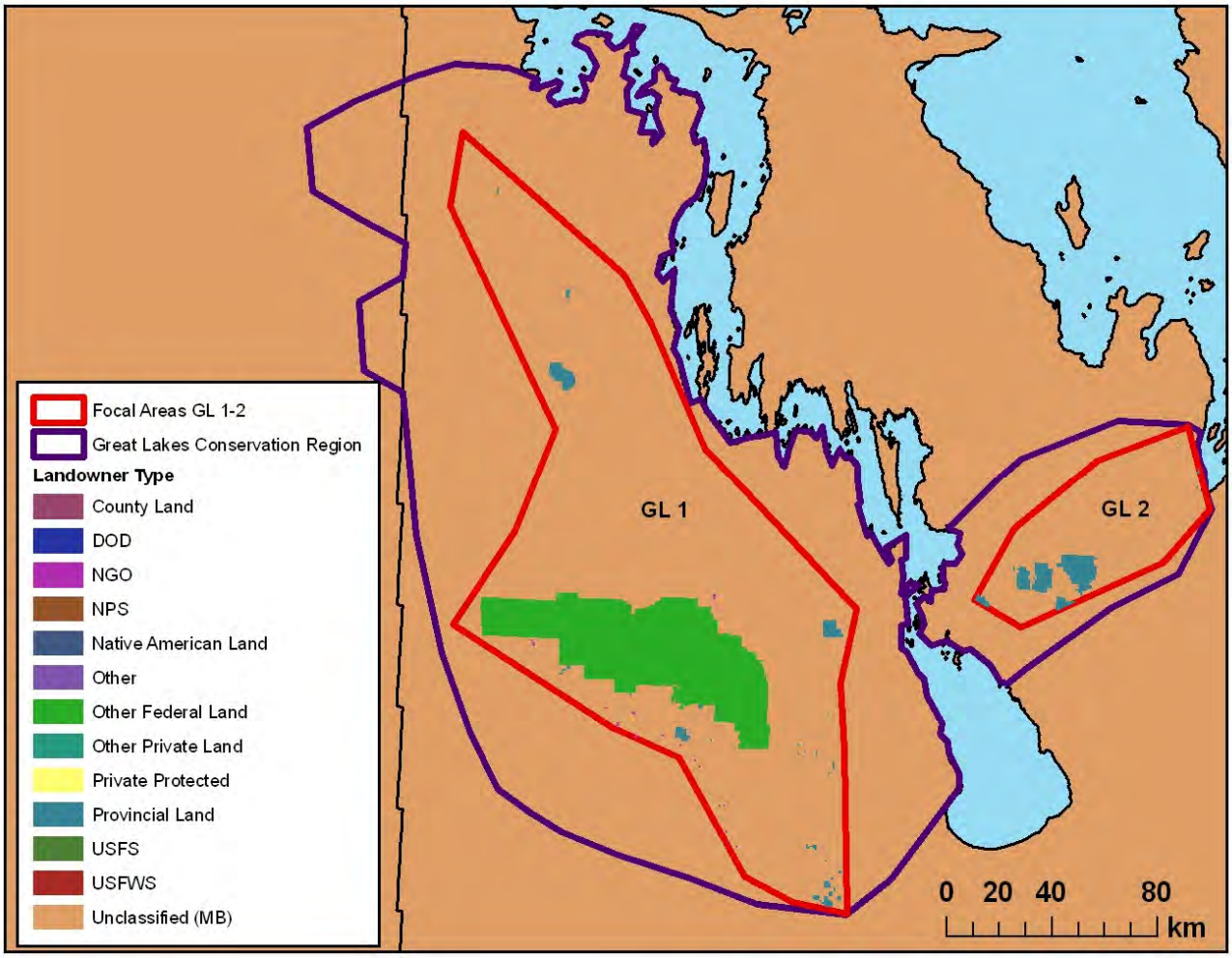


Figure 3–41. Percentage of landowner types and spatial layout of public and protected areas in the Northwest focal areas (Conservation Areas Reporting and Tracking System (CARTS) and Atlas of Canada 1,000,000 National Frameworks Data, Protected Areas, http://geogratis.cgdi.gc.ca/geogratis/en/option/select.do?id=BA8D1149-7714-EC04-343B-6AFEC3BDA84A). Some protected areas are not mapped due to incomplete land ownership datasets.

Lake of the Woods Subregion (Focal Area GL3; Figures 3–42 and 3–43; Table 3–11)

General Description

This focal area supports approximately 2% of the region's and world's Golden-winged Warblers. The primary habitats in this area are young aspen forest, aspen parkland, and oak/pine barrens.

Blue-winged Warblers and hybrids are rare here, so this is one of the last strongholds for pure Golden-winged Warblers. Populations appear to be increasing naturally in this area.

Note: there was insufficient remotely sensed data to model Golden-winged Warbler habitat associations in this subregion.

*Table 3–11. Population and habitat goals for focal areas in the Lake of the Woods subregion.**

Focal Area Map ID	Focal Area Name	Estimated Population for 2010 (individuals)	Population Goal for 2050 (individuals)	Estimated Breeding Habitat for 2010 in acres (ha)	Breeding Habitat Goal for 2050 in acres (ha)
GL3	Lake of the Woods	7000	10,500	35,000 (14,000)	52,500 (21,200)

**Population estimates are based on expert knowledge and Golden-winged Warbler Atlas Project data.*

Potential Partners and Priority Sites

National/Regional – Environment Canada (Golden-winged Warbler Recovery Team), Upper Mississippi River and Great Lakes Region Joint Venture

State/Provincial – Manitoba Conservation, Ontario Ministry of Natural Resources (provincial reserves), Minnesota Department of Natural Resources (state forests, state parks, wildlife management areas), University of Minnesota Extension

NGOs – Bird Studies Canada, The Nature Conservancy Canada, Nature Manitoba (Manitoba Naturalists Society), Audubon Minnesota, local forest owners associations (contact extension service for information)

Industry – Minnesota Forest Industries

Tribal – First Nations in Manitoba, First Nations in Ontario

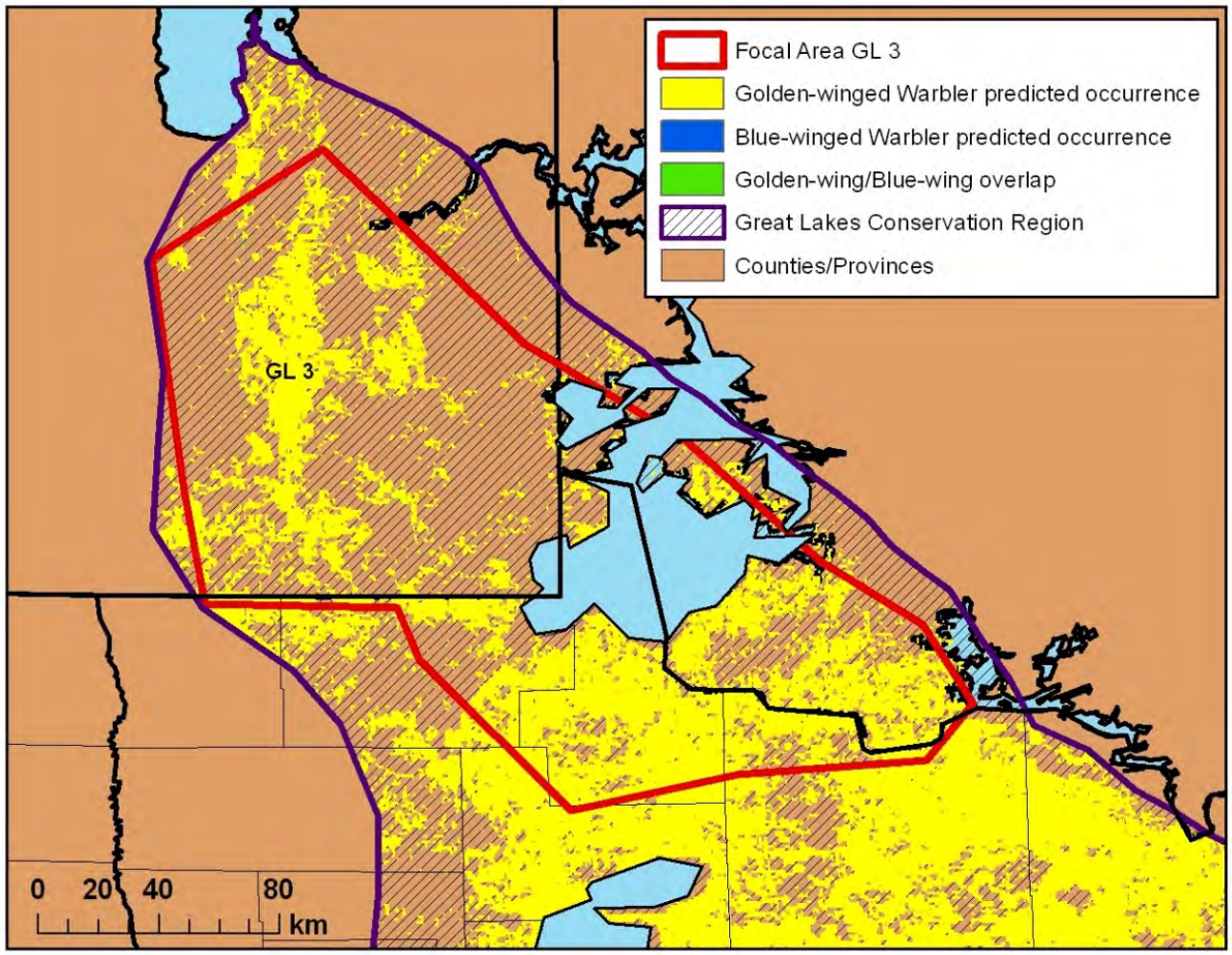
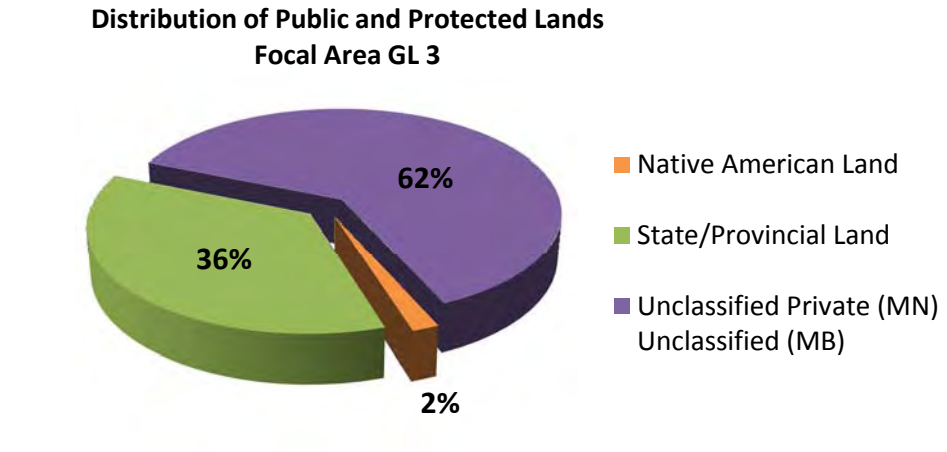


Figure 3–42. Model results showing the current predicted distribution of Golden-winged and Blue-winged warblers in Lake of the Woods. Locations inside focal areas and without Blue-winged Warbler should receive highest priority for conservation and management actions. A smaller number of ecological variables were available to model the estimated warbler distribution in Canada, and thus estimates for some areas within the Great Lakes Conservation region are preliminary. However, model predictions for this focal area demonstrated relatively good support.



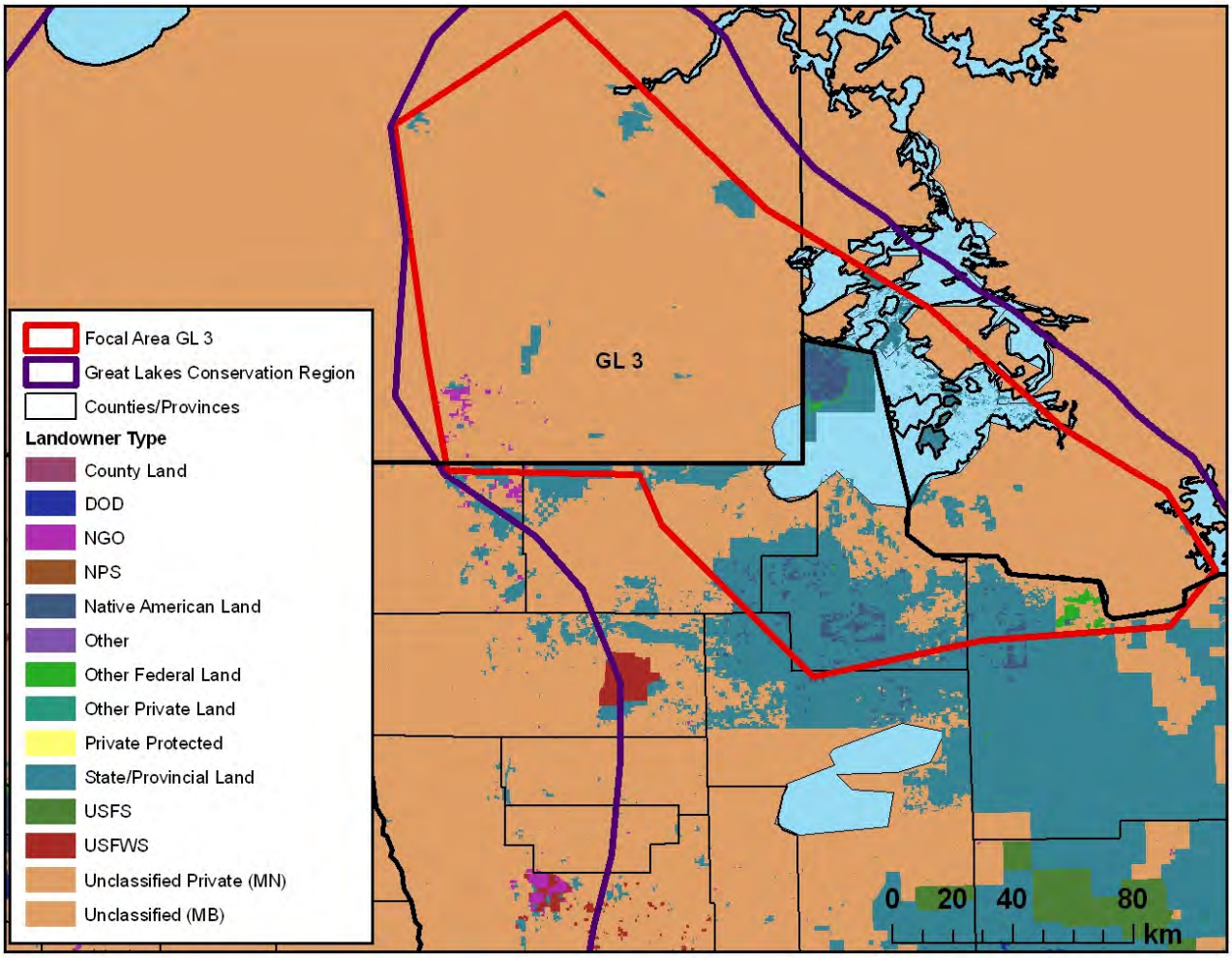


Figure 3–43. Landowner types and spatial layout of public and protected areas in the Lake of the Woods focal area (USGS Protected Areas Database of the USA, version 1.2, www.protectedlands.net/padus/; Conservation Areas Reporting and Tracking System (CARTS); and Atlas of Canada 1,000,000 National Frameworks Data, Protected Areas, http://geogratis.cgdi.gc.ca/geogratis/en/option/select.do?id=BA8D1149-7714-EC04-343B-6AFEC3BDA84A). Some protected areas are not mapped due to incomplete land ownership datasets.

Minnesota-Wisconsin Core Subregon (Focal Areas GL4–GL6; Figures 3–44 and 3–45; Table 3–12)

General Description

This subregion supports approximately 61% of the region's (and 58% of the world's) Golden-winged Warblers. The primary habitats for Golden-winged Warblers in these focal areas are shrub wetlands and young aspen forest. Major threats in these areas are the decline of even-aged forest management (conversion to northern hardwood forest and agencies falling short of aspen harvest goals), forest fragmentation by second-home development, and Blue-winged Warbler encroachment (especially in the Central Forest of Wisconsin). There is a high potential for creating young forest and for protecting shrub wetland communities, and enhancing these communities through active management. Additionally, there is potential for overlapping management with Sharp-tailed Grouse within this subregion.

Macro Landscape Context (within 1.5 mi (2.5 km) of management site)

Golden-winged Warblers are generally associated with landscapes containing:

- The following primary land cover types: 22% herbaceous and 70% forest cover that is predominantly 33–82 ft (10–25 m) in height (large sapling to small sawtimber sized trees).
- A ratio of 70:30 deciduous:coniferous trees with low or no Golden-winged Warbler occurrence in forested landscapes containing greater than 35% coniferous forest.
- Tree communities dominated by balsam poplar, aspen, or paper birch with trees that are 16–33 ft (5–10 m) tall (sapling-sized trees).

Micro Landscape Context (within 0.15 mi (0.25 km) of management site):

Sites where Golden-winged Warblers are found generally contain:

- The following primary land cover types: deciduous forest (44%); woody wetlands (20%); emergent herbaceous wetlands (6%), shrub-scrub (6%). Blue-winged Warblers used very similar habitats (only ±2–3% different in each category).

*Table 3–12. Population and habitat goals for focal areas in the Minnesota-Wisconsin Core subregion.**

Focal Area Map ID	Focal Area Name	Estimated Population for 2010 (individuals)	Population Goal for 2050 (individuals)	Estimated Breeding Habitat for 2010 in acres (ha)	Breeding Habitat Goal for 2050 in acres (ha)
GL4	Northern Minnesota and Wisconsin	226,000	339,000	1,130,000 (457,000)	1,695,000 (685,900)
GL5	Wisconsin Central Forest	5000	7500	25,000 (10,000)	37,500 (15,200)
GL6	Northeast Wisconsin and Upper Peninsula Michigan	8000	12,000	40,000 (16,000)	60,000 (24,000)

**Population estimates are based on expert knowledge and Golden-winged Warbler Atlas Project data.*

Potential Partners and Priority Sites

National/Regional – Natural Resources Conservation Service, US Fish and Wildlife Service (Necedah and Tamarac National Wildlife Refuges, Partners for Fish and Wildlife), USDA Forest Service (Chequamegon-Nicolet, Chippewa, and Superior National Forests), Upper Mississippi River and Great Lakes Region Joint Venture

State – Michigan Department of Natural Resources (Landowner Incentive Program), Minnesota Department of Natural Resources, Wisconsin Department of Natural Resources, Michigan State University Extension, University of Minnesota Duluth (Natural Resources Research Institute), University of Minnesota Extension, University of Wisconsin-Extension, University of Wisconsin-Green Bay, county forests, Legislative-Citizen Commission on Minnesota Resources (Environment and Natural Resources Trust Fund)

NGOs – Audubon Minnesota, Bird Conservation Minnesota, Minnesota Ornithologists' Union, Friends of Sandhill, Michigan Audubon, Michigan Bird Conservation Initiative, private landowners, Wild Rivers Interpretive Center, The Wildlife Society (University of Wisconsin-Stevens Point, University of Wisconsin-Madison), Wisconsin Audubon, Wisconsin Bird Conservation Initiative, Wolf Ridge Environmental Learning Center, Ruffed Grouse Society, Wisconsin Woodland Owners Association, local forest owners associations (contact extension service for information), local bird clubs and nature centers

Industry – Plum Creek Timber Company, Potlatch Corporation, UPM Blandin Forestry, RMK

Tribal – Leech Lake, White Earth, Fond du Lac, Lac Court Oreilles, Lac du Flambeau, St. Croix, Mole Lake, and Potawatomi Tribal Nations.

