

# Golden-winged Warbler

## Status Review and Conservation Plan



# Golden-winged Warbler Status Review and Conservation Plan

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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 Eriksson.*

The **Cornell** Lab of Ornithology



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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.*

## 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 forest 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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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 Breeding Bird Survey (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 BBS, 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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*Photo by Ashley Jensen*

## CHAPTER 1 SUMMARY

Golden-winged Warbler (*Vermivora chrysoptera*) is one of the most rapidly declining forest songbirds breeding north of Mexico, having lost an estimated two-thirds of its population since 1970. The species has been petitioned for listing as threatened under the *Endangered Species Act* in the U.S. and is currently listed as Threatened under the *Species at Risk Act* in Canada. It is a long-distance Nearctic/Neotropical migrant that breeds from May through July mainly in the Great Lakes and Lawrence/Champlain provinces and states from Manitoba to Vermont and in the Appalachian Mountains from New York to Tennessee; it spends the northern winter mostly in the tropical highlands of Central America and the northern Andes of Colombia and Venezuela.

Golden-winged Warbler also has seen one of the most substantial recent range shifts of any North American passerine. Over the last 150 years in the Upper Midwest, the southern limit of the species range has shifted northward some 340 miles (550 km) and expanded perhaps 500 miles (800 km) northwestward into Manitoba; the breeding range has contracted substantially in the Appalachians and in New England such that Golden-winged Warbler now may be extirpated as a breeding species from Georgia, South Carolina, Connecticut, Massachusetts, Rhode Island, Illinois, Indiana, and Ohio. With the recent loss of persistent populations in central New York, the species breeding population is now divided into a Great Lakes and an Appalachian Mountains range segment.

Golden-winged Warbler is dependent on dynamically changing forested landscapes in which disturbance patterns create patches of regenerating forest dominated by shrubs, small trees, and a grassy herbaceous layer. Such young forest openings are heavily utilized for nesting, but breeding adults also forage widely in mature deciduous or mixed forest and may even prefer adjacent mature upland forests or northern forested wetlands during the post-fledging period.

Overall declines in young forest acreage and loss of shrubby breeding habitat as abandoned fields become reforested have been identified as a major cause of range-wide Golden-winged Warbler population declines. However, complex interactions with its very closely related and more southerly distributed congener, Blue-winged Warbler (*V. cyanoptera*), have also been blamed for its demise; in a given area, the Golden-winged Warbler phenotype tends to be replaced by that of Blue-winged Warbler over a period of 40-60 years after secondary contact. Cryptic hybridization (presence of mitochondrial Blue-winged Warbler DNA in individuals otherwise resembling Golden-winged Warbler) is widespread. But as introgression also occurs in the reverse direction, and as recent research suggests very little nuclear divergence between the two forms, the dynamics of the species phenotype replacement remain puzzling.

During the stationary non-breeding (winter) season in Central and northern South America, Golden-winged Warbler prefers mid-elevation moist premontane forested slopes, generally below 8200 feet (2500 meters), with numerous vine tangles, hanging dead leaves, and epiphytes—conditions caused by some form of disturbance and also available in advanced secondary and agroforestry systems (e.g., shade coffee plantations). Individuals join mixed-species foraging flocks, but are otherwise territorial with large home range sizes. Thus large areas of tropical forest may be needed to support wintering Golden-winged Warbler populations. Recent demographic analysis suggests that winter survival may be an important factor contributing to observed breeding season population declines—highlighting the need for habitat conservation action throughout the annual cycle, including the non-breeding season.

Regional and state status summaries indicate widespread differences in population trajectory. Golden-winged Warbler populations currently appear stable to slightly increasing in Manitoba, Ontario, Minnesota, and to a lesser extent in Wisconsin. In other states in which the species now occurs, extirpation is a possibility in the absence of conservation action if current trends continue.

## GOLDEN-WINGED WARBLER: A SONGBIRD IN TROUBLE

Golden-winged Warbler (*Vermivora chrysoptera*) is a Nearctic/Neotropical long-distance migrant songbird that breeds from May through July mainly in the Great Lakes and St. Lawrence/Champlain states and provinces from Manitoba to Vermont and in the Appalachian Mountains from New York to Tennessee. From October/November through February/March, it spends the northern hemisphere winter in

tropical habitats from Central America to the northern Andes of Colombia and Venezuela (Figure 1–1). Although specific connectivity between breeding and non-breeding populations has yet to be determined, it is possible that at least some individuals make annual round trips of more than 6,000 miles (9600 km)—quite a remarkable achievement for a bird that weighs a third of an ounce (9–10 g).