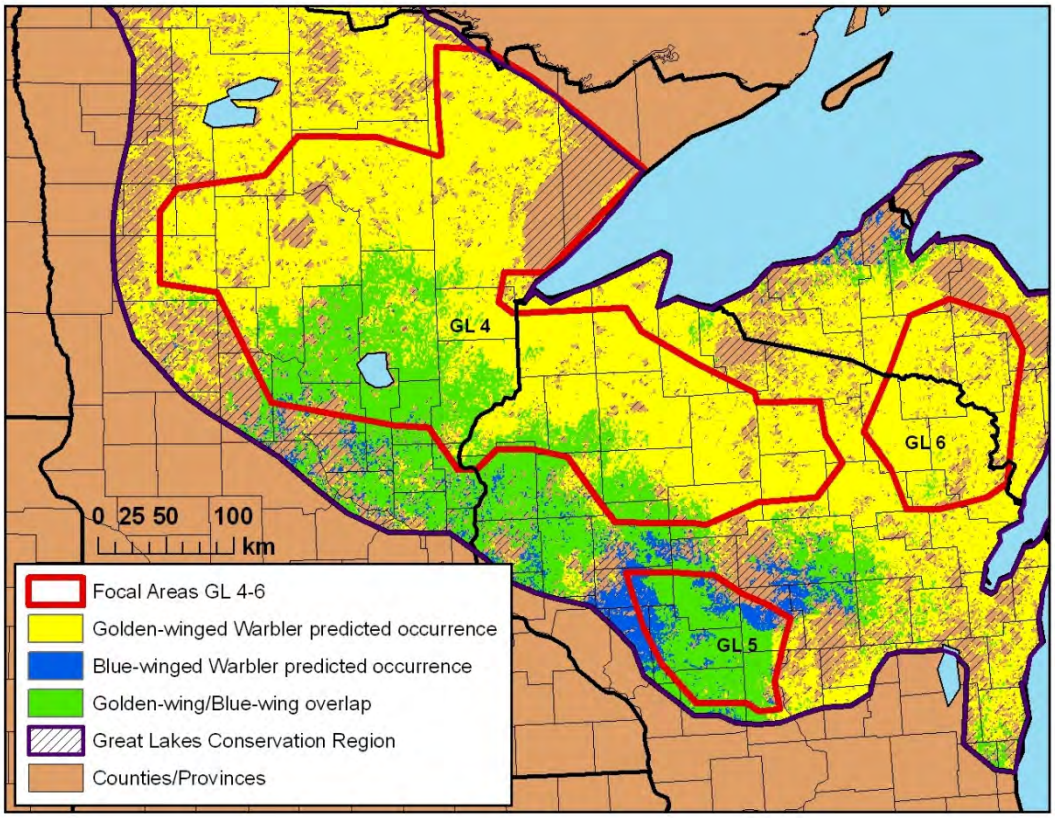
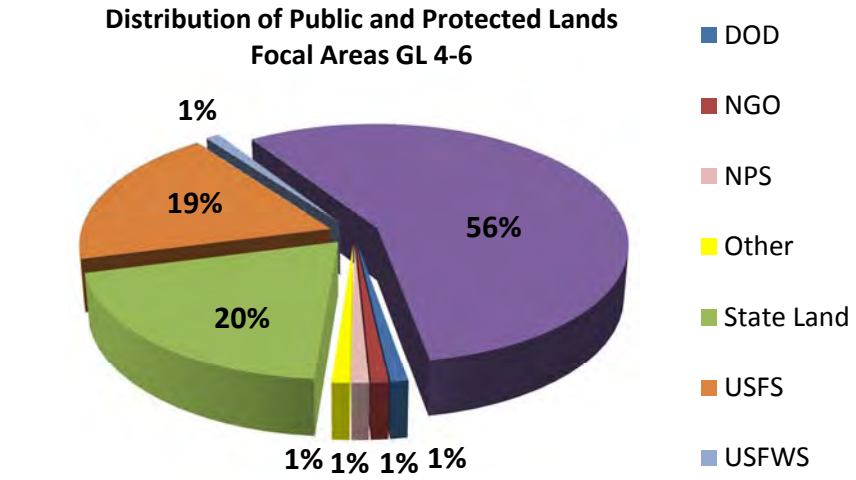


Figure 3–44. Model results showing the current predicted distribution of Golden-winged and Blue-winged warblers in Minnesota-Wisconsin Core. Locations inside focal areas and without Blue-winged Warbler should receive highest priority for conservation and management actions. Blue-winged Warbler occurrence may be lesser than depicted in some areas and includes areas lacking regular breeding activity in east-central Minnesota and the western Upper Peninsula of Michigan. A smaller number of ecological variables were available to model the estimated warbler distribution in Canada, and thus estimates for some areas within the Great Lakes Conservation region are preliminary. The model may over-estimate the distribution of the Blue-winged Warbler in GL4.



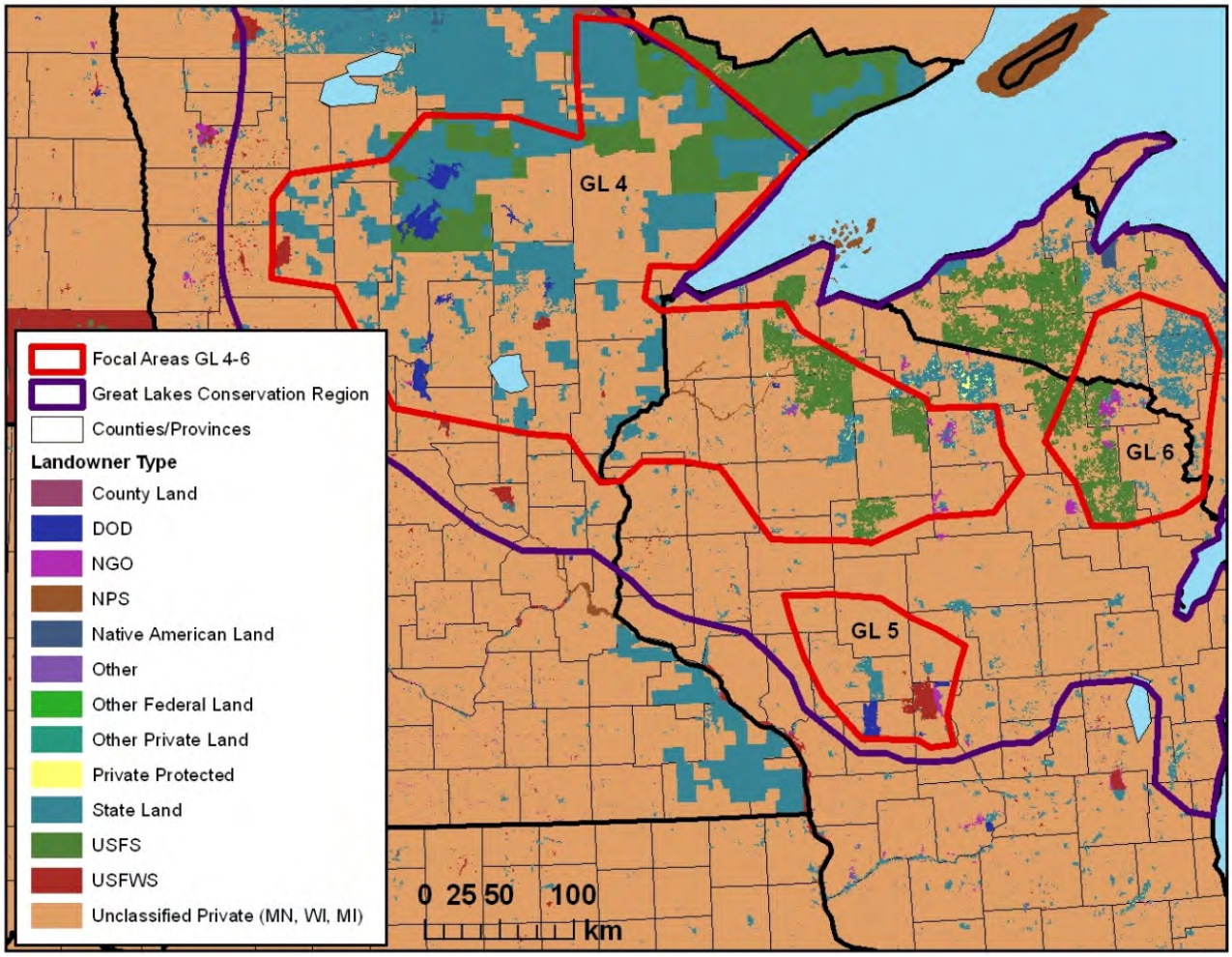


Figure 3–45. Percentage of landowner types and spatial layout of public and protected areas in the Minnesota-Wisconsin Core focal areas (USGS Protected Areas Database of the USA, version 1.2, www.protectedlands.net/padus/). NOTE: Wisconsin and Michigan county forests and many tribal lands, and potentially other protected areas that were not intentionally excluded, are missing from this map and pie chart.

Lower Michigan Subregion (Focal Areas GL7–GL8; Figures 3–46 and 3–47; Table 3–13)

General Description

This subregion supports approximately 3% of the region's (and 2% of the world's) Golden-winged Warblers. The primary habitats for Golden-winged Warbler in these focal areas are young aspen forest and shrub wetlands. Major threats in these areas are the lack of even-aged forest management and Blue-winged Warbler encroachment (especially in the south). There is a high potential for creating young forest here, but private lands are crucial.

Macro Landscape Context (within 1.5 mi (2.5 km) of management site)

Golden-winged Warblers are generally associated with landscapes containing:

- The following land cover types: 22% herbaceous and 70% forest that is predominantly 33–82 ft (10–25 m) in height (large sapling to small sawtimber sized trees).
- A ratio of 70:30; deciduous:coniferous trees with low or no Golden-winged Warbler occurrence in forested landscapes containing greater than 35% coniferous forest.
- Tree communities dominated by balsam poplar, aspen, or paper birch with trees that are 16–33 ft (5–10 m) tall (sapling-sized trees).

Micro Landscape Context (within 0.15 mi (0.25 km) of management site)

Sites where Golden-winged Warblers are found generally contain:

- The following land cover types: deciduous forest (44%); woody wetlands (20%); emergent herbaceous wetlands (6%), shrub-scrub (6%). Blue-winged Warblers used very similar habitats (only ±2–3% different in each category).

*Table 3–13. Population and habitat goals for focal areas in the Lower Michigan subregion.**

Focal Area Map ID	Focal Area Name	Estimated Population for 2010 (individuals)	Population Goal for 2050 (individuals)	Estimated Breeding Habitat for 2010 in acres (ha)	Breeding Habitat Goal for 2050 in acres (ha)
GL7	Michigan Northwestern Lower Peninsula	5000	7500	25,000 (10,000)	37,500 (15,200)
GL8	Michigan Gladwin Lake Plain (IBA) with northern extension	5000	7500	25,000 (10,000)	37,500 (15,200)

**Population estimates are based on expert knowledge and Golden-winged Warbler Atlas Project data.*

Potential Partners and Priority Sites

National/Regional – Natural Resources Conservation Service, US Fish and Wildlife Service (Partners for Fish and Wildlife), USDA Forest Service (Huron-Manistee National Forest), Upper Mississippi River and Great Lakes Region Joint Venture

State – Michigan Department of Natural Resources (Landowner Incentive Program), Michigan State University Extension

NGOs – local bird clubs, Michigan Audubon, Michigan Bird Conservation Initiative, private big game refuges and hunting clubs, private landowners, Ruffed Grouse Society, local forest owners associations (contact extension service for information)

Industry – Northland Timber Company, Pike Lumber Company

Tribal – Little River Band of Ottawa Indians, Little Traverse Bay Band of Odawa Indians, Saginaw Chippewa Tribal Nation

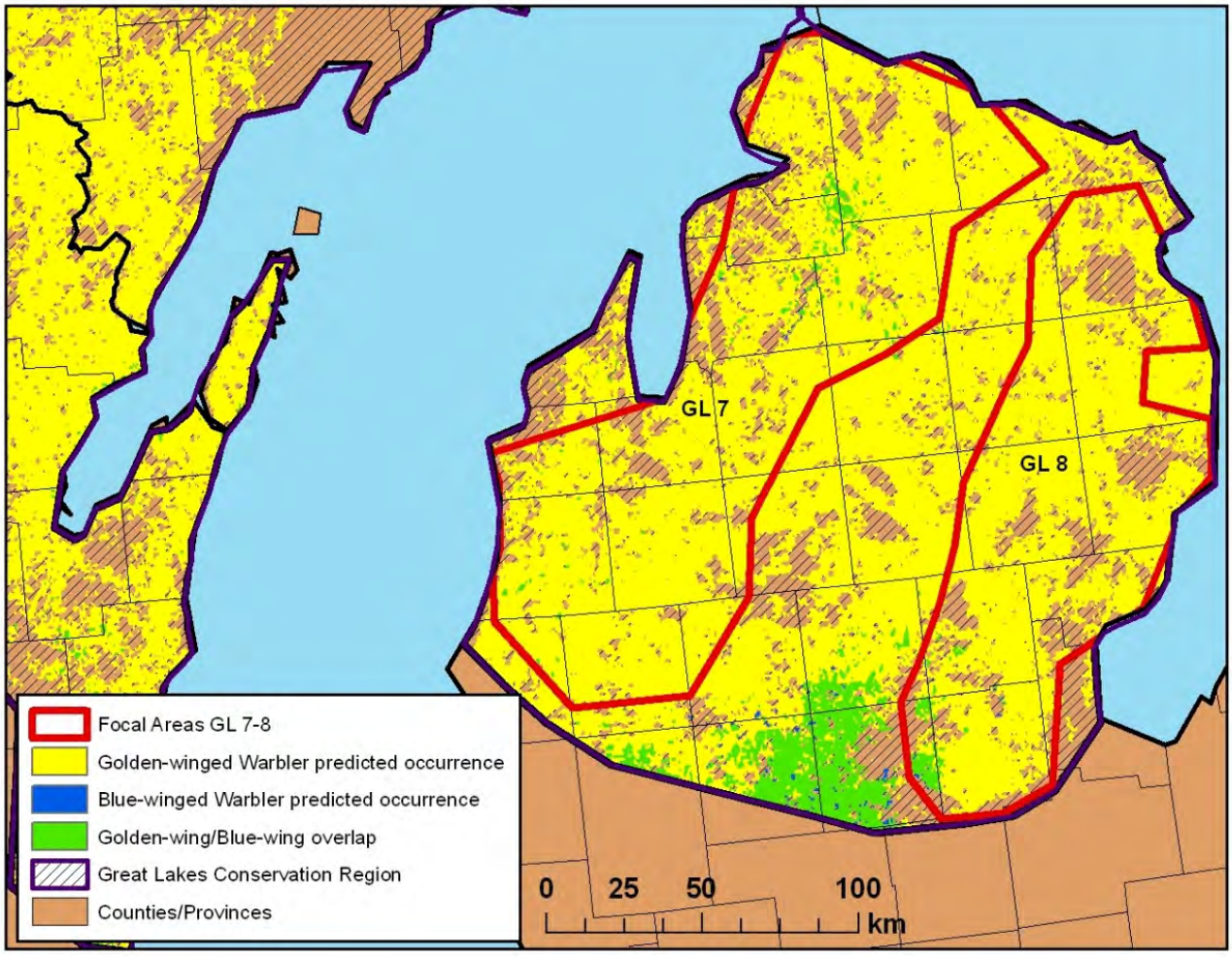
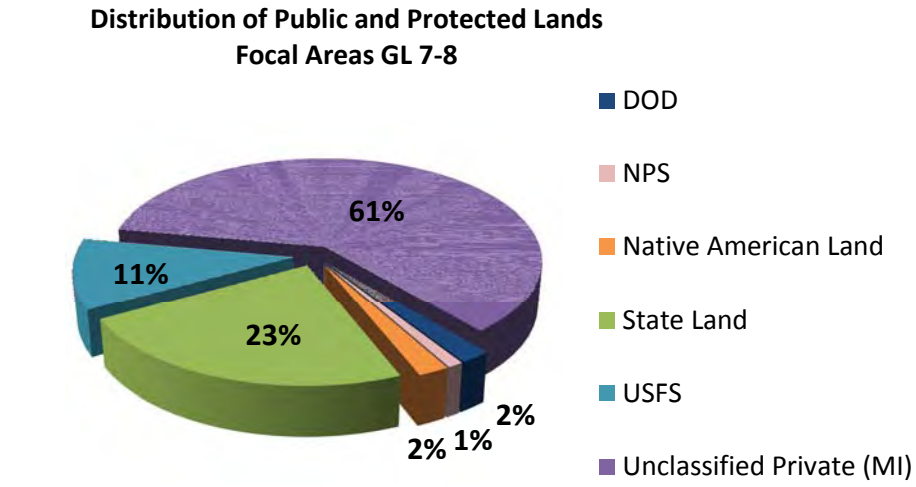


Figure 3–46. Model results showing the current predicted distribution of Golden-winged and Blue-winged warbler in Lower Michigan. Locations without Blue-winged Warbler and inside focal areas should receive highest priority for conservation and management actions. A smaller number of ecological variables were available to model the estimated warbler distribution in Canada, and thus estimates for some areas within the Great Lakes Conservation region are preliminary. The model for these focal areas may under-predict the presence of Blue-winged Warbler, particularly in southern GL7 and GL8, and this should be considered in management planning on a site-by-site basis.



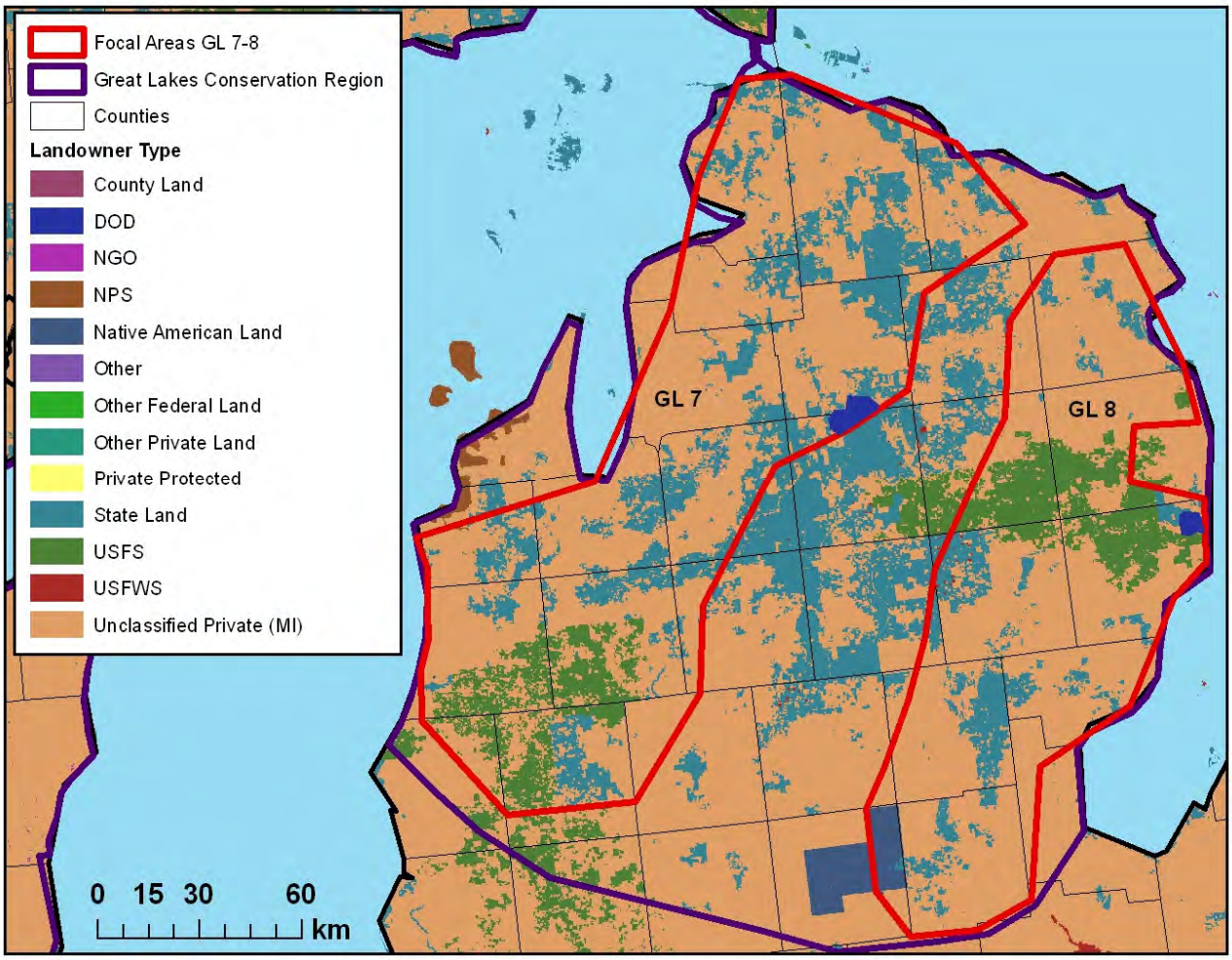


Figure 3–47. Percentage of landowner types and spatial layout of public and protected areas in the Lower Michigan focal areas (USGS Protected Areas Database of the USA, version 1.2, www.protectedlands.net/padus/). Some protected areas are not mapped due to incomplete land ownership datasets.

Eastern Ontario Subregion (Focal Areas GL9–GL11; Figures 3–48 and 3–49; Table 3–14)

General Description

The focal areas in this subregion support approximately 3% of the region's and world's Golden-winged Warblers. They are most commonly found where the landscape is a mosaic of abandoned and marginal farmland, rock barrens, wetlands, and forest (Vallender 2007). Major threats in these areas are natural succession and Blue-winged Warbler encroachment.

Note: there was insufficient remotely sensed data to model Golden-winged Warbler habitat associations in this subregion.

*Table 3–14. Population and habitat goals for focal areas in the Eastern Ontario subregion.**

Focal Area Map ID	Focal Area Name	Estimated Population for 2010 (individuals)	Population Goal for 2050 (individuals)	Estimated Breeding Habitat for 2010 in acres (ha)	Breeding Habitat Goal for 2050 in acres (ha)
GL9	Ontario Lake Nipissing	1000	1500	5000 (2000)	7500 (3000)
GL10	Pembroke-Ottawa River	200	300	1000 (400)	1500 (610)
GL11	Southern Edge of Canadian Shield	10,000	15,000	50,000 (20,000)	75,000 (30,000)

**Population estimates are based on expert knowledge and Golden-winged Warbler Atlas Project data.*

Potential Partners and Priority Sites

National/Regional – Environment Canada (Golden-winged Warbler Recovery Team)

Provincial – Ontario Ministry of Natural Resources, Queen's University Biological Station

NGOs – Bird Studies Canada, The Nature Conservancy Canada, local forest owners associations (contact extension service for information)

Industry – unknown

Tribal – First Nations in Ontario

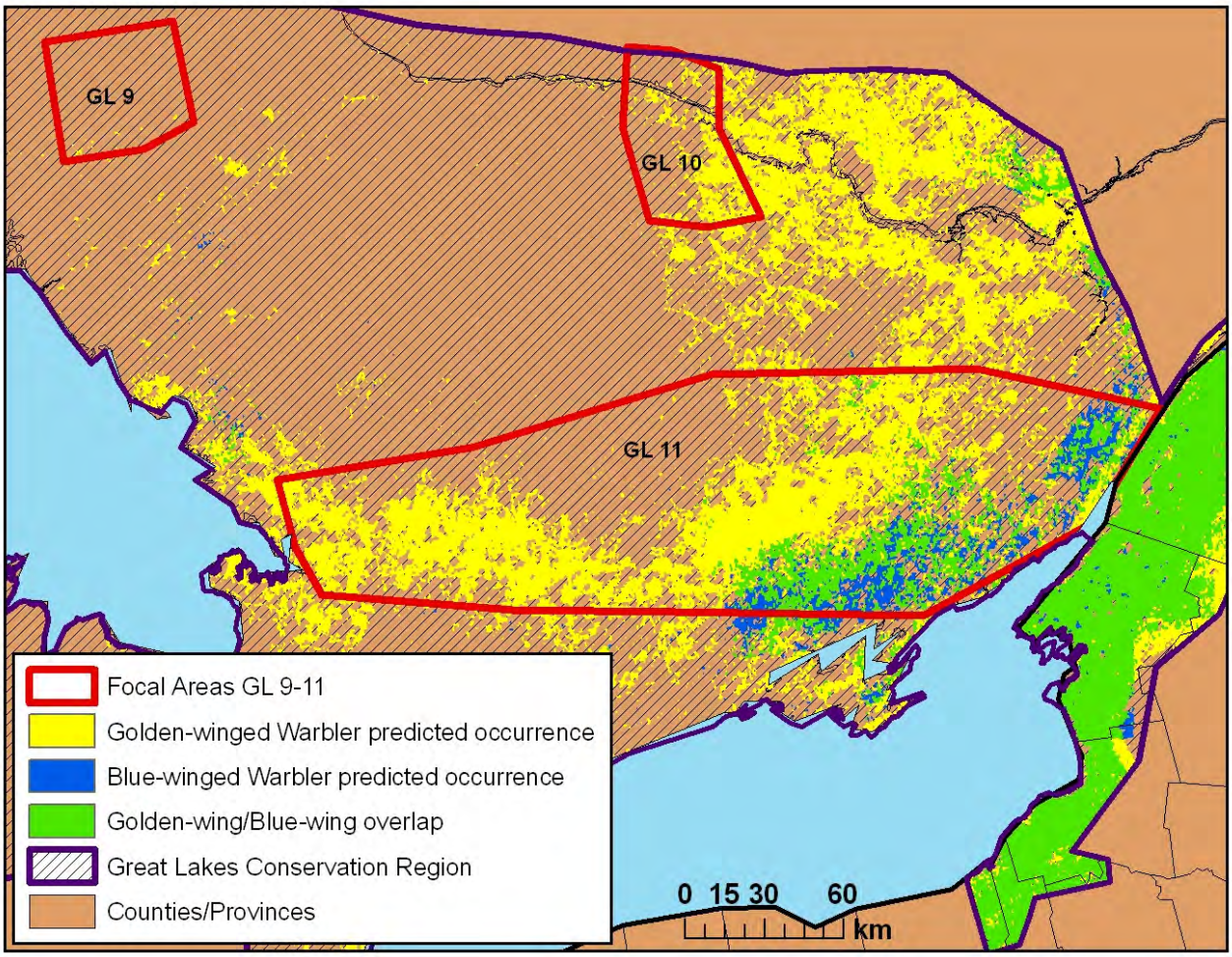
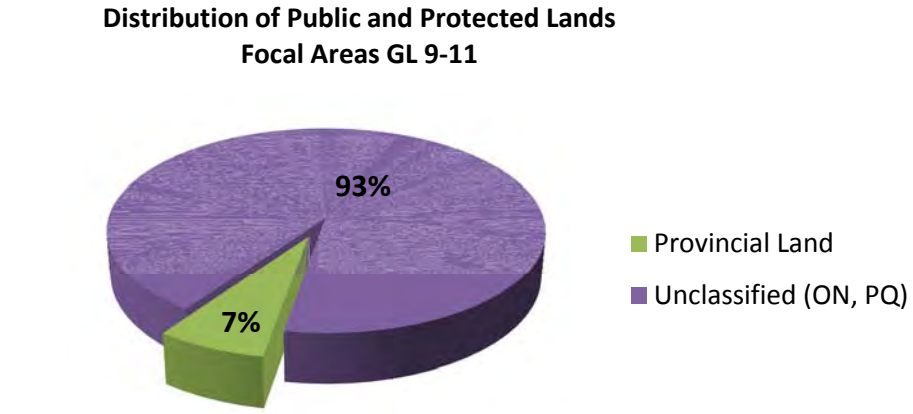


Figure 3–48. Model results showing the current predicted distribution of Golden-winged and Blue-winged warblers in Eastern Ontario. Locations inside focal areas and without Blue-winged Warbler should receive highest priority for conservation and management actions. A smaller number of ecological variables were available to model the warbler distribution in Canada. As a result, the distribution of the Golden-winged Warbler may be greater than predicted for these focal areas.



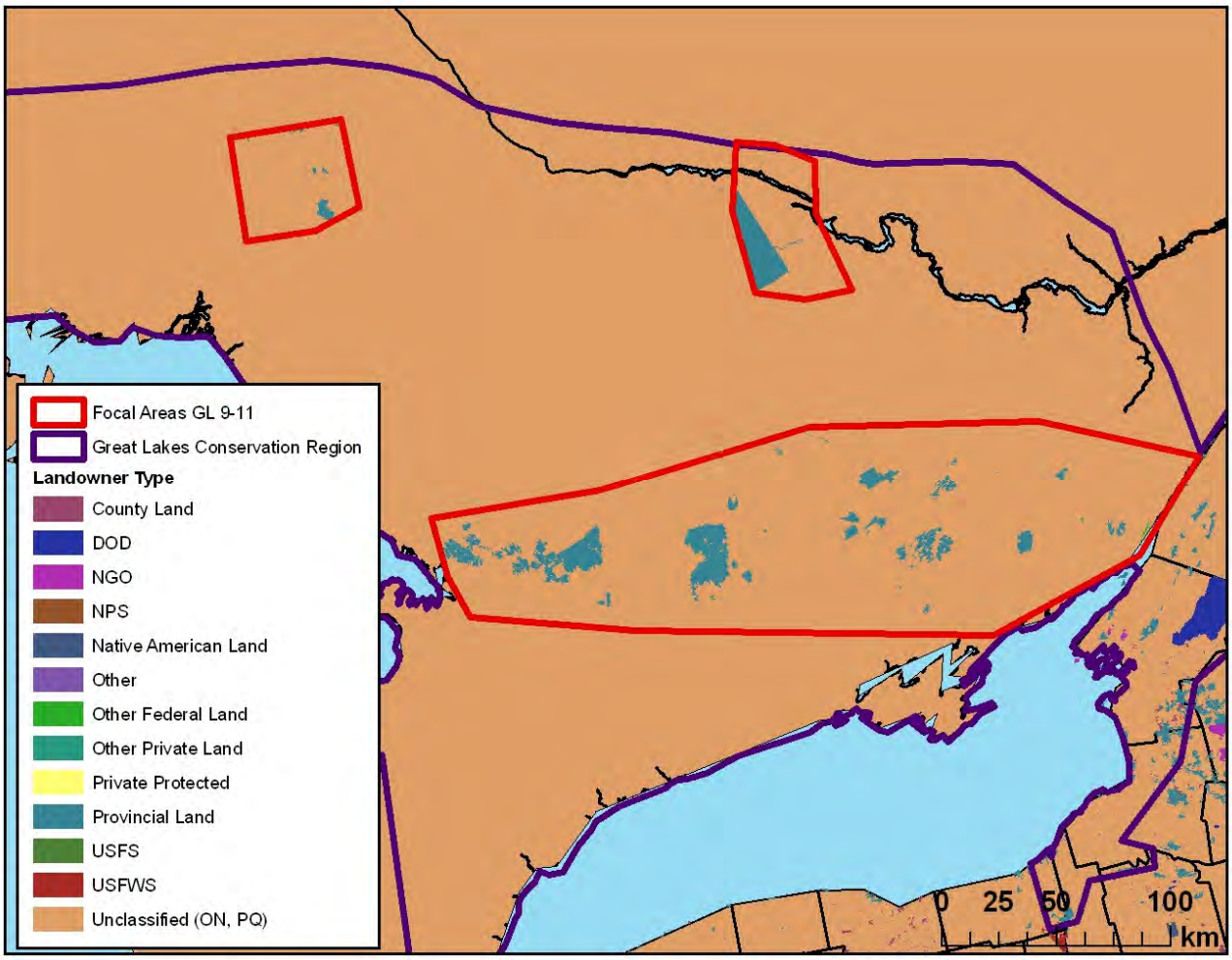


Figure 3–49. Landowner types and spatial layout of public and protected areas in the Eastern Ontario focal areas (Conservation Areas Reporting and Tracking System (CARTS) and Atlas of Canada 1,000,000 National Frameworks Data, Protected Areas, http://geogratis.cgdi.gc.ca/geogratis/en/option/select.do?id=BA8D1149-7714-EC04-343B-6AFEC3BDA84A). Some protected areas are not mapped due to incomplete land ownership datasets.

New England Subregion (Focal Areas GL12–GL16; Figures 3–50 and 3–51, Table 3–15)

General Description

This subregion contains the St. Lawrence Valley, Lake Champlain, and Quebec and supports approximately 0.4% of the region's and world's Golden-winged Warblers. The primary habitats for Golden-winged Warblers in these areas are upland shrubs, shrub wetlands, and successional forest. Major threats to the small populations found here are succession, conversion to agricultural land use, and Blue-winged Warbler encroachment.

Macro Landscape Context (within 1.5 mi (2.5 km) of management site)

Golden-winged Warblers are generally associated with landscapes containing:

- The following types of primary land cover: 10% herbaceous cover, 15–40% shrub cover, and 58% forest cover with the latter comprised of trees that are 16–33 ft (5–10 m) tall (5%), 33–82 ft (10–25 m) tall (60%), and 82–160 ft (25–50 m) tall (10%).

Micro Landscape Context (within 0.15 mi (0.25 km) of management site)

Sites where Golden-winged Warblers are found generally contain:

- The following primary land cover types: deciduous forest (44%); pasture/hay (8%); woody wetlands (9%). More Golden-winged Warblers were associated with woody and emergent wetlands, shrub-scrub and grassland-herbaceous meadows than Blue-winged Warblers. More Blue-winged Warblers are associated with pasture-hay, cultivated cropland, and coniferous and mixed forests than Golden-winged Warblers.

*Table 3–15. Population and habitat goals for focal areas in the New England subregion.**

Focal Area Map ID	Focal Area Name	Estimated Population for 2010 (individuals)	Population Goal for 2050 (individuals)	Estimated Breeding Habitat for 2010 in acres (ha)	Breeding Habitat Goal for 2050 in acres (ha)
GL12	St. Lawrence Valley	1000	1500	5000 (2000)	7500 (3000)
GL13	Fort Drum	400	600	2000 (800)	3000 (1200)
GL14	New York/Quebec border	30	45	150 (61)	225 (91)
GL15	Quebec: Iron Hill	20	30	100 (40)	150 (61)
GL16	Lake Champlain/Vermont	20	30	100 (40)	150 (61)

**Population estimates are based on expert knowledge and Golden-winged Warbler Atlas Project data.*

Potential Partners and Priority Sites

National/Regional – Atlantic Coast Joint Venture, Environment Canada (Golden-winged Warbler Recovery Team), Natural Resources Conservation Service, St. Regis Mohawk Tribe, US Department of Defense (Fort Drum), US Environmental Protection Agency (Great Lakes Initiative), US Fish and Wildlife Service (Migratory Bird Program, Partners for Fish and Wildlife)

State/Provincial – New York Natural Heritage Program, New York State Department of Environmental Conservation (private lands foresters), Partnerships for Regional Invasive Species Management, Clarkson University, Cornell Cooperative Extension (Master Forest Owners), Middlebury College, SUNY College of Environmental Science and Forestry, SUNY Plattsburgh, The University of Vermont Extension, Quebec Ministry of Natural Resources and Wildlife (aka Ministère des Ressources naturelles et de la Faune)

NGOs – National Audubon Society, Audubon New York, Audubon Vermont, Cornell Lab of Ornithology, land trusts (Indian River Lakes Conservancy), local/regional hunting clubs, native plant societies, The Nature Conservancy, New York Farm Bureau, New York Forest Owner's Association, New York Sea Grant, New York Society of American Foresters, Northern New York Audubon, Onondaga Audubon, Vermont Center For Ecostudies, Wildlife Management Institute, Quality Deer Management Association, Ruffed Grouse Society, Wild Turkey Federation, Bird Studies Canada

Industry – Hydro Quebec

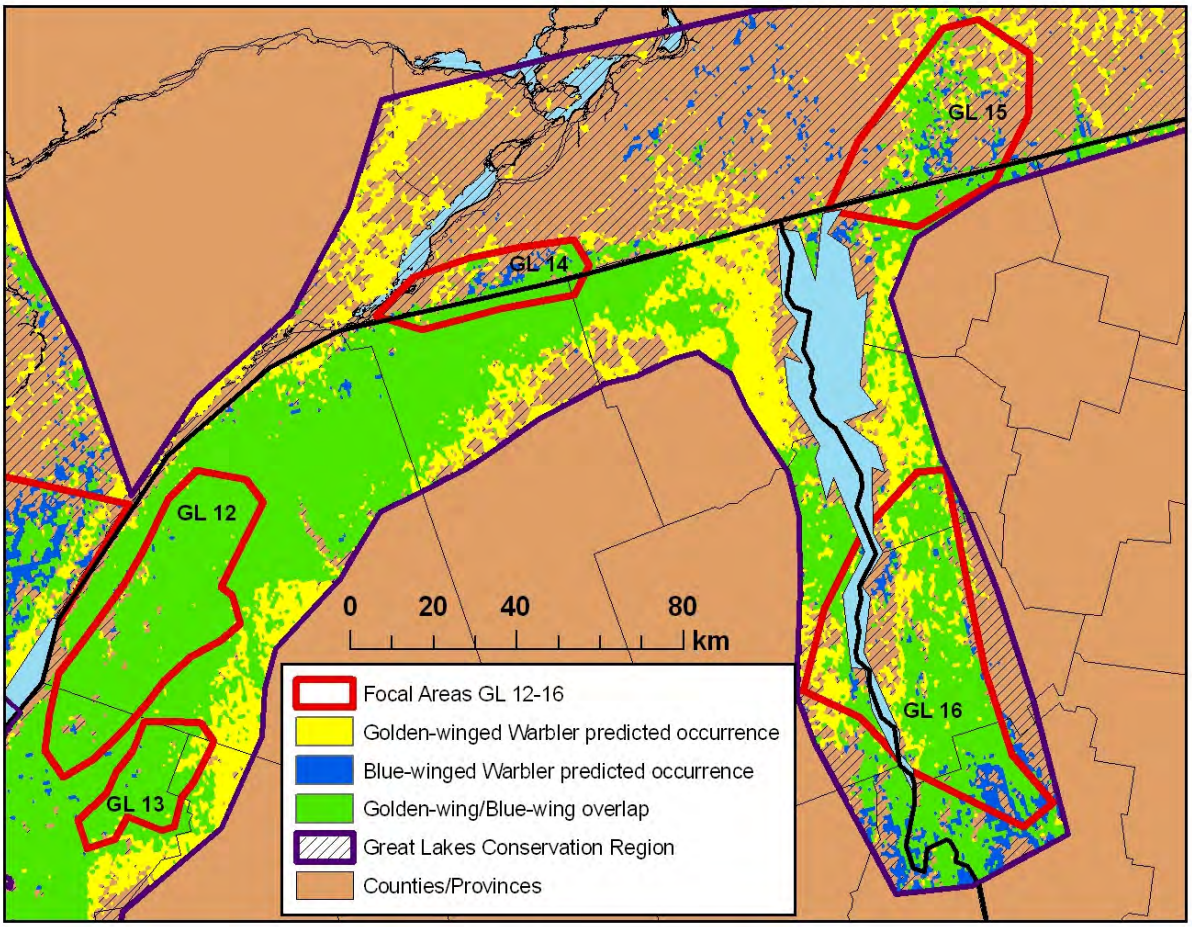
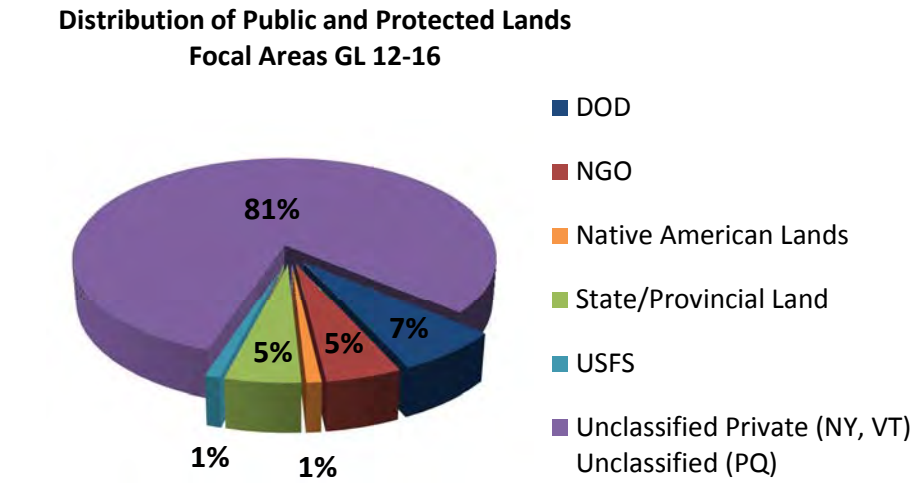


Figure 3–50. Model results showing the current predicted distribution of Golden-winged and Blue-winged warblers in New England subregion. Locations inside focal areas and without Blue-winged Warbler should receive highest priority for conservation and management actions. A smaller number of ecological variables were available to model the estimated warbler distribution in Canada. As a result, the model for the Great Lakes Conservation Region may over-predict the degree of overlap between warbler distributions for these focal areas.