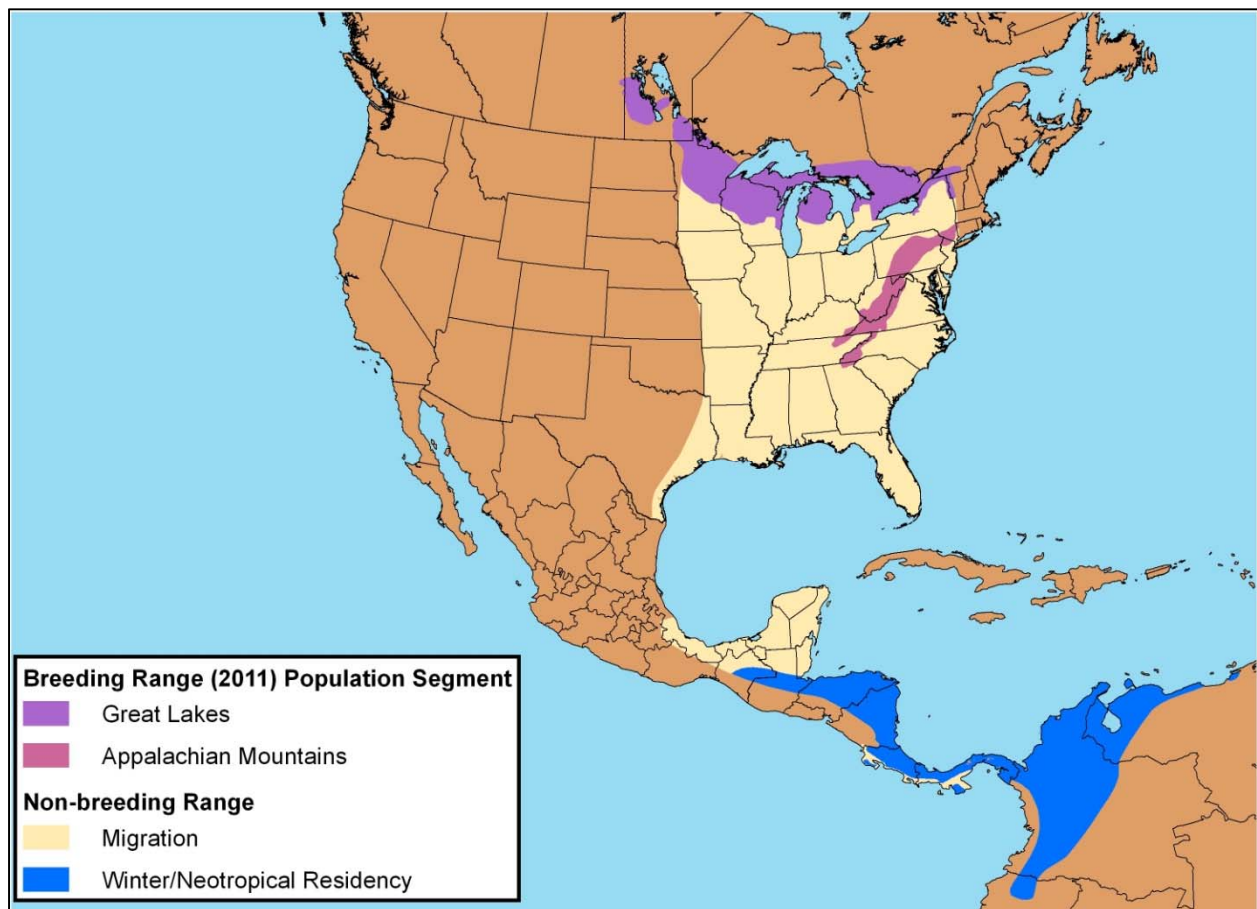


Figure 1–1. Golden-winged Warbler breeding and wintering (resident non-breeding) range. The breeding season range is based on expert knowledge of persistent breeding populations as of 2011. The primary known migratory range is inferred from concentrations of recent eBird records; regions with only a few scattered records (e.g., east-central Mexico and Caribbean islands) are excluded. Winter range is based on NatureServe (2011).

## Taxonomy and Identification

Golden-winged Warbler belongs to the order Passeriformes (perching birds), the family Parulidae (wood warblers), and the genus *Vermivora*, which contains only three species in North America (Chesser et al. 2010), one of which is now believed to be extinct (Bachman's Warbler, *V. bachmanii*). Classic Golden-winged Warblers are gray-backed and whitish-bellied, with a yellow crown and large yellow wing patches; males have a black and females a gray facial mask and throat (Figure 1–2). Although Golden-winged Warbler is described as a distinct species in the 7<sup>th</sup> Edition of the Check-list of

North American Birds (AOU 1998), it is closely related to and hybridizes with Blue-winged Warbler (*V. cyanoptera*). Parkes (1951) suggested that phenotypically distinct first-generation hybrids (Brewster's Warbler) displayed the dominant plumage characters of a white belly and reduced head patterning; backcrosses between hybrids and Golden-winged or Blue-winged warblers were thought to produce the distinct Lawrence's Warbler, which expressed recessive traits of a yellow belly and more extensive head patterning. (Figure 1–2).