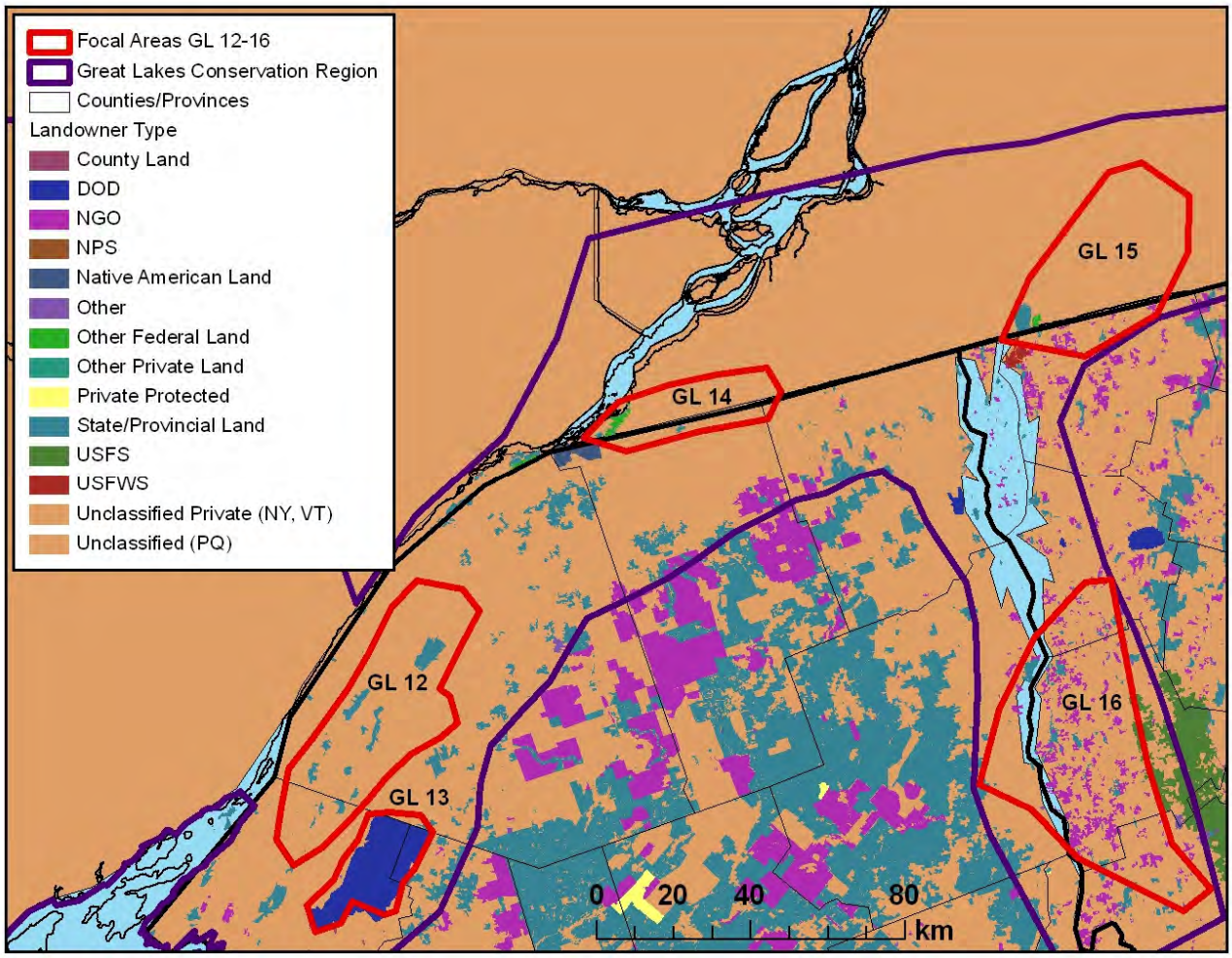


Figure 3–51. Percentage of landowner types and spatial layout of public and protected areas in the New England subregion (USGS Protected Areas Database of the USA, version 1.2, www.protectedlands.net/padus/; Conservation Areas Reporting and Tracking System (CARTS); and Atlas of Canada 1,000,000 National Frameworks Data, Protected Areas, http://geogratis.cgdi.gc.ca/geogratis/en/option/select.do?id=BA8D1149-7714-EC04-343B-6AFEC3BDA84A). Some protected areas are not mapped due to incomplete land ownership datasets.

IMPLEMENTATION

Golden-winged Warbler Working Group

The Golden-winged Warbler Working Group was founded in 2003 and is comprised of over 133 United States, Canadian, and Latin American ornithologists, conservationists, and managers from academia, federal and state agencies, international non-governmental organizations, and industry. Their mission is to ensure the conservation of Golden-winged Warbler populations through sound science, education, and management.

The Golden-winged Warbler Working Group members will play a pivotal role in continuing to conduct research, leading monitoring efforts, and implementing the following conservation actions. Working Group activities can be followed at www.gwwa.org/.

In Canada, the Golden-winged Warbler is listed as Threatened on Schedule 1 of the Canadian *Species at Risk Act* (SARA), which necessitates the preparation of a recovery strategy and action plan. Thus, the Canadian members of the Working Group have a separate mandate necessitated by Canadian law, which presents additional opportunities for collaboration and integration with this plan.

Golden-winged Warbler Working Group Objectives

1. Increase awareness of Golden-winged Warbler conservation status throughout its range.
2. Identify gaps in knowledge and develop priorities for coordinated Golden-winged Warbler research and management.
3. Develop and implement a conservation plan for Golden-winged Warbler that includes research, education, management, regional coordination, and monitoring.
4. Develop a mechanism for information sharing and conservation action follow-through.

Canadian Recovery Team

The Canadian Golden-winged Warbler Recovery Team was founded in 2009 and is comprised of representatives from the federal and provincial governments, and non-governmental organizations. The main objectives of the team are to produce a recovery strategy, guide the implementation of the strategy, report on progress and success of recovery efforts, and establish project priorities by providing biological advice on how to best recover the Golden-winged Warbler as guided by SARA. The team estimates to have a draft strategy ready for public review mid-2012.

The recovery team uses information gathered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to begin developing a recovery strategy. The recovery strategy sets out the population and distribution objectives, identifies threats to the survival of the species and the broad approaches to address these threats, identifies the species' critical habitat, if possible, and sets time lines for the preparation of an action plan.

The recovery strategy is currently in draft form and will be posted as a final document to the Species at Risk Public Registry upon completion. The draft population and distribution objective is

to maintain the Golden-winged Warbler population at its current range of abundance (approximately 19,000 to 50,000 pairs (COSEWIC 2006)) in Canada and to maintain the areas where minimal overlap occurs with Blue-winged Warblers within the Canadian range, while allowing continuing range expansion and contraction; and genetically pure populations where they occur within this range.

Next Steps

Development of this conservation plan does not guarantee implementation. Many conservation actions need to be stepped down into specific tasks so as to implement each action. Specific partners need to be identified to be accountable for the implementation of these tasks and other components of this plan.

At a minimum, the Golden-winged Warbler Working Group, Wildlife Management Institute, and other key partners should work together under the objectives of the National Fish and Wildlife Foundation's Early Successional Business Plan to make habitat recommendations compatible and consistent across all focal areas, and ensure, when appropriate, that implementation strategies and management activities consider all associated species.

Further, given the strong interest in ESH by a large number of potential researchers and land managers, an organized effort should be made to update National Fish and Wildlife Foundation's Early Successional Business Plan to help guide future work and funding. The need to step down the plan by identifying management sites and conservation strategies in each state is an important agency process that the Golden-winged Warbler Working Group should assist with in the future.

This plan is a dynamic document that will require periodic reviews and updates. We propose an initial national review and associated workshop in 2015. Keeping the conservation planning process fluid will allow for incorporation of new science and provide information useful to the U.S. Fish and Wildlife Service in making decisions about listing the species under the Endangered Species Act. Further, we suggest that periodic reviews be coordinated with the 5-year Canadian recovery plan review process as required by SARA.

EVALUATING ACCOMPLISHMENTS

Strategy for Evaluating Population and Habitat Goals

Adaptive habitat management that results in successfully stabilizing or reversing declining bird populations requires evaluation and monitoring programs that track population trends and measure species-level responses at multiple relevant scales. Evaluation programs are necessary to assess management practices, identify limiting factors, and document population change and recovery at the local, regional, and rangewide scales. Because ESHs that support breeding Golden-winged Warbler are ephemeral and dependent on regular disturbance, evaluation strategies must also help guide the timing and frequency of land-management actions. In addition, because Golden-winged Warbler is a long-distance Neotropical migrant, evaluation of breeding-season conservation actions must be tied to year-round demographic parameters, using protocols yet to be developed. Finally, the unique biology of Golden-winged Warbler, and threats from hybridization with closely related Blue-winged Warblers, requires that evaluation programs include a component for measuring genetic purity of established populations and tracking the dynamics of hybridization. In this section, we describe an overall strategy to track the success of our conservation efforts in terms of 1) numbers of acres established or enhanced, and 2) the response by Golden-winged Warbler and associated species at several spatial scales. Evaluating this response will be necessary to inform future conservation actions in an adaptive management framework.

Habitat Tracking

The most immediate measure of conservation action will be the number of acres of ESH suitable for breeding Golden-winged Warblers established, enhanced, or protected within each focal area identified in this Plan.

Tracking the number of acres of new ESH established under this Plan must be evaluated in the context of overall landscape-scale trends in available ESH. Conservation of Golden-winged Warbler and associated species will not be successful if new habitat is established at rates that do not exceed rates of regional habitat loss, or if new habitat is established in areas that can no longer support regional populations of Golden-winged Warbler (i.e., become population sinks). At present, identification and tracking of ESH using remote sensing data and GIS technology is extremely difficult. Existing data layers and modeling tools are inadequate for evaluating habitat availability for Golden-winged Warbler and other ESH specialists. Developing new tools and models for interpreting ESH from remotely sensed data is a critical research, conservation, and evaluation need.

The Wildlife Management Institute (WMI) is developing a web-based tool to track ESH created through American Woodcock management. Rather than duplicate the effort, we will work with WMI to help support and use this tool for tracking Golden-winged Warbler habitat. WMI has agreed to facilitate this effort (S. Williamson, pers. comm.).

Tracking acres of ESH on the landscape is just the first step; however, in evaluating success of the Golden-winged Warbler Conservation Plan. Not all acres of ESH within a region will be suitable for Golden-winged Warbler, and not all suitable acres of Golden-winged Warbler habitat will be occupied. In addition, the appearance of male Golden-winged Warbler,

especially in the years immediately following habitat manipulations, may not ensure successful breeding, or that a breeding population of Golden-winged Warbler is established. Tracking the population-level response to habitat change, including fecundity and genetic purity of newly established Golden-winged Warbler populations, is essential for meeting the population goals in this conservation plan.

Population Response by Golden-winged Warbler

Continued monitoring of Golden-winged Warbler populations is critical to: 1) track rangewide trends in the context of meeting population goals and understanding the pace and status of overall population recovery, and 2) measure local response to habitat establishment and manipulation, helping to determine if newly created habitats are being occupied and if reproductive performance is adequate to create source populations. Monitoring must inform knowledge of population dynamics and management decisions at all relevant scales – rangewide, regional, focal area, and local management sites. The population sampling that occurs at these different scales should be hierarchical and coordinated in such a way as to produce outputs that are comparable across spatial scales. We recommend using protocols (see Appendix G) established under the Golden-winged Warbler Conservation Initiative to measure local response of Golden-winged Warbler to habitat manipulations, and then relate these to regional and rangewide population goals established under the Golden-winged Warbler Conservation Plan and the ESH Business Plan developed for the National Fish and Wildlife Foundation.

The patchy nature of present-day Golden-winged Warbler distribution prevents effective surveying with traditional methods, such as the North American BBS. This makes estimates of regional population size and trend difficult. At present, BBS data give us a general measure of long-term trends over the entire range, but low detection rates, especially in the Appalachian Region (BCR 28), preclude estimation of trends over smaller areas (regions/states/provinces) and potentially erodes confidence in rangewide trends. To overcome these problems, the Golden-winged Warbler Working Group developed and tested a spatially balanced sampling methodology (see Appendix F) aimed at establishing a monitoring strategy that is effective for patchily distributed species, but not overly cumbersome or costly to implement.

Under the NFWF-funded Golden-winged Warbler Conservation Initiative, this spatially balanced monitoring design was pilot-tested in Pennsylvania in 2008 and throughout the Appalachian Region in 2009, and implemented successfully during the 2010 and 2011 breeding seasons. Partners in nine states, with supplemental support from USFWS, carried out Golden-winged Warbler sampling at roughly 520 points each year, giving us the ability to detect significant regional population changes. The flexibility of the spatially balanced monitoring design allows for additional sampling within states, provinces, and focal areas to provide inferences at finer spatial scales and to track the fate of local populations. Wildlife agencies in eight states (KY, MD, NC, NJ, PA, TN, VA, WV) have committed to future monitoring of sampling points within their states. Centralized coordination of monitoring and data management and analysis, as well as coordination of field personnel to complete the sampling design, will be necessary to fully implement this evaluation program.

Presently, spatially balanced monitoring is only being implemented in the Appalachian region where populations have been declining for decades. However, given that Golden-winged Warblers are now declining in the upper Midwest and Canada, and the BBS program has route-level

data deficiencies for Michigan, Wisconsin, Minnesota, Quebec, and Manitoba, we recommend that spatially balanced monitoring be used in both the Appalachian and Great Lakes regions, as well as in Canada where the density of BBS routes is inadequate to develop robust population trends (www.mbr-pwrc.usgs.gov/bbs/reglist07.html). Expanding the spatially balanced monitoring design to these new regions will require further coordination and commitments by new partners.

Ideally each management site should become a case history with documentation of habitat quality before and after management, and the response of Golden-winged Warbler, American Woodcock, and other associated species should be tracked before and after management activities. At a minimum, evaluation protocols must document the occurrence of Golden-winged Warbler at managed sites; ideally evaluation would document the reproductive performance of Golden-winged Warbler population response in the context of focal-area and regional population goals, presence of Blue-winged Warbler and other associated species, and measures of genetic purity or introgression. Evaluation protocols implemented at managed sites should be compatible with regional and rangewide protocols established by the Golden-winged Warbler Conservation Initiative to track population response over larger areas.

Past experience with other Neotropical migrant species tells us that measuring occurrence or density of Golden-winged Warbler at managed sites will be insufficient for documenting population response to conservation actions. Specifically, careful attention must be paid to how our management is influencing fecundity. Because efficient, inexpensive protocols to measure fecundity do not currently exist, we recommend developing several experimental protocols, possibly including brood counts and the collection of Breeding Bird Atlas type data in different habitats, to create an index of demography across sites and correlated across habitat types. Research is necessary to determine the effectiveness of simple protocols and to see if they yield the type of results useful to managers. Intensive research should continue within long-term study sites to calibrate any new demographic index.

Because of the real and imminent threat of genetic swamping and competition from the Blue-winged Warbler, populations targeted for management should be monitored to assess genetic integrity, to discourage management that may favor introgression by Blue-winged Warbler, and to measure the genetic health of Golden-winged Warbler populations throughout their range. Even with a demographic index in place, there is still the question of how much introgression exists at each site and how this is influencing fecundity in Golden-winged Warbler populations. Monitoring introgression is straightforward, using simple blood and feather sampling protocols developed under the Golden-winged Warbler Conservation Initiative (Appendix H). Newly developed DNA-assay techniques are then performed at qualified labs; these include existing mitochondrial DNA assays, and the addition of nuclear DNA sampling as future techniques improve. Biologists working at managed and experimental sites should collect blood as often as possible. We recommend periodic (i.e., every 5 years) blood sampling at permanent locations to track introgression across the Golden-winged Warbler's range starting in 2016 and then again in 2021. After the first sampling period in five years, sampling could continue in five year increments; however, this time period should remain flexible to adjust to new findings. Sampling and analysis of blood samples for genetic purity can be carried out by the Golden-winged Warbler Working Group partners and assayed via a molecular systematics laboratory such as the Fuller Evolutionary Biology Program at the Cornell Lab of Ornithology.

Response of Associated Species

We recommend that future Golden-winged Warbler survey protocols at all relevant scales record the presence or relative abundance of selected associated species (Figure 3—52) listed in Table 2—2. For response of American Woodcock, the Wildlife Management Institute has a survey protocol available for use in documenting response to habitat management (www.timberdoodle.org/). Additional species may be surveyed using other protocols to evaluate the response of birds not well detected by the above point count protocols (e.g. owls, nightjars, grouse, winter birds) or other non-bird species (e.g. imperiled herptiles or mammals). Moreover, supplemental observation of Golden-winged Warbler associated species will help guide management for a broader suite of species. Conversely, where other species are the focus of monitoring and research in ESH within the Golden-winged Warbler range, Golden-winged Warbler should be a high priority for monitoring as an associated species.

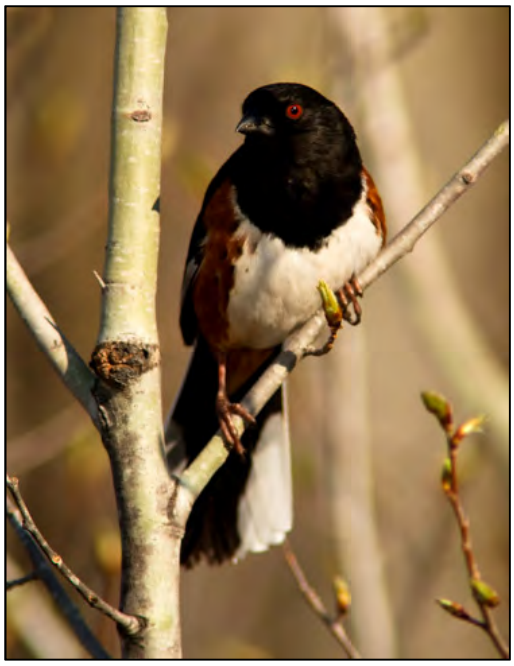


Figure 3–52. Eastern Towhee is a species frequently associated with Golden-winged Warbler. Photo by Laurie Smaglick-Johnson.

Coordination of Evaluation Strategy

A centrally coordinated database and monitoring system with consistent effort across years would be ideal for successful evaluation and monitoring of Golden-winged Warbler population response at relevant scales. A single Evaluation Coordinator could implement the evaluation strategy for tracking progress toward meeting the project's goals, tracking activities (land manager and landowner contacts, training workshops conducted and their outputs, awareness, etc.), recording project outputs (acres created or restored, population responses, etc.), and providing continuity with coordination of all previous aspects of the Golden-winged Warbler Conservation Initiative. This Coordinator would rely on the support of state, provincial, and federal agencies and non-governmental organizations to contribute to rangewide and regional surveys, possibly employing monitoring teams consisting of qualified volunteers and technicians to keep it sustainable, and would help research teams and land managers establish monitoring points within the focal areas and management sites. Without this centrally coordinated, long-term monitoring program of Golden-winged Warbler populations, associated species, and key sites, it will be very difficult to effectively evaluate and track the overall effectiveness of the Conservation Plan's management prescriptions to increase Golden-winged Warbler populations and improve the overall integrity of early successional communities as they begin to be implemented by land managers.

Evaluating Response at Management Site

Until a centrally coordinated monitoring system is in place, we recommend that biologists working with land managers address the following question:

Are Golden-winged Warblers present and if so, is there a breeding population?

Research has shown that documenting the presence of territorial males alone does not indicate a breeding population. Additional evidence must be gathered before you can be confident that males are acquiring mates and actually breeding. The following are two methods to help you document these two responses to management:

1. Follow the field protocol described in Appendix F to determine if Golden-winged Warblers are present.

2. If Golden-winged Warblers are located on-site, then attempt to confirm breeding activity. Probable breeding activity includes one of the following: Presence of a female Golden-winged Warbler or presence of at least 4 territorial males within singing distance of one another. Confirmed breeding activity includes observation of one of the following: copulation behavior, female carrying nest material, nest with eggs or nestlings, female or male carrying food or fecal sac, or fledglings. If your state or province is conducting a Breeding Bird Atlas, we encourage you to submit breeding evidence data to them.

Photo by Auriel Van Der Laar.

Evaluating Progress toward Conservation Objectives

The two goals of this plan can only be realized by measuring the progress towards meeting each of the objectives and specific conservation actions identified for each objective above. The actions for each objective are numerous and progress will hinge on cooperation among many organizations and agencies. We have identified specific metrics and targets for evaluating success toward meeting this plan's conservation goals and related objectives (Table 3–16).

Table 3–16. Summary of conservation, research, and monitoring objectives and suggested metrics to evaluate success of each objective.

Conservation Objectives	Evaluation Metrics and Targets
Goal 1: Increase breeding populations to meet rangewide, regional, and focal area goals.	
Maintain and increase populations through creation of quality breeding habitat for Golden-winged Warbler across the breeding range.	• Establish and fund a centrally coordinated monitoring program. • Number of individuals and breeding pairs as estimated through coordinated monitoring, BBS, and measured against stated population goals. • Track habitat acreage created via USFS FIA, WMI web tracker, and state/provincial/federal agencies.
Conserve wetland and forested landscapes.	• Number of wetland and forest acres protected especially in focal areas, as tracked through USGS Protected Areas Dataset, WMI web tracker, state/provincial/federal agencies, wetland inventories, etc. • Periodically model spatial and temporal characteristics of the forested landscapes to evaluate fragmentation and other forest trends.
Support management action through policy recommendations and prioritization.	• Acres and enrollees in state/provincial/federal habitat incentive programs. • Number of policies adjusted by federal/state/provincial agencies and number of these agencies adopting the Golden-winged Warbler conservation plan. • As forest management plans are drafted and updated, maintenance / management of ESH components are included. • Number of policy meetings attended by Golden-winged Warbler Working Group members on topics of climate, bird collisions with structures, and energy.
Coordinate management and policy activities between the USA and Canada.	• Existence of shared monitoring and conservation activities as facilitated through regular joint meetings (every 1–2 years) between U.S. Golden-winged Warbler Working Group members and Canadian Recovery Team.
Communicate the importance of Golden-winged Warbler conservation and habitat management to stakeholders.	• Number of Golden-winged Warbler Conservation Initiative website visits, attendance at webinars and workshops. • Number of new outreach tools developed and distributed. • Creation of a communication plan.

Goal 2: Identify factor(s) limiting global and regional populations to inform Goal 1.

Identify factor(s) limiting global and regional populations to inform conservation actions by undertaking the following tasks:	• Achieving Goal 2 will be measured against the development of a full life cycle research program to inform conservation activities leading to stabilization and increase in populations.
Understand demographics and response to habitat management	• Measure demographic response to habitat management at appropriate scales and develop feedback mechanism to ensure the conservation plan continues to be adaptive.
Quantify effect of cowbird parasitism	• Proportion of nests parasitized and breeding effects as measured through coordinated monitoring.
Clarify effects of interaction with Blue-winged Warbler	• Map and measure hybridization and mitigating environmental factors through coordinated research. • Successfully identify nuclear DNA markers that differentiate Golden-winged Warbler from Blue-winged Warbler
Assess connectivity between breeding grounds and non-breeding grounds and changes in distribution	• Map and measure geographic changes in population through coordinated, rangewide monitoring. • Number of countries represented in stable isotope samples and degree of successful connection between breeding and winter populations.
Identify migratory obstacles and scale of effect on populations	• Initiate research on migration ecology and stopover habitat. • Understand risk to Golden-winged Warblers and how to mitigate them.
Understand effect of climate and climate change	• Examine climatic needs of Golden-winged Warblers and periodically compare against climate change models. • Successfully add Golden-winged Warbler to National Phenology Network database.

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Appendices

APPENDIX A. GLOSSARY OF TERMS

Adaptive Management: An iterative conservation strategy where management recommendations are modified over time based on monitoring and other new information that becomes available.

Anthropogenic: An effect or object resulting from human activity.

Associated Species: Different species that are found in the same area during the same time of year. For Table 2–2 in this plan, association results are delineated by the probability of detecting the respective species based on point count surveys (high = > 30%, moderate = 15–30%, and low = < 15%).

Basal Area: The area of a breast-high cross section of a tree or of all the trees in a stand.

Biome: A major habitat type such as tundra, boreal forest, temperate broadleaf forest, etc.

Bird Conservation Regions: Ecologically distinct regions in North America with similar bird communities, habitats, and resource management issues. Bird Conservation Regions facilitate domestic and international cooperation in bird conservation, because they traverse state, provincial, and national borders. (www.nabci-us.org/bcrs.htm)

Breeding Bird Survey (BBS): A cooperative program of the U.S. Geological Survey and the Canadian Wildlife Service for monitoring population changes in North American breeding birds by using point counts along roads. Three-minute counts are done at 0.5-mi (0.8-km) intervals along a 24.5-mi (39.4-km) route. (www.pwrc.usgs.gov/bbs/)

Breeding Grounds: The specific geographic locations within the breeding range where habitat and community characteristics are such that breeding occurs.

Breeding Range: The geographic area over which breeding is carried on by individual pairs or breeding populations of a particular species.

Brood: A group of young birds hatched or cared for at the same time.

Clump: A group of plants clustered together rather than dispersed evenly. Bulluck and Harding (2010) defined shrubs that were spaced < 7 ft (2 m) apart as clumped and shrubs spaced > 7 ft (2 m) apart as scattered.

Conservation Region: A subset of the current breeding range that is ecologically similar from the perspective of regional ecological patterns, broad habitat characteristics deemed important to Golden-winged Warbler, and populations with similar demographics and spatial (continuous versus patchy) characteristics. See page 3–7 for map.

Critical Habitat: In the Canadian Species at Risk Act (SARA), critical habitat is defined as the specific habitat necessary for the survival or recovery of a listed wildlife species and is identified in the recovery strategy or in an action plan for the species.

Cryptic Hybrid: An individual that is phenotypically a normal Golden-winged or Blue-winged warbler but has mixed ancestry in its genotype.

DBH: Diameter at breast height. A common tree measurement used by foresters.

Demography: The study of group life-history patterns. Specifically, things like annual survival rates and fecundity which can then be used to estimate population change over time. In birds, for example, clutch size and survival rate during migration are important demographic factors.

DOD: U.S. Department of Defense. (www.defense.gov/)

Early Successional Habitat: Habitats such as grassland, old field, shrubland, and young forest. It can develop naturally through succession or it can be created and maintained by using various land management techniques. Some early successional habitats, such as alder swamps, may be relatively permanent, but most are constantly changing and need some sort of disturbance to be maintained.

Ecotone: A transitional area between two adjacent but different land cover types, such as forest and grassland.

Ecozones: Broad ecological zones that cover a large range of ecosystems such as temperate forest, grassland, extensive river systems, and farmlands. Each ecozone has its own climate, relief, soil, fauna, flora, and distinct human activities.
(http://atlas.nrcan.gc.ca/auth/english/maps/environment/forest/forestcanada/terrestrialecozones/1)

Feathered Edge: A border between habitat types that is not narrow and sharp but rather wide and more gradual (one habitat blending into another).

Fecundity: Birth rate, or in the case of birds, the number of young that are fledged.

Focal Area: As defined by the Golden-winged Warbler Working Group, is a place where the maintenance of a core population will be important for sustaining and growing the current distribution of Golden-winged Warblers.

Focal Species: In this plan, focal species refers to a species listed in the USFWS Focal Species strategy. The USFWS selected species that need investment because they: 1) have high conservation need, 2) are representative of a broader group of species sharing the same or similar conservation needs, 3) act as a potential unifier for partnerships, and/or 4) have a high likelihood that factors affecting status can be realistically addressed.
(www.fws.gov/migratorybirds/CurrentBirdIssues/Management/FocalSpecies.html)

Forb: An herbaceous plant that is not a grass, especially one growing in a field, prairie, or meadow.

Genotype: The inherited instructions an organism carries within its genetic code. Not all genes are expressed in the phenotype, however. The cryptic hybrids discussed in this plan are a good example. An

individual can look like a Golden-winged Warbler, but it may have some Blue-winged Warbler genetic material in its genotype.

Geolocator: A lightweight electronic tracking device usually used in bird migration research. It records changes in light levels at different latitudes and longitudes. It uses low power technology and data compression, so it is able to record data for long periods of time. Geolocator data are not as accurate as GPS data, but the devices are lighter and cheaper.

Habitat Edge: The distinct boundary between different habitat types or between distinctly different successional stages of the same habitat.

Habitat Interspersion: The intermixing of patches of different habitat types.

Habitat Turnover: Changing from one seral stage to another (succession). In this document, habitat turnover refers to suitable habitat changing to unsuitable habitat.

Herbaceous Cover: Plant cover that includes grasses, sedges, and forbs (non-woody plants).

Hybridization: Breeding that occurs between two individuals of different, but usually closely-related, species.

Incidental Take: The accidental harm to an individual or species caused by management activities.

Introgression: The movement of genes from one species into another closely related species. It results from successful hybridization and subsequent backcrossing of the hybrids with one of the parental populations.

Joint Venture: A partnership of state and federal agencies, non-governmental organizations, and industries who work together to ensure the long-term sustainability of native bird populations. There are many habitat and regional Joint Venture partnerships in the U.S.

Keystone Species: In this plan, keystone species refers to one of a set of species identified by the National Fish and Wildlife Foundation. They are imperiled species that are a high priority for state or federal agencies and for which NFWF believes its investment can make a measureable impact.

Land Cover: As offered by the Multi-Resolution Land Characteristics Consortium (www.mrlc.gov/) where land cover classes are defined into 21 different classes using the Anderson Level I and Level II (Anderson 1976; Cowardin et al. 1979).

Land cover classification definitions as follows:

Barren land - Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

Coniferous (Evergreen) Forest - Areas dominated by trees where 75% or more of the tree species maintain their leaves all year. Canopy is never without green foliage. At the site scale, this generally

includes trees greater than 16 ft (5 m) tall and greater than 20% of the vegetation cover. At the landscape scale, these values are unknown.

Cultivated crops – Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation, this class also includes all land being actively tilled.

Deciduous Forest – Areas dominated by trees where 75% or more of the tree species shed foliage simultaneously in response to seasonal change. At the site scale, this generally includes trees greater than 16 ft (5 m) tall and greater than 20% of the vegetation cover. At the landscape scale, these values are unknown.

Emergent Herbaceous Wetlands – Areas where perennial herbaceous vegetation accounts for 75-100% of the cover and the soil or substrate is periodically saturated with or covered with water.

Mixed Forest – Areas dominated by trees where neither deciduous nor evergreen species represent more than 75% of the cover present. At the site scale, this generally includes trees greater than 16 ft (5 m) tall and greater than 20% of the vegetation cover. At the landscape scale, these values are unknown.

Pasture/Hay – Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.

Shrub/scrub – Areas dominated by shrubs; less than 16 ft (5 m) tall with shrub canopy typically greater than 20% of the total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions that tend to be drier than woody wetlands.

Woody Wetlands – Areas where forest or shrubland vegetation accounts for 25-100% of the cover and the soil or substrate is periodically saturated with or covered with water.

Landscape: A large area surrounding a Golden-winged Warbler observation or management site. In this plan, we often refer to macro landscape (within 1.5 mi (2.5 km)) and micro landscape (within 0.15 mi (0.25 km)).

Management Site: The area that is receiving active habitat management, and the contextual habitat that will potentially receive management action in the future. Management sites can range in size from a few acres or hectares to hundreds of acres or hectares.

Micro-edge: As used in this plan, a micro-edge is any readily perceived change in vegetation type or height, such as where grasses change to sedge at the border of a wet area or where an herbaceous opening is bordered by dogwood or *Rubus* shrubs.

Model (Modeling): A description of a system that uses mathematical concepts and language. To use a mathematical formula to describe the behavior of a system.

Neotropical Migrant: A bird species that winters in the Neotropics (Central America, South America, and West Indies) and breeds in the Nearctic (North America).

Nest Site: The area immediately around the nest itself (within a 33-ft (10-m) radius).

NFWF: National Fish and Wildlife Foundation (www.nfwf.org/AM/Template.cfm?Section=Home)

NGO: Non-governmental Organization. Generally, they are non-profit citizens' groups which are organized and run by people with a common interest.

NPS: U.S. National Park Service (www.nps.gov/index.htm)

Occurrence: The presence of a particular species at a given place.

Partners in Flight Watchlist: Bird species that have multiple reasons for conservation concern across their entire ranges. They were identified in the PIF North American Landbird Conservation Plan (Rich et al. 2004). (www.partnersinflight.org/watchlistneeds/Research%20Crosswalk%20Taxon.htm)

Patch: In this plan, we use the term patch to refer to a smaller unit residing within a management site that is the focus of current or future activities.

Phenotype: The observable characteristics of an organism that are produced by a combination of genotype and the influence of environmental factors (appearance). Not all genes are expressed in the phenotype, however. The cryptic hybrids discussed in this plan are a good example. An individual can look like a Golden-winged Warbler, but it may have some Blue-winged Warbler genetic material in its genotype.

Population: All the individuals of the same species that live in the same geographic area.

Remotely Sensed Data: Information used to detect and classify objects on the Earth that is collected by using aerial sensors or cameras mounted on aircraft or satellites.

Sapling: In general use, a young tree. In forestry terms, a tree that is taller than 4.5 ft (1.4 m) and is 0.4–4 in (1–10 cm) DBH.

Sawtimber: A log or tree that is large enough to be sawn into lumber (usually at least 10–12 in (25–30 cm) in diameter and a minimum of 8 ft (2.4 m) in length).

Seral Stages: The series of plant communities that develop during ecological succession as an area moves towards its climax community. Annual plants, perennials and grasses, shrubs, softwood trees, hardwood trees, for example.

Shelterwood Harvest: The removing of trees in a series of two or more cuttings so that new seedlings can grow from the seed of older trees (leave trees). This method ultimately produces an even-aged forest. The new stand is established under the shelter of the leave trees, and then the leave trees are removed when the new even-aged stand is well developed.

Shrub: A low, usually several-stemmed woody plant.

Silviculture: The practice of controlling the establishment, growth, composition, and quality of forest vegetation to meet landowner objectives. In other words, the agriculture of forest trees.

Single-brooded: Normally raise one brood per breeding season. Single-brooded species may renest, however, if the first nest fails for some reason.

Site: The specific area where something has happened or is happening. See management site and nest site.

Source-sink Demographics: An ecological theory describing how variation in habitat quality may affect population levels of organisms. The source is an area of high quality habitat that allows the population to increase. The sink is an area of low quality habitat that cannot support a population by itself. If the excess individuals from the source area frequently move to the sink area, however, the sink population can survive.

Spatially Balanced Monitoring: A type of monitoring where the sample sites are more or less evenly dispersed over the extent of the resource that is being monitored. This is opposed to the commonly used random sampling.

Species of Greatest Conservation Need: High-priority species as identified by individual State Wildlife Action Plans.

Stable Isotope Research: In ornithology, a technique used to identify the general area where a feather was grown. The food that birds eat while growing feathers contains isotopes of hydrogen, carbon, and nitrogen, and these isotopes vary in known patterns across the landscape. The isotopic content of a feather reflects the bird's diet when the feather was grown, and, thus the area where the feather developed.

State Wildlife Action Plans: Plans (technically known as comprehensive wildlife conservation strategies) developed by each state and territory. Congress ordered the plans to make the best use of the federal funds provided through the Wildlife Conservation and Restoration Program and the State Wildlife Grants Program.

Subregion: A smaller spatial extent of a Conservation Region containing one or more ecologically similar focal areas. See pages 3–46 and 3–63 for maps.

Succession: The process of more or less orderly and predictable changes in the species composition and structure of an ecological community over time. It can follow either disturbance or the initial colonization of bare land.

Territory: The defended area in which the male and female spend the bulk of their time during the breeding period. Territory size varies with habitat quality and type, but a good frame of reference for Golden-winged Warbler is 2–5 ac (1–2 ha).

USFS: U.S. Forest Service (http://www.fs.fed.us/)

USFWS: U.S. Fish & Wildlife Service (www.fws.gov/)

WMI: Wildlife Management Institute (www.wildlifemanagementinstitute.org/)

APPENDIX B. ADDITIONAL INFORMATION AND RESOURCES

- Golden-winged Warbler Conservation Initiative website (contains a webpage with resources and a list of published literature): www.gwwa.org/

- Golden-winged Warbler Habitat Best Management Practices for Forestlands in Maryland and Pennsylvania (Bakermans et al. 2011) : www.abcbirds.org/abcprograms/domestic/pdf/GWWA_bmp_FinalSmall.pdf

- Natural Resources Conservation Service Golden-winged Warbler programs and services: www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/?&cid=stelprdb1046990

- U.S. Fish & Wildlife Service Golden-winged Warbler information: www.fws.gov/midwest/MidwestBird/birds_golden_winged_warbler.htm

- Birds of North America account (requires a subscription or institutional access): bna.birds.cornell.edu/bna/species/020/articles/introduction

- Ontario's Forest Management Guides, including topics on landscape-scale management, conserving biodiversity at the stand and site scale, and natural disturbance pattern emulation, are available at: www.mnr.gov.on.ca/en/Business/Forests/2ColumnSubPage/STEL02_164533.html

APPENDIX C. ESTIMATING THE RISK OF QUASI-EXTINCTION

To estimate extinction risk for Golden-winged Warbler, we used a count-based population viability analysis first developed for estimating extinction risk of Pacific salmonid stocks (McClure et al. 2003, Holmes et al. 2007). This approach has been used for estimating extinction risk in other rare species of concern, namely Cerulean Warbler (*Setophaga cerulea*) (Thogmartin et al. 2006) and shortjaw cisco (*Coregonus zenithicus*) (Bronte et al. 2010). The approach estimates extinction risk by way of a diffusion approximation from data that contain environmental noise in year-to-year transitions in population indices ("process error"), random errors in sampling, and possible biases in the samples; these latter two sources of error are described as "non-process error" (Holmes 2004, Holmes et al. 2007). A Bayesian sampling-importance-resampling (SIR) algorithm addressed uncertainty in the parameter estimates given the data. Thus, rather than developing a single function describing the probability of population extinction, the methodology employs uncertainty in the parameter estimates to estimate the uncertainty surrounding the probability of extinction through time. These probabilities of probabilities were derived from a large number of candidate vectors chosen at random from prior distributions and their importance (i.e., their contribution to the likelihood). Samples of these vectors were drawn—with replacement and in proportion to their importance—to generate a sample from the posterior distribution. A state-space Kalman filter, evaluating likelihoods from a running-sums method (Holmes 2004), was used to discriminate process error from non-process error.

Population viability was predicted at levels above which demographic stochasticity and Allee effects may become important (Lande et al. 2003, Fagan and Holmes 2006). As such, we did not estimate absolute risk of extinction per se, but rather the potential for *quasi-extinction*—a drop in the population below some subjective level. Both the World Conservation Union's International Union for the Conservation of Nature (IUCN) risk criteria (Mace and Lande 1991) and the proposed quantitative criteria for the U.S. Endangered Species Act (DeMaster et al. 2004) rely on quasi-extinction probabilities for inference.

Setting a quasi-extinction level is not necessarily straight-forward, as it can be subjective and value-laden. Ordinarily, a minimum detection level is selected in accordance with the survey method used to assess population trend for the species in question. However, in the trend analyses for Breeding Bird Survey (BBS) counts, it is not clear what minimum detection level exists. Thus, to overcome this uncertain minimum detection issue, quasi-extinction was calculated for a relative abundance index of 10% of the year 2000 estimate. This, in effect, calculates the probability of obtaining an additional 90% decline from the year 2000 population.

APPENDIX D. COLLABORATIVE RESEARCH STUDY SITES

The study sites listed below collaborated during the 2008-2010 Golden-winged Warbler Rangewide Conservation Initiative to provide the nest monitoring and detailed habitat measurements that resulted in the analysis and consequent management guidelines presented in Chapter 3. Coordination of research objectives and shared protocols across the entire Golden-winged Warbler breeding range (and including seven states) provides an excellent example of the kind of focused research activity possible under the broad umbrella of an active Golden-winged Warbler Working Group. Funding for the 2008-2010 study was provided by the National Fish and Wildlife Foundation and partner match. Several of the sites had been involved in Golden-winged Warbler monitoring, research, and management prior to the period of the collaboration, as indicated below.