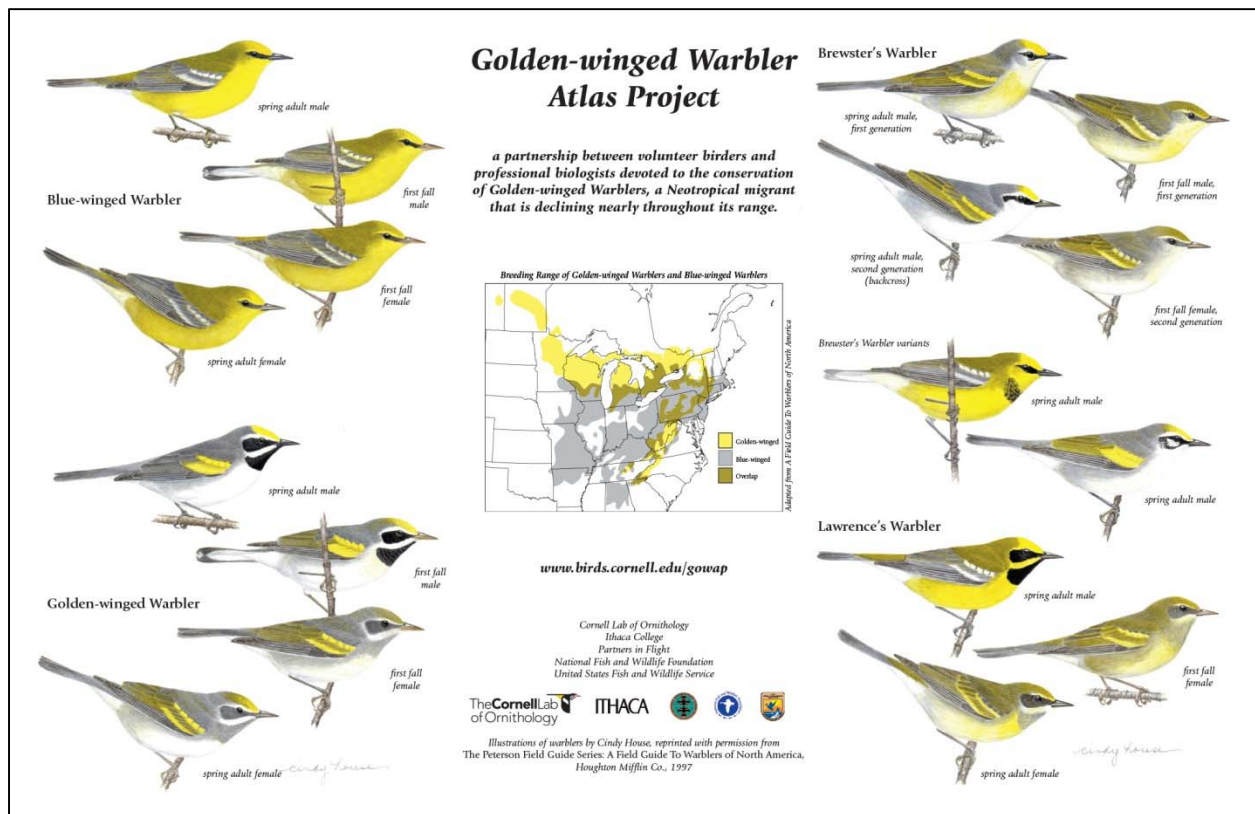


Figure 1–2. Plumages of Golden-winged Warbler, Blue-winged Warbler, and hybrids.

However, many individuals which appear at first glance to be clearly one species can, on closer inspection, show color flushes typical of the other. In addition, recent mitochondrial DNA (mtDNA) sequencing work reveals that genetic mixing appears to be much more extensive than is suggested by the identification of classical

Brewster's and Lawrence's forms, producing an array of introgressed birds (i.e., that exhibit plumage intermediate between the parental types but do not conform to either the Brewster's or Lawrence's classification) as well as "cryptic hybrids" that resemble the parental types phenotypically but which carry genes of the other

species (Vallender et al. 2007b, 2009). Since birds that appear phenotypically pure may occasionally sing the song characteristic of the other species

(Gill and Murray 1972), visual confirmation of heard birds is necessary, especially in zones of known overlap and hybridization (see Figure 1–3).