Tamarac National Wildlife Refuge. Becker County, west-central Minnesota. 2008-2010. *Site Description:* Mixed hardwood and conifer forest with successional habitats, usually associated with harvest. *Principal Investigator and co-PIs:* J. Loegering (University of Minnesota), H. Streby, D. Andersen.

Northern Highlands State Forest. Vilas, Oneida, and Iron counties, north-central Wisconsin. 2007-2010. *Site Description:* Aspen forests in three age classes (2-10, 10-20, 20+ years) and three retention types (oak, conifer, none). *Principal Investigator and co-PIs:* A. Roth (Michigan Tech University), D. Flaspohler, C. Webster.

Central Sand Plains Ecological Landscape. Wood, Clark, Jackson, and Juneau counties, central Wisconsin. 2008-2009. *Site Description:* Six sites each in young aspen stands, young hardwood stands, and swamp edges. *Principal Investigator and co-PIs:* M. Fowlds (University of Wisconsin), S. Lutz, K. Martin (Wisconsin Department of Natural Resources).

Watauga County, North Carolina. Northwestern North Carolina. 2007-2012. *Site Description:* Successional forests at mid to high elevations (>1000 m). *Principal Investigator:* C. Smalling (Audubon North Carolina).

North Cumberlands Wildlfife Management Area. Scott, Campbell, and Anderson counties,northeastern Tennessee. 2003-2012. *Site Description:* Reclaimed coal mines at elevations >600 m. *Principal Investigator and co-PIs:* D. Buehler (University of Tennessee), L. Bulluck, K. Percy, K. Caruso.

Monongahela National Forest. West Virginia. 2008-2012. *Site Description:* Grazing allotments. *Principal Investigator and co-PIs:* P. Wood (West Virginia Cooperative Fish and Wildlife Research Unit), K. Aldinger (West Virginia University).

Sproul State Forest (SSF) and Bald Eagle State Park (BESP). Clinton and Centre counties, central Pennsylvania. 2008-2012. *Site Description:* SSF— successional habitat associated with 10,000 ac (4,046 ha) burn within a forested matrix; BESP— barrens, state park lands managed for shrub habitat. *Principal Investigator:* J. Larkin (Indiana University of Pennsylvania).

Sterling Forest State Park. Orange County, southeastern New York. 2000-2011. *Site Description:* Restoration footprint— herbs and shrubs, especially coppice growth; adjacent swamp forests— tussock sedge and <70% canopy closure; marsh— < 30% canopy closure with tussock sedge and marsh fern. *Principal Investigator:* J. Confer (Ithaca College).

APPENDIX E. ANALYSIS METHODS FOR HABITAT ASSOCIATIONS AND PREDICTIVE SPATIAL MODELING ACROSS MULTIPLE SPATIAL SCALES

Analysis of Rangewide Habitat Characteristics

A dataset of 31,555 "modern" (1998-2010) occurrence points for the Golden-winged Warbler and Blue-winged Warbler were collected from 5 primary sources: 1) Golden-winged Warbler Project data managed by the Cornell Lab of Ornithology (n = 8281), 2) Summer eBird records (n = 17,644; Sullivan et al. 2009), 3) Warbler data collected by collaborators (n = 1693), 4) Breeding Bird Atlas (n = 1128), and 5) BBS (n = 2809).

We examined the distributions of Golden-winged Warbler and Blue-winged Warbler as a function of climatic and ecological variables using an ensemble forecasting approach. This method mitigates for inter-model variation by employing several models within a single framework and the resulting projections analyzed (Araujo and New 2006). The ensemble is composed of several simulations, each of which permutes the initial conditions, model class parameters and boundary conditions. The final projection is evaluated through a measure of the central tendency across all model output.

The distribution of the Golden-winged Warbler, Blue-winged Warbler, and hybrids was modeled with 16 variables related to temperature and precipitation (Hijimans et al. 2005; www.worldclim.org), land cover characteristics, and elevation at 0.6 mi (1 km) and 3 mi (5 km) spatial scales. A third set of analyses at the 500m scale excluded climatic variables (unavailable at this scale). To examine how ecological variation influences warbler distribution at different spatial scales, analyses were conducted at the rangewide scale, the Conservation Regions scale (Great Lakes and Appalachian Conservation Region) and at the focal sub-regional scale (See Chapter 3, Part II, page 3–46). We chose environmental variables that characterized early-successional habitat. Studies of early successional habitat landscapes demonstrate that these landscapes are characterized by a high degree of spatial heterogeneity, with relatively open canopy, dense and a well-developed sub-story community of shrub and perennial herbaceous species (Swanson et al. 2011).

Environmental parameters indicating Golden-winged Warbler distribution were modeled using an ensemble approach, where the consensus or median model is calculated from among the models with the highest levels of support (Thuiller et al. 2009; Angelo-Marini et al. 2010). The predictive performance of each model was evaluated by selecting 80% of the data to train the model, and the remaining 20% used for model testing. To ascertain the central tendency across the model simulations and to calculate the final projection, we selected the 4 models with the highest AUC and kappa criteria, and then calculated the un-weighted average probability distribution across all pixels. This mean model was then used to project the species distribution. In the Appalachian region, elevation was the most important predictor of distribution with Golden-winged Warbler occupying higher elevations compared to Blue-winged Warbler. Elevation was followed in importance by the percent of deciduous forest present within the study area, vegetation height, and maximum summer temperature. In general, we found Golden-winged Warblers tend to occupy habitat that is cool, dry, at moderate to high elevation (range approximately 1000–2500 ft (~330–762 m) and composed of approximately 50% deciduous tree species that were between approximately 16–65 ft (5–20 m) in height. These results inform suggested management prescriptions at the landscape and regional scales (See Chapter 3).

Focal Area Group Identification

A set of 12 independent variables was preliminarily identified as significant to Golden-winged Warbler habitat selection at the 0.6 mi (1 km) scale (see Chapter 3, Part II, page 3–46). A principal components analysis was conducted to examine how variation among the independent variables was distributed among focal areas. Results demonstrated that more than 92% of the variation was explained by the first three principal components. High eigenvalues on the first component represent a trend from high to low elevation. The second principal component is associated with large values for % vegetative cover and vegetation height. The third principal component represents variation in the type of tree community present within the study area, with large positive values associated with deciduous trees such as aspen, maple and birch, and low values associated with coniferous species. The principal components analysis reduced the 34 focal areas to 11 ecologically distinct focal subregions (Figure AP–E1).

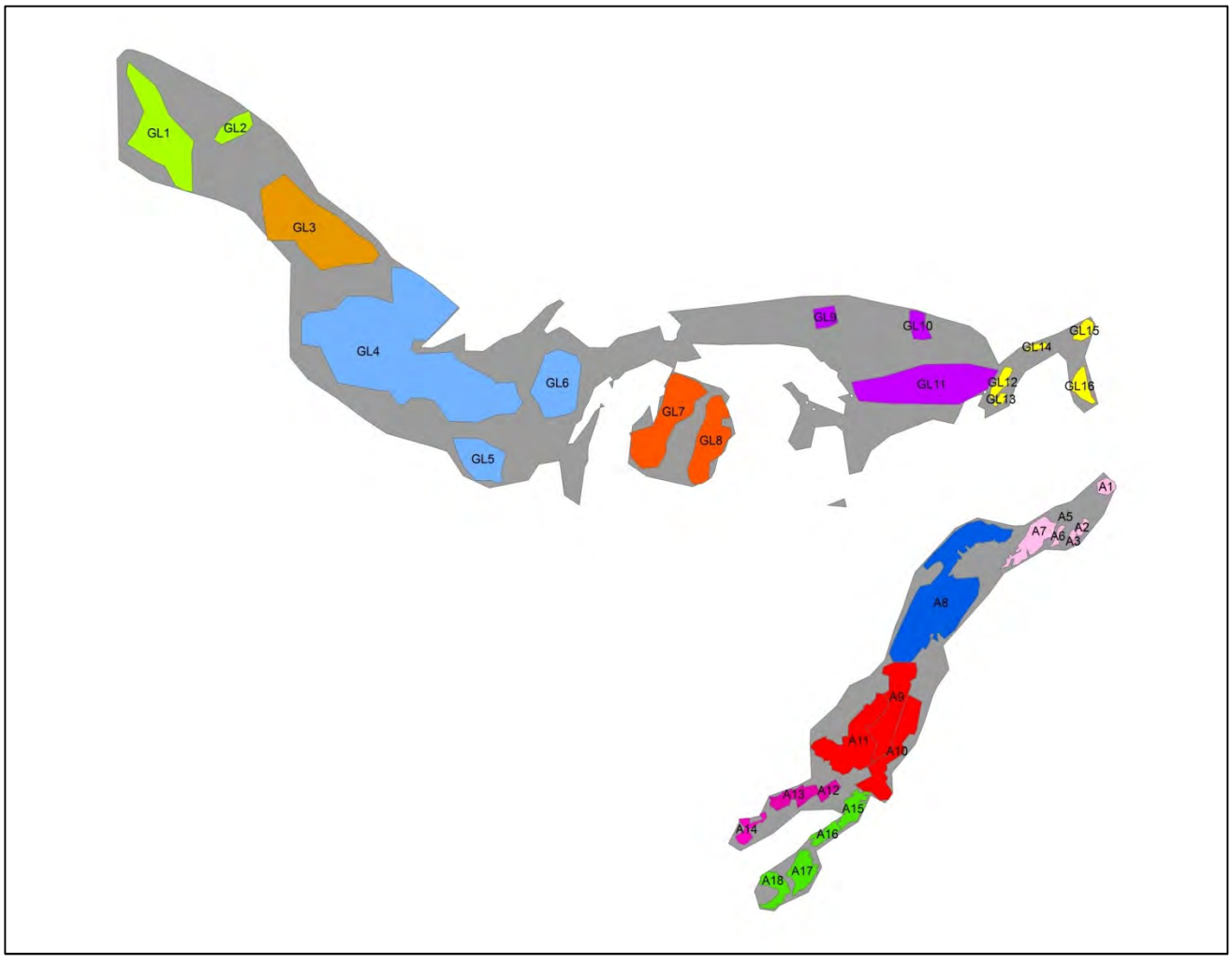


Figure AP–E1. Focal Area groups identified from analysis of environmental data. Each focal area group is indicated as a distinct color.

Predictive Habitat Modeling

Locality data and habitat characteristics indicative of Golden-winged Warbler habitat identified from previous analyses were used to parameterize models that indicate where the species was likely to occur, given habitat preferences. Data for the Blue-winged Warbler was included to examine the degree of overlap between the predicted distributions of the two species. The predictive models were calculated using a multi-model inference approach in R v.2.12. This approach constructs a set of candidate models, and each model is constructed using different assumptions about the fit of the data (assumptions: 1) data normally distributed; 2) no assumptions). We used an ensemble forecasting approach to project warbler distributions using R v.2.1.2. Predictive distribution models for both species exhibited great levels of support ($AUC_{Golden\text{-}winged\ Warbler}$ = 0.912; $AUC_{Blue\text{-}winged\ Warbler}$ = 0.878). The predicted range for both species was most distinguished at the rangewide scale by differences in elevation and land cover type similar to results from habitat analyses. Despite the degree of overlap in the predicted distribution of the species, models depicted areas in the southern Appalachians and in the upper Midwest where Golden-winged Warbler is expected to occur in the absence of Blue-winged Warbler. Notably, some of these areas occur outside the boundary of current focal areas. These areas of allopatry suggest places where management strategies to promote genotypically pure populations of Golden-winged Warbler may be most effective.

Modeling Hybridization Dynamics

Spatial and temporal extent of study

Recent work on the distribution of the Golden-winged Warbler identified two primary management and conservation regions within the breeding range of the species that delimited relatively stable populations over time; a region across the northern end of the Golden-winged Warbler range (Upper Great Lakes and Canada polygon) and a second region across the Appalachian Mountain region (Appalachian polygon). This current breeding range of the Golden-winged Warbler was set as the spatial extent of the hybridization analysis. The resultant data was partitioned into historical (1935–1997; n = 13,012) and current (1998–2010, n = 27,455) time periods following Crawford et al., 2012 (in prep). Historical data was not considered in this study.

Genotypic Data

A dataset of 2105 records resulted from the NFWF Genetic Atlas Project (1999–2010). This dataset consists of two classes of information: 1) the number of birds identified phenotypically in the field as Golden-winged Warbler, Blue-winged Warbler or hybrid; and 2) the genotypic identification for each bird record based on a blood sample. A genotyping method developed at the Cornell Lab of Ornithology was used in the genotypic analysis (Vallender et al. 2009). The combination of phenotype/genotype combinations helped to identify hybrid birds (Table AP–E1). The data was projected in ArcGIS v.10.0 to classify the data into 50 unique study sites (Figure AP–E2). The number of genotypic Golden-winged Warbler, Blue-winged Warbler, and hybrids were summarized for each study site (subsequently, "species" for analysis purposes).

Table AP– E1. The phenotypic/genotypic combinations assessed in this study.

Phenotype of bird	Genotype of bird	Study Category
Golden-winged Warbler	Golden-winged Warbler	Pure Golden-winged Warbler
Golden-winged Warbler	Blue-winged Warbler	Cryptic hybrid
Blue-winged Warbler	Blue-winged Warbler	Blue-winged Warbler

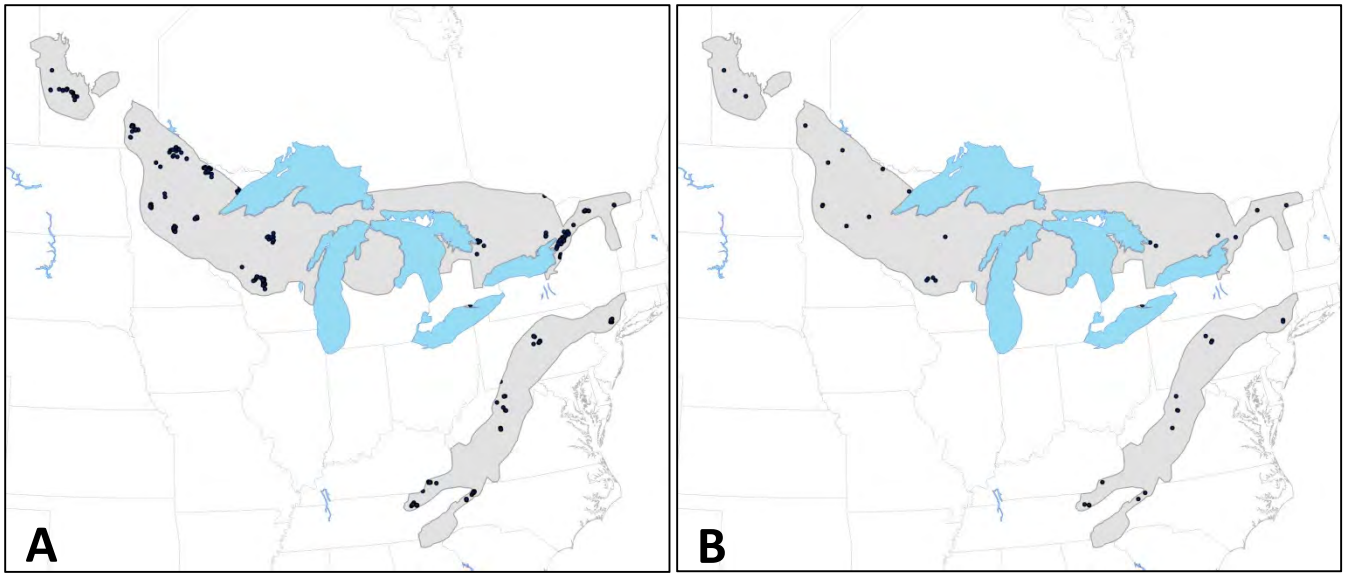


Figure AP– E2. Distribution of genotypic data (A), and the 50 unique sites identified (B).

Genotypic Correction

To correct for variation associated with the identification of cryptic hybrids in the field, a correction factor was developed. Here, the number of cryptic hybrids was divided by the total number of Golden-winged Warblers originally identified for each study site to yield a spatially explicit correction that was subsequently applied to observational data from numerous field surveys.

Predicting hybridization across the breeding range

A model was constructed to estimate the likelihood of hybridization across the current breeding range of the Golden-winged Warbler. The final model used to estimate hybridization was composed of 4 sub-models: 1) an ecological model that described the habitat characteristics of the species; 2) a climate model that estimated suitable habitat given temperature and precipitation; 3) an elevation model; and 4) a model that described the probability that both a Golden-winged and a Blue-winged Warbler co-occurred within the study area (i.e. 0.6 mi (1 km) grid cell). Model performance was evaluated using permutation and evaluation (i.e. comparison of AUC values after multiple runs of each model) so that the most likely sub-model was fed into the final model, which was evaluated in the same manner.

The locality data used in the hybrid model was a phenotypic dataset that included the latitude, longitude and species identification based on appearance. A genotypic correction (see above) was applied to the phenotypic data to correct the number of Golden-winged Warbler reported with the percentage that are likely cryptic hybrids. The phenotypic data included 37,767 occurrence points for Golden-winged Warbler and Blue-winged Warbler. Data were pooled from 5 primary sources: 1) Golden-winged Warbler Project data managed by the Cornell Lab of Ornithology (n = 8137), 2) Breeding Bird Census (n = 397), 3) Breeding Bird Atlas (n = 10,834), 4) Summer eBird records (n = 17,637; Sullivan et al. 2009), and 5) Warbler data collected by collaborators (n = 762).

The same climate, elevation and habitat characteristics identified from previous analyses as influential to the Golden-winged Warbler (Chapter 3, Part II) were examined in this analysis. A model that represented the likelihood that both Golden-winged and Blue-winged warblers were both present within the study area was estimated. The probabilities were modeled with a binomial distribution, p_{GW} and p_{BW} and the joint probability was p_{GW} x p_{BW}.

Nest Habitat Selection

We conducted an analysis of nestsite characteristics to examine habitat selection at a smaller scale (i.e. compared with rangewide or regional analyses). Surveyors collected nest site parameters from paired observed and random locations using a standardized protocol. The following parameters were measured at seven survey locations in five states during 2008–2010:

- % Litter cover
- % Bare cover
- % Woody cover
- % Vine cover
- % *Rubus* cover
- % Other cover
- Edge distance
- Mean vegetation density
- Mean Litter depth
- Sapling height
- Shrub height
- Snag count
- Basal Area

The analysis consisted of a saddlepoint approximation (SSA) and conditional logistic regression analyses. First, an SSA analysis takes advantage of the paired observed versus random sampling scheme, which is suited to an evaluation of habitat use versus availability. Here, SSA was conducted where the upper and lower values for habitat parameters are a proxy for habitat suitability. The cumulative frequency distribution for each variable was modeled using several functions (i.e. Poisson, Gaussian) and evaluated. The model with the highest support was transformed into a probability density function (pdf). The pdf was plotted against the distribution of random points to yield the selection function for each habitat parameter. In this way, a selection function > 1 indicates selection of a habitat characteristic and a function < 1 represents avoidance (Arredondo et al. 2007). Following, a conditional logistic regression was conducted to evaluate the effects of multiple habitat parameters on nest site selection. Through all analyses and across sites, five habitat parameters best explain nest site selection by the Golden-winged Warbler (% woody cover, % forb cover, % grass cover, vegetation density, and % *Rubus* cover).

Nest Success Analysis

We examined the habitat parameters most influential to nest success in the Golden-winged Warbler. Data for Blue-winged Warbler and known hybrids were included for comparison. Nest success was measured primarily through the number of fledglings, clutch size, and mean daily survival. Analyses of clutch size and fledgling number compared to hybrids demonstrated lower overall nesting success of Golden-winged Warblers. Habitat parameters on nest survival were modeled. The explanatory power of each model was evaluated using the Akaike's Criterion including a penalty for extra parameters (AIC_c), for which the performance of a model is measured by how much information is lost (the model with the lowest AIC_c value is considered the best supported). A model of % grass cover and nest height were among the best supported (AIC_c = 945.801) compared to a model with no habitat parameters (AIC = 959.89).

Genetic-Habitat Analyses

We examined the relationship between habitat covariates and presence of the Golden-winged Warbler, Blue-winged Warbler and cryptic hybrids (hereafter, "species") using analysis of variance and regression in R v.2.14.1. Data on the vegetative community for this Genetic-Habitat project was collected from survey sites in New York, West Virginia, Tennessee, North Carolina, Pennsylvania and Wisconsin (Table AP–E2). The nested spatial scale examined plant structure and composition at 3 scales; 1m plots, 5m plots and 11.3m plots (Figure AP–E3). Data was collected during 2009-2010, though not for all sites.

Table AP– E2. Examples of vegetative characteristics examined as a function of Golden-winged Warbler, Blue-winged Warbler and hybrid presence at three scales.

Vegetation characteristic	**Scale**
% grass cover	1m
% forb cover	1m
% fern cover	1m
% *Rubus* spp.	1m
# shrubs 1-2m in height	5m
# shrubs > 2m in height	5m
# saplings < 10cm dbh	5m
Shrub and tree species	11.3m
Tree species diversity	11.3m
# snags	11.3m

Data was vetted and errors removed, and then aggregated into 3 datasets, one for each of the 3 spatial scales. At the 11.3m scale, we also included the as an additional habitat covariate of tree species diversity to test its effect on warbler presence. The species reported for each record was treated as the dependent variable, with 3 groups. We compared the habitat characteristics to presence as species-pair comparisons: 1) Golden-winged Warbler versus Blue-winged warbler, and 2) Golden-winged Warbler versus hybrid. We tested the hypothesis that groups differ in habitat use using a hierarchical analysis of variance approach. First, we tested the effect of the independent variables on group membership using a multivariate analysis of variance. Independent variables that were not significant to Golden-winged Warbler/Blue-winged Warbler/hybrid membership in the MANOVA were dropped from subsequent analyses. Following, we examined the difference between group means among the independent variables using a post-hoc in a univariate analysis of variance with the LSD test, which minimizes Type I errors. Bar plots were also used to visualize the habitat differences between species pairs. A series of multivariate regression analyses were conducted to identify the independent variables that were the best predictors of group membership.

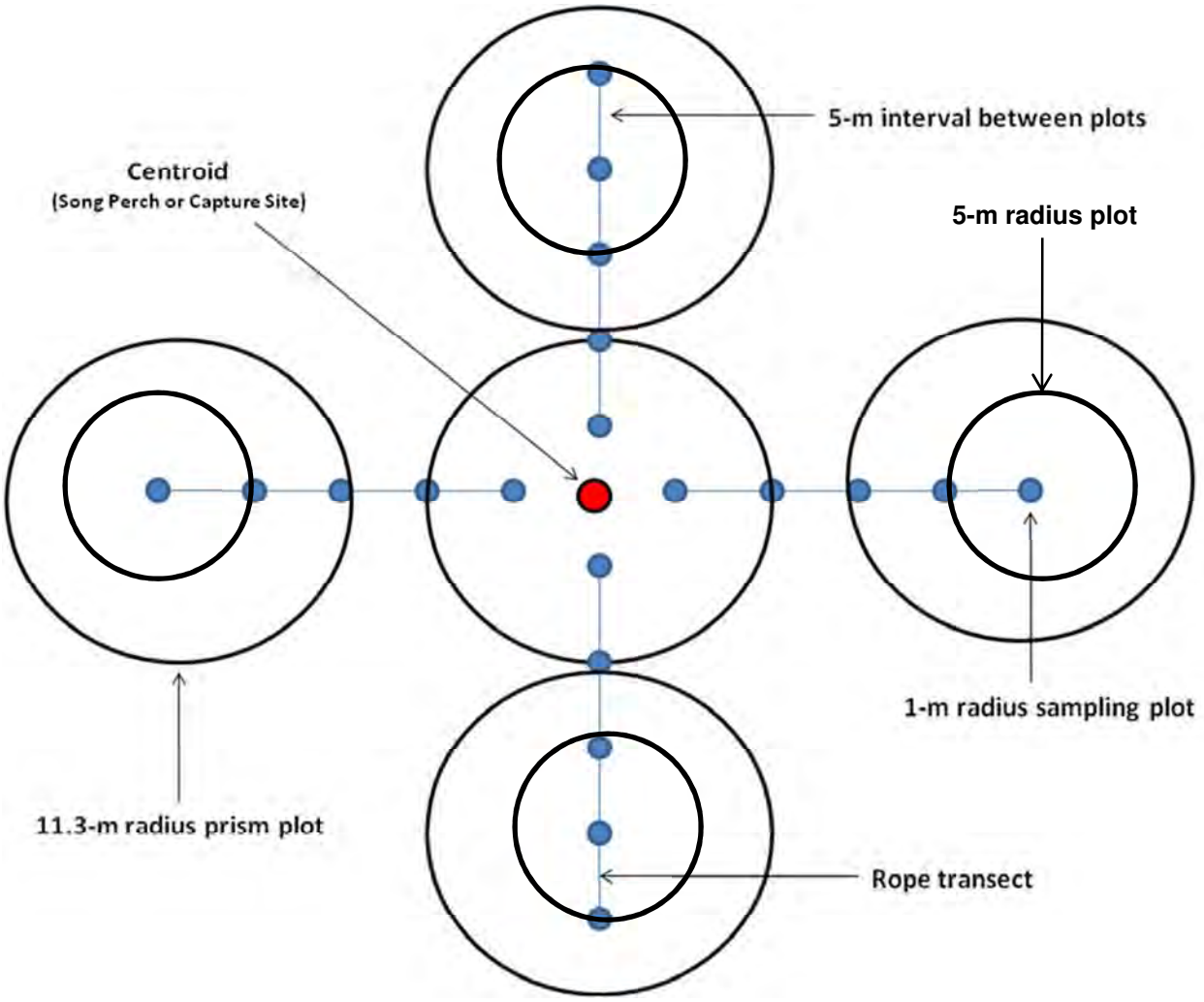


Figure AP– E3. Spatial sampling scheme for the Genetic-Habitat Project.

APPENDIX F. SPATIALLY BALANCED MONITORING PROTOCOL AND DATA FORM

The patchy nature of present-day Golden-winged Warbler distribution prevents effective surveying with traditional methods, such as the North American Breeding Bird Survey (BBS). This makes estimates of regional population size and trend difficult. To overcome these problems, the Golden-winged Warbler Working Group, under the NFWF-funded Golden-winged Warbler Conservation Initiative, developed and tested a spatially balanced sampling methodology (see page 3–89) aimed at establishing a monitoring strategy that is effective for patchily distributed species, but not overly cumbersome or costly to implement.

This spatially balanced monitoring design was pilot-tested in Pennsylvania in 2008 and throughout the Appalachian Region in 2009, and implemented successfully during the 2010 and 2011 breeding seasons. Partners in nine states, with supplemental support from USFWS, carried out Golden-winged Warbler sampling at roughly 520 points each year, giving us the ability to detect significant regional population changes. Wildlife agencies in eight states (KY, MD, NC, NJ, PA, TN, VA, WV) have committed to future monitoring of sampling points within their states.

Note: This protocol was initially developed for only the Appalachian region; however, given the BBS program has route-level data deficiencies for Michigan, Wisconsin, Minnesota, Quebec, and Manitoba, the spatially balanced monitoring protocol is being considered for expansion to the Great Lakes region as well.

Below you will find a snap shot of what was distributed to participants during the project. Included is an example of the protocol instructions and data form from a single year. Participants also received an example data form with fields pre-filled to act as a reference, an MP3 file of the playback sequence, and an excel spreadsheet for data entry that included a data dictionary to explain the various entry fields and the site locations and coordinates from the previous season.

Golden-winged Warbler Monitoring Protocol

In 2009, the Cornell Lab of Ornithology, along with partners in the Appalachian region, will broaden the application of a spatially balanced sampling design to monitor Golden-winged Warblers. In 2008, we pilot tested a similar design in Pennsylvania and now hope to apply a refined version to begin monitoring population trends throughout the Appalachians and portions of New York.

Golden-wings are patchily distributed and poorly sampled by the Breeding Bird Survey and other similar surveys; thus a long-term monitoring methodology is needed to track occupancy, relative abundance, and population trends. The methodology must be able to both monitor known sites without the biases associated with non-random sampling and ameliorate the logistical drawbacks of randomization. At the point level, the design must employ an efficient survey protocol, capable of detecting uncommon species with regularity. The points you visit this year, and in subsequent years, are a subset of 100 monitoring locations from New York to North Carolina that have been established using geo-spatial tessellation algorithms in SPsurvey(http://www.epa.gov/nheerl/arm/analysispages/software.htm). The 100 quarter Delorme pages were selected from a pool of 425 that had positive reports of golden-wings from the Cornell Lab of Ornithology's Golden-winged Warbler Atlas Project (1999-2005). We hope that by monitoring points over time, we will be able to efficiently track golden-wing populations region-wide to help formulate conservation decisions and provide early indications of potential population collapses.

Objectives for the 2009 field season

- Test the feasibility of spatially balanced sampling (monitoring) at a region-wide scale in the Appalachians.
- Determine habitat suitability status of initial 500 monitoring points (5 in each of 100 quads) and identify replacement points where necessary.
- Begin collecting population data to model occupancy, relative abundance, and population trends.
- Complete final year of field testing the passive/playback detection protocol.
- Identify imperiled subpopulations and locations for conservation action.
- Determine presence/absence of early successional indicator species at points with and without golden-wings.

Suggested Dates for Surveys

Central Pennsylvania and southern states:
May 10 to June 15
Central Pennsylvania and northern states:
May 15 to June 20

Please note, repeat visits are unnecessary for implementing the spatially balanced monitoring protocol. However, it is okay if you want to make repeat visits for your own data collection requirements.

Time of Day to Survey

Identification must be based on visual ID of the study species and, therefore, should not begin until there is sufficient light to recognize subtle differences in plumage. We recommend that you start your surveys around sunrise.

Monitoring should end by the following times:
By 11:00 am before May 20/May 25
By 10:30 am between May 20/25 and May 31/June 5
By 10:00 am between May 31/June 5 and June 15/20

Identifying Suitable Habitat

A key to the success of this monitoring protocol is to ensure that points are located in suitable golden-wing habitat. Golden-wings, blue-wings and hybrids frequently nest in dry, upland sites produced by natural succession on abandoned farmland and in openings of forest clear cuts or power-line ROWs. They also occur in alder swamps, beaver meadows, and along the edge of tamarack swamps. In dry areas the herbaceous growth usually includes goldenrod, while the shrubs include dogwood, witchhazel, raspberries, and *Viburnum*. In wetter areas the vegetation includes sedge, alder, willow, and dogwood, and sometimes cattails. They occur in young conifer plantations that still have deciduous vegetation and abundant open areas between the trees.

Golden-wing and blue-wing territories are large, typically 2-5 acres (1-2 hectares). Oblong territories often extend for 600 feet (175 meters). Territories will usually be dominated by herbaceous growth with patches of shrub, including some forested edge. Territories often include some taller trees, especially along edges, which are used as singing perches. Most golden-wing territories have less than 60% herbaceous growth and less than 10% forest cover. Most territories include patches of shrub that are over 10 feet (3 meters) tall and unmowed or ungrazed herbaceous growth. Since golden-wings are found in a wide variety of shrub habitat in natural and manipulated areas, locating suitable habitat may require some preliminary searching on your part.

Selecting New Survey Points

The latitude and longitude for your survey points have been sent to you previously. You will be surveying 5 points within each selected Delorme atlas quarter page or quad.

There are three possible reasons why you may need to select new (additional up to 5) points within a Delorme quad in addition to those that were sent to you; 1) an original point has become unsuitable, 2) there were not 5 points within the original Hybrid Index quad due to its size (small inset instead of full page), or 3) the quad was selected based on Population Survey data and did not have 5 survey points to choose from within the quad boundaries. Select your new survey points in suitable golden-wing habitat types for your region.

- Go to the closest suitable golden-wing habitat to your original point and place a new survey point at this location. Do not select a point based on prior knowledge of a golden-wing territory, however if you get to the closest suitable habitat and a previously unknown golden-wing is present, it's acceptable to use this point.
- Make sure to stay within your quad boundaries when selecting a new point.
- New survey points may be placed within the extent of suitable habitat if accessible or along existing roads, trails, and public rights-of-way (ROW) that border the habitat.
- New survey points should be at least 400 meters (0.25 miles) from any existing points to ensure that you don't count the same birds twice.
- More than one survey point may be established in the same block of habitat as long as all the points are at least 400 meters (0.25 miles) apart.
- Be sure to mark the exact location of each survey point by using a GPS unit and record your coordinates on the data form in decimal degrees.

Field Surveys

The field protocol combines a standard passive point count with audio playback. It is very similar to the Golden-winged Warbler Atlas Project protocol, except that the initial GWWA Type I song sequence has been lengthened to 5 minutes and a mobbing sequence has been added. The total protocol lasts for 17 minutes.

This protocol is being used to test the relative effectiveness of the three components (passive observation, conspecific playback, mobbing playback) at detecting golden-wings. Always use the "GWWA PB first" track for this protocol.

1) Passive Point Count: Begin with a 3-minute point count (silent watch and listen period) divided into 3, 1-minute time bands. All detections should be recorded in the appropriate 1-minute band on the data form. Remember to record early successional indicator species.

2) Conspecific Playback: This 8-minute golden-wing sound file is included with all silent periods built into the track. Record all detections in the appropriate 1-min time band on the data form.

5-min GWWA Type I
1-min silent observation period
1-min GWWA Type II
1-min silent observation period

3) Mobbing Playback: This 6-minute mobbing sequence (Black-capped Chickadee and Eastern Screech-Owl) sound file is included. Record all detections in the appropriate 1-min time band on the data form.

5-min Mobbing Sequence
1-min silent observation period

- When conducting playback, set the volume so it sounds natural to your ear when listening to a golden-wing.
- Golden-wings, blue-wings, and hybrids sing the same Type II song so it is important to get a visual ID of each bird.
- During the playbacks and observation periods, make sure to search in all directions for golden-wings, blue-wings, and hybrids. Individuals may fly in from great distances, may approach silently, or may fly back and forth past the speaker.
- **NOTE: Finish the entire protocol even if a golden-wing is detected before the end of the third sequence.**

Completing the Data Form

Please use one data form per Delorme Atlas Quad and the associated 5 survey points.

All data should be entered into the Excel spreadsheet provided by Cornell and hard copies mailed to the address below at the end of the season. If you have questions, please contact:

Sara Barker
Cornell Lab of Ornithology
159 Sapsucker Woods Rd.
Ithaca, NY 14850
607-254-2465
sb65@cornell.edu

The following instructions refer to the Point Status, Location Data, Habitat Data, and Bird Data sections on the dataform. Please complete the Point Status, Location Data, and Habitat Data sections on the same day as your bird survey if possible. All habitat related data refer to an area within a 150-m radius from the survey point.

Point Status

Stand at the original survey point and evaluate whether or not the habitat surrounding you continues to be suitable for golden-wings. If yes, mark the yes block under the appropriate point number and move to the next section on your data form. If no, please mark the box that most closely describes why the habitat has become unsuitable and describe if necessary. Refer to the *Selecting New Survey Points* section for detailed instructions about how to select a replacement for unsuitable points.

Location Data

Give a very brief location description, such as distance to prominant land marks like roads, bodies of water, towns, etc.

Record county and latitude and longitude in decimal degrees from a GPS unit at the time of your survey. Make sure to record a latitude and longitude for ALL points, not just the newly created points.

Habitat Data

- HABITAT CODE (within 150-m radius)

Please write the one habitat code from the list at the bottom of the form that best applies to your site. If you choose MOSAIC, list all applicable habitat codes in parentheses after MOS. If you choose the 'other' habitat codes (UP or WE) describe in the comments section.

AF (upland abandoned farm) an early stage of succession, over 50% herbaceous cover that was once used for agriculture.

CC (upland clearcut) an area of intentionally managed forest, recently clearcut. The stumps and/or growth of saplings from stumps is visible (Succession=EARLY).

PB (upland pine barren) sandy areas with scattered pine trees.

SHF (upland shrubby field) essentially open, but with patches of dense, woody stems under 20 feet (6 meters) covering much of the survey site. Can have scattered tall trees. (Succession=EARLY) Does not include harvested forest (clearcuts).

SM (upland abandoned strip mine)

SUF (upland successional forest) young forest, other than clearcut, dominated by woody stems greater than 20 feet (6 meters). Includes young conifer plantings. (Succession=MIDDLE or LATE).

UP (other upland habitat) if not covered by the above categories. Make sure this is not MOSAIC.

UT-U (upland utility right-of-way) a gas pipeline or electrical transmission line in an upland or dry area.

BW (beaver wetland) wetlands created or enlarged by beaver activity.

HS (hardwood swamp) dominated by hardwood trees greater than 20 feet (6 meters).

SEM (sedge grass wetland) mostly sedge meadow with small clumps of shrubs and/or small aspen or hardwood islands.

TB (tamarack bog) bog/swamp dominated by tamarack trees (or other conifers).

UT-W (wetland utility right-of-way) a gas pipeline or electrical transmission line in a wetland.

WE (other wetland) if not covered by the above wetland categories. Make sure this is not MOSAIC.

WS (shrub wetland) wetland/swamp, lowland shrub community with deciduous shrubs throughout and/or along the edge (AL habitat descriptor if >60% alder).

MOS (mosaic) if your site is made up of two or more habitat types, use MOS followed by all applicable habitat codes (example: MOS (SHF/WS/SUF)).

- HABITAT DESCRIPTOR (within 150-m radius)

Record the predominant species at your survey point.

AL (alder) dominated (> 70%) primarily by alder shrubs.

AP (aspen) dominated (> 70%) primarily by aspen trees.

CF (conifer forest) pine plantations, black spruce, jack pine, cedar, etc., with > 75% conifers.

MHC (mixed hardwood & conifer) with at least 10% conifers.

NH (northern hardwoods) 90% or more mixed hardwoods--birch, red oak, maple, aspen, etc.

OT (other species) dominated (> 70%) primarily by some other species; name the species.

- ELEVATION

Note the elevation from your GPS unit at your survey point in feet. **Record one number, not a range.**

- EXTENT OF POTENTIAL HABITAT

Estimate the extent of potential Golden-winged Warbler habitat at your survey point in acres. This may be the same for several points that fall within the same habitat patch. If you can't clearly see the extent of the habitat, try to use a map to help determine the size. **Record one number, not a range.**

- SUCCESSION (within 150-m radius)

List the stage of succession based on the age and size of trees.

EARLY seedlings and small saplings; trees < 20 feet tall, about 0-6 years old, or < 1.2 inch DBH on average.

MIDDLE large saplings and pole timber; trees 20-40 feet tall, about 6-20 years old, or 1.2 - 4.7 inches DBH on average.

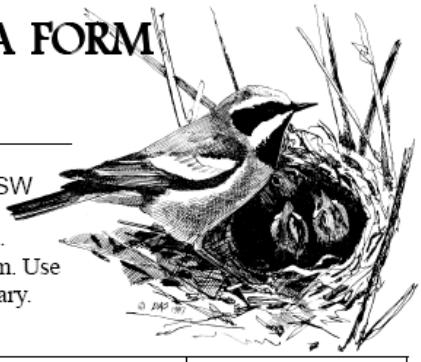
LATE large pole and saw timber; trees > 40 feet tall, > 20 years old, or > 4.7 inches DBH on average.

Bird Data

- Record all relevant bird observations in each of the 17-time bands. Use the codes that are provided at the bottom of the Bird Data section of your data form. Make sure to put a zero in the time band if nothing is detected, thus there should be a code or zero in every time band. See scanned example form.
- Circle the species code in the appropriate time band when visual confirmation of each indivdual is made for the first time. Your bird might already be singing. You only need to circle an individual once.
- If a hybrid is detected, please differentiate the hybrid type and record either Brewster's Warbler, Lawrence's Warbler, or introgressed (a weird looking hybrid that does not conform to the stereotyped plumage designations).
- Although we are most interested in the abundance of golden-wings, blue-wings and their hybrids, please also record the presence of other early sucessional indicator species (BRTH, FISP, PRAW, EATO, WIFL) using the codes provided **only during the passive point count period.**
- Provide notes in the comments section if any behavioral or breeding information is observed.
- Keep copies of all data forms and maps for your records.

Thank you for participating!

GOLDEN-WINGED WARBLER DATA FORM
MONITORING PROTOCOL



Observers _____ State _____

Delorme Atlas Page _____ Quad (1/4 Delorme page) ☐ NE ☐ NW ☐ SE ☐ SW

Survey the 5 assigned points in each Delorme Atlas Quad (check appropriate box above). Be sure to record within the correct time band under "Bird Data" on the back of the form. Use the comments section on the back to provide more detail about any section if necessary.

POINT STATUS:

Point No.	1.	2.	3.	4.	5.
Point in suitable GWWA habitat?	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
If not suitable, then why? (check box, then describe in cell as best as possible below other)	☐ succession ☐ development ☐ other (describe)	☐ succession ☐ development ☐ other (describe)	☐ succession ☐ development other (describe)	☐ succession ☐ development ☐ other (describe)	☐ succession ☐ development ☐ other (describe)

NOTE: If original point is unsuitable, make sure to establish a NEW point in the closest suitable GWWA habitat (see protocol instructions for details) and be sure to check the "new point" box beside the appropriate point number below.

LOCATION DATA: Make sure to record a latitude and longitude for EVERY point, even if it's not new.

Point No.	1. ☐ new point	2. ☐ new point	3. ☐ new point	4. ☐ new point	5. ☐ new point
Location (brief description)					
County					
Latitude					
Longitude					

HABITAT DATA: Habitat, Descriptor, and Succession codes are listed below. All variables apply to a 150-m radius circle around the point (see protocol instructions for details). Record a single value, not a range and only one habitat code unless within a mosaic.

Point No.	1.	2.	3.	4.	5.
Habitat code					
Habitat descriptor					
Elevation-ft					
Extent of potential habitat - acres					
Succession					

HABITAT CODES

AF (upland abandoned farm)
CC (upland clear cut)
PB (upland pine barren)
SHF (upland shrubby field)
SM (upland abandoned strip mine)
SUF (upland successional forest)
UP (other upland habitat)
UT-U (upland utility ROW)
BW (beaver wetland)
HS (hardwood swamp)
SEM (sedge wetland)
TB (tamarack bog)
UT-W (wetland ROW)
WE (other wetland)
WS (shrub wetland)
MOS (mix, list all)

SUCCESSION

Early, Middle, or Late

HABITAT DESCRIPTOR

AL (alder)
AP (aspen)
CF (conifer forest)
MHC (mixed hardwood/conifer)
NH (northern hardwoods)
OT (list other dominant sp)

BIRD DATA: Record bird observations in each of the 17-time bands by using the codes at the bottom. Put a zero in the time band if nothing is detected, thus there should be a code or zero in every time band. Circle the species code in the appropriate time band when visual confirmation of each indivdual is made for the first time.

		Point No.	1.	2.	3.	4.	5.
		Date					
		Time					
TIME BANDS	Passive Pt. Count	1:					
		2:					
		3:					
	Conspecific Playback (CPB)	1T1:					
		2T1:					
		3T1:					
		4T1:					
		5T1:					
		6OB:					
		7TII:					
		8OB:					
	Mobbing Playback (MPB)	1M:					
		2M:					
		3M:					
		4M:					
		5M:					
		6OB:					
		Total of each spp.					

Use these codes to note study species, # of individuals, and sex in EVERY time band:

Golden-winged Warbler = G
Blue-winged Warbler = B
Brewster's Warbler = R
Lawrence's Warbler = L
Introgressed = I
female = f (lower case f next to sps. code)

Use these codes to note other species, in the 3 PASSIVE POINT COUNT time bands:

Brown Thrasher = T
Field Sparrow = F
Prairie Warbler = P
Eastern Towhee = E
Willow Flycatcher = W

If no birds are detected in a given time band, mark a 0 (zero) in that box.

Circle the species code in the appropriate time band, the FIRST time the bird is seen visually (the bird might already be singing).

COMMENTS

APPENDIX G. GOLDEN-WINGED WARBLER FIELD SURVEY PROTOCOL

This protocol is used by state cooperators and other research partners who are implementing the Appalachian Region spatially balanced sampling design or other monitoring efforts that are aimed at accessing regional long-term trends, relative abundance estimates, or occupancy.

This field protocol combines a standard passive point count with audio playback and can be used within any sampling framework. The complete spatially balanced sampling design methodology, digital audio file for playback, and data forms can be obtained from Sara Barker sb65@cornell.edu at the Cornell Lab of Ornithology.

1. **Passive Point Count:** begin with a 3-minute point count (silent watch and listen period) divided into 3, 1-minute time bands. All detections should be recorded in the appropriate 1-minute band on a data form. It is a good idea to record any associated early successional bird species during this period.

2. **Conspecific Playback:** broadcast 8-minute Golden-winged Warbler audio sequences with built in silent periods. Record all detections by 1-minute time bands on a data form.

   5-min Golden-winged Warbler Type I
   1-min silent observation period
   1-min Golden-winged Warbler Type II
   1-min silent observation period

3. **Mobbing Playback:** broadcast 6-minute mobbing sequence (Black-capped Chickadee and Eastern Screech-Owl). Record all detections by 1-minute time band on a data form.

   5-min Mobbing Sequence
   1-min silent observation period

Additional Information:

- When conducting playback, set the volume so it sounds natural to your ear when listening to a Golden-winged Warbler.

- Golden-winged Warblers, Blue-winged Warblers, and hybrids sing the same Type II song so it is important to get a visual ID of each bird.

- During the playback and observation periods, make sure to search in all directions for Golden-winged Warblers, Blue-winged Warblers, and hybrids. Individuals may fly in from great distances, may approach silently, or may fly back and forth past the speaker.

- Finish the entire protocol even if a Golden-winged Warbler is detected partway through the protocol.

APPENDIX H. PROCEDURES FOR EVALUATING GENETIC PURITY OF A GOLDEN-WINGED WARBLER POPULATION

How Many Individuals Do You Need to Sample?

Ideally, we recommend collecting genetic samples from a minimum of 50 adult individuals for each site or group of nearby sites, thus this may take multiple years of collection. This many samples are necessary to adequately estimate the genetic introgression rate, especially where cryptic/genetic hybrids are relatively rare.

Golden-winged Warbler Genetic Atlas

Please submit your genetic results to the Fuller Evolutionary Biology Lab at the Cornell Lab of Ornithology (159 Sapsucker Woods Road, Ithaca, NY 14850 USA) for inclusion in the international Golden-winged Warbler Genetic Atlas. For each sample collected include information on the collector (name, institution, address, email, phone #), GPS coordinates of capture site, name of capture site, and bird specifics (sex, age, USFWS/CWS band#). The Atlas provides a broad picture of genetic introgression across North America and will allow continuity in tracking genetic introgression at specific sites through time by providing a central location for housing these data.

Standard Operating Procedures for Collecting Blood, Feathers and Claws from Birds

Prior to collecting samples, please make sure you have completed the following:

1. Confirmed that you know what you need to do to properly collect, store, and ship the samples to a genetics lab. Ensure that the lab where you will send the samples has the capability to analyze them and that you have communicated in advance regarding the most appropriate storage method for samples (e.g. feather, blood collected on filter paper, blood collected in a lysis buffer). Also, you should know what data from the bird, capture site, and collector need to be supplied before heading to the field.

2. Acquired all necessary capture and collection permits (e.g. USGS Bird Banding Lab Federal Bird Banding permit or Environment Canada Scientific Permit to Capture and Band Migratory Birds, relevant state/provincial agency permits), as well as Institutional Animal Care and Use approvals. If the lab is in another country, then you may need an export permit, the lab may need an import permit, and a zoo sanitary certificate.

3. The collector has received training for proper and safe collection of the samples.

General Instructions

Please be careful and considerate of the birds you sample. No data point is worth causing unnecessary stress or death.

If you have not taken blood samples before, it is very important that you obtain your initial training from someone who has experience with these or similar protocols. Taking blood samples is simple once you have practiced, but no set of instructions can replace hands-on instruction. If birds are handled carefully, bleeding should result in zero mortality and no lowered fitness of sampled birds (Sheldon et al. 2008).

Needles and Glass Hematocrit Tubes (capillary tubes)

Used disposable needles and hematocrit tubes **must not** be bent, sheared, broken, recapped or otherwise manipulated by hand before disposal; rather, they must be carefully placed in a disposal container and disposed of as regulated medical waste in accordance with regulations set out by your academic institution.

For adult warblers, you should be using 27 gauge sterile needles. They can be purchased from Fischer Scientific for $10.45/100 needles. Catalogue number: 14-826-48, Item number: 305109, www.fishersci.com/ecomm/servlet/cmstatic?href=index.jsp&store=Scientific&segment=scientificStandard&&storeId=10652

Do not dispose of needles in the regular solid waste stream.

Blood Collection Instructions

1. Once you have a bird in hand, prepare the needle by loosening it from its cap. Remove a hematocrit tube from its container and have it easily available with a piece of cotton and the rubbing alcohol out and ready to grab. Once you pierce the vein, you want to move quickly for all of the following steps.

2. Hold the bird with the wing extended. Find the brachial vein and use a Q-tip dipped in rubbing alcohol to dampen the feathers around the vein. The alcohol will help hold the feathers away from the vein and will also cause the vein to thicken slightly. Be cautious to not apply too much alcohol, especially in cold weather. Some people use Vaseline to dampen the feathers - the choice is up to you. If you do use Vaseline make sure you apply only a very thin layer to the area.

3. Prick the vein with a needle, using a new sterile needle for each bird. Place the used needle in a "sharps" waste container without recapping it. While in the field, a small soda bottle wrapped in duct tape works well as a sharps container.

4. Use a capillary tube to draw up the drop(s) of blood. For our purposes, a single large drop is sufficient. Blood will coagulate in the tube if left there for any length of time, so immediately transfer (see note 1 below) the blood to a lysis-buffer tube and mix well by capping the tube and shaking. Don't simply place the capillary tube into the buffer or the blood will clot. Place the used capillary tube into the sharps waste container.

5. Place a piece of cotton over the site of venipuncture, close the wing, and apply gentle pressure to stop any further bleeding.

6. Label lysis buffer tube (see note 2 below) and fill in the data sheet before processing another bird.

Notes and Suggestions

1. There are two ways to transfer blood from capillary tubes to sample tubes. If you use a capillary tube bulb to hold your capillary tube, you can blow the blood out of the cap tube by squeezing the rubber stopper of the bulb. Practice using some drops of water if you have not tried this method in the past. The alternative method is to blow gently across the top of the capillary tube **without touching your mouth or lips to the tube** (for your own health and safety). Be sure to mix the blood and lysis buffer immediately by inverting or gently shaking the capped tube.

2. When labeling tubes and envelopes, it is critical to label them as you use them, one by one. Sample switches can easily occur if there are multiple, unlabeled tubes in your work area. Label each tube using a sharpie marker with the unique ID number of the bird (preferably the USFWS/CWS band number) and the four-letter alpha code (e.g. GWWA = Golden-winged Warbler, BWWA = Blue-winged Warbler). Please put this information on the top and side of the tube. Also include the date of capture.

3. If you can't get a good bleed please don't release the bird prior to pulling a feather sample. DNA from feathers is not as good, or as plentiful, as DNA from blood, but it's preferable to not getting a sample at all. See the feather collection section below.

Data Sheets

Please create a datasheet like the one below in which to enter every bird that you capture. Note that the datasheet should include information with your contact information and the locations where you obtained samples, in addition to information about the individual birds you sampled. The fields that are important to include on a data sheet:

1. Location of capture (i.e. site name)
2. State/province
3. Name of collector/bander
4. Species (by phenotype)
5. Date
6. FWS/CWS band number
7. Age (HY, SY, ASY)
8. Sex
9. Song type (GWWA or BWWA)
10. LATITUDE of capture site (in decimal degrees, e.g. 36.19442)
11. LONGITUDE of capture site (in decimal degrees, e.g. -84.39111)
12. Notes (e.g. plumage abnormalities)
13. Blood collected? (Y or N)
14. Feather collected? (Y or N)
15. Claw clipping collected? (Y or N)

GWWA, BWWA, & HYBRID BANDING DATA															
	Location of capture	State	Name of bander	Species (phenotype)	Date	FWS band #	Age (HY, SY, AHY)	Sex	Song (GWWA or BWWA)	LATITUDE of capture site (in decimal degrees, e.g. 36.19442)	LONGITUDE of capture site (in decimal degrees, e.g. -84.39111)	Notes (e.g. plumage abnormalities)	Blood taken? (yes or no)	feathers?	clawclips?
1															
2															
3															
4															
5															

Storage of Blood Samples

DNA in blood preserved in the lysis buffer below is stable at room temperature and should not be frozen. If possible, store the samples in a refrigerator, but this is not at all critical. It is important to keep the samples out of direct sunlight or other heat sources.

Lysis Buffer Ingredients: 100 mM TRIS, 100 mM Na_2EDTA, 10 mM NaCl, 0.5 % SDS (2.0% SDS if going to be shipped internationally)

Hallux & Feather Collection (see diagram below if needed)

In order to obtain a claw sample please use small, sharp scissors and cut the very end of the hallux claw (Figure AP–H1). Keep in mind that the claw may bleed if you cut too far and hit the quick. Included below is a diagram that shows approximately where you should cut. It ends up being about a 1.5mm piece in Golden-winged Warbler.

Place the claw sample in an empty sample tube and label as detailed above in note 3. This is a very fiddly process and thus recommend doing the cutting over a blank piece of white paper so that you can see where the claw samples lands.

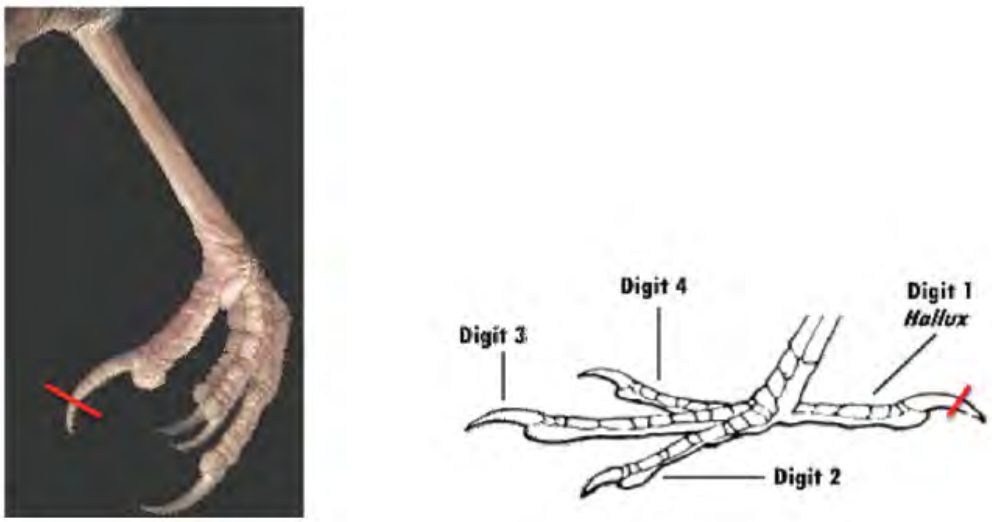


Figure AP-H1. Diagram showing approximately where the hallux should be cut, about a 1.5 mm piece in a Golden-winged Warbler.

Feathers provide a back-up DNA source and can also be used in a stable isotope study that will help us link breeding and wintering grounds of Golden-winged Warblers.

Please pull the following feathers (Figure AP–H2) and place them in a small envelope:

- P1
- R3 or R1 (**Please make a note of which one you pull)
- 3 or 4 black facial mask feathers
- 1 claw sample (hallux)

The best way to obtain a P1 or R feather is to grasp the feather at the base (where it attaches to the body) and pull it out in one quick motion. The facial feathers may be easier to obtain with tweezers.

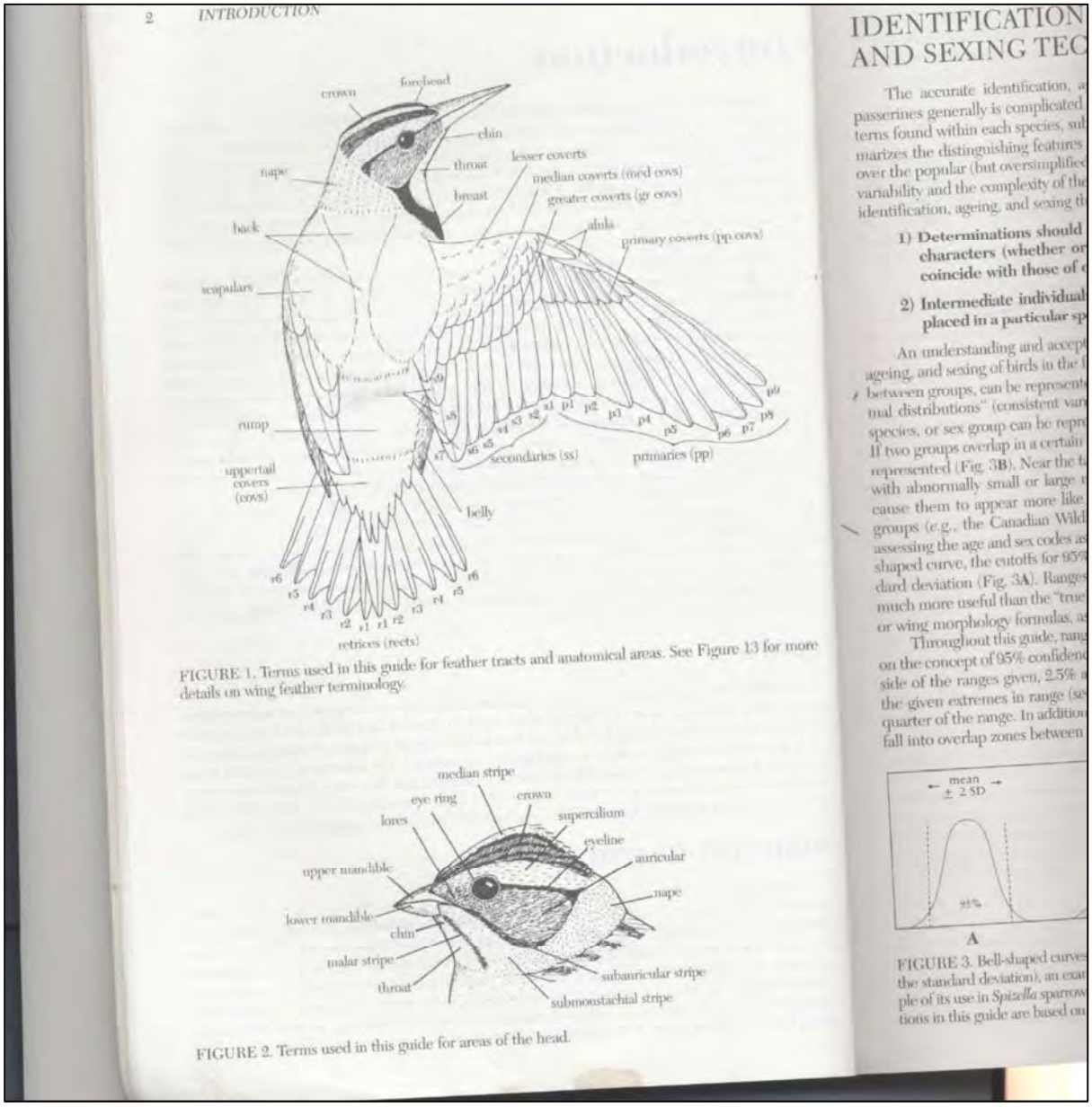


Figure AP-H2. Diagram showing a bird's body and facial feathers.

Photographs and Identification Issues (if possible)

It is helpful to photograph (either using film or a digital camera) the birds from which you obtain genetic samples. Traditionally, all studies of avian systematics were based on vouchered specimens permanently archived in museum collections. In this case, a photograph can serve as a partial voucher in the sense that it preserves an independent record of the bird's phenotype.

Photographs will be particularly useful in studies of hybridizing taxa where the photographs can be used to generate a 'hybrid index' of plumage traits.


National Fish and Wildlife Foundation


TheCornellLab
of Ornithology


GOLDEN-WINGED WARBLER
WORKING GROUP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DEPARTMENT OF THE INTERIOR


ITHACA
COLLEGE


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VT


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UNIVERSITY
OF MINNESOTA
Driven to Discover℠


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Indiana University of Pennsylvania
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Environnement Canada


TALL TIMBERS
Stewards of Wildlife & Wildlands


AMERICAN BIRD
CONSERVANCY


APPALACHIAN
MOUNTAINS
JOINT VENTURE


DCNR
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AND NATURAL RESOURCES


Alianza Alas Doradas


RUFFED GROUSE SOCIETY


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