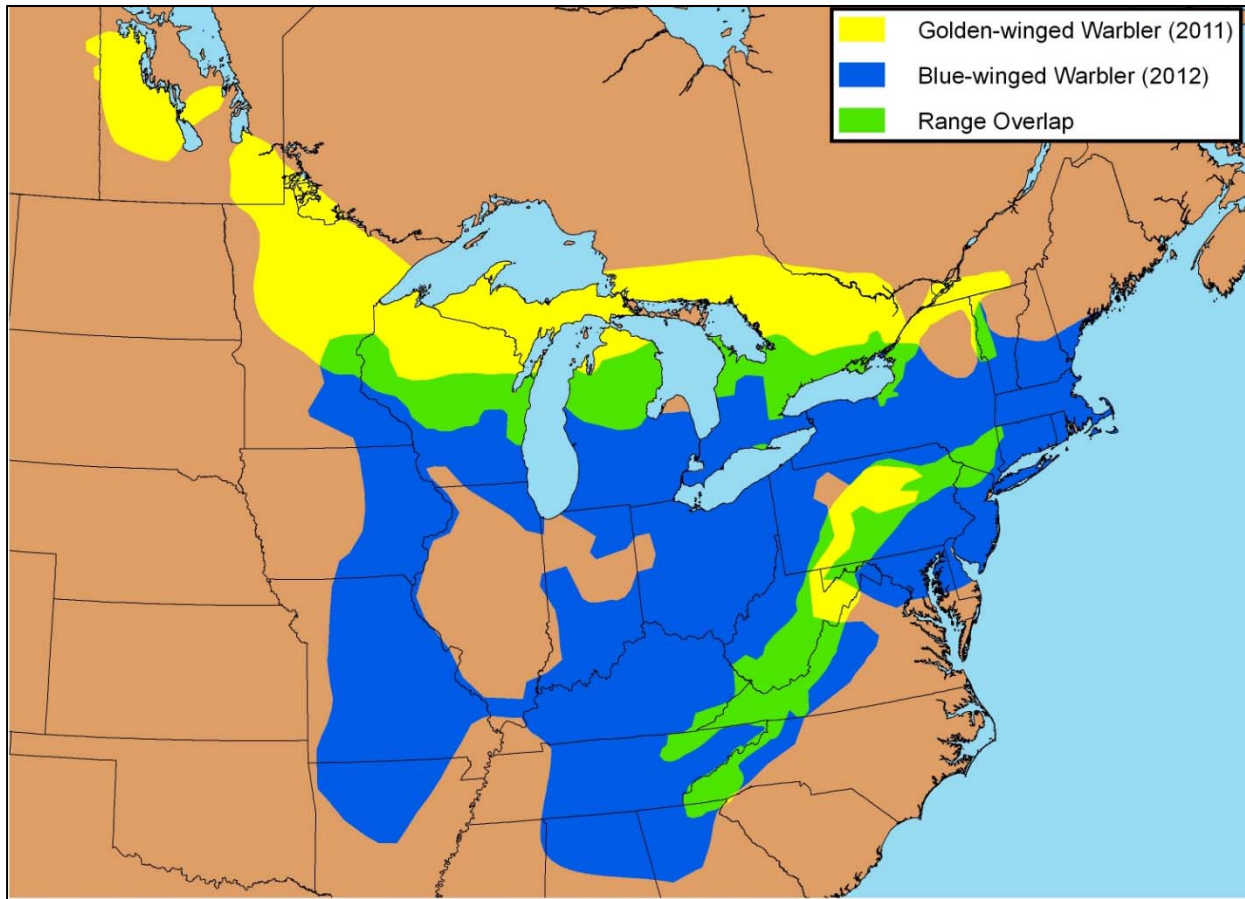


Figure 1–3. Approximate current breeding range overlap between Golden-winged and Blue-winged warbler. The Golden-winged Warbler range is based on expert knowledge of persistent breeding populations as of 2011. The Blue-winged Warbler range is inferred from GOWAP (Barker Swarthout et al. 2009), recent eBird records, and recent state breeding bird atlas detections, when available. Consequently the range overlap is approximate; particularly in the Appalachians, local distribution resulting from elevation and habitat differences would result in a much more patchy representation at a finer scale of resolution.

## Legal Status in the United States

Golden-winged Warbler is one of the highest conservation concern landbird species not yet listed as a federally Threatened or Endangered species in the United States. However, the U.S. Fish and Wildlife Service (USFWS) received a petition in February 2010 to list the species as threatened under the *Endangered Species Act* (ESA) and on 2 June 2011 published a 90-day Finding in the Federal Register indicating that the

petition was considered to be substantial (76 FR 31920). A substantial 90-day Finding initiates information gathering and evaluation leading to a 12-month Finding and a decision as to whether listing under the ESA is warranted. Progress on the 12-month Finding is dependent on specific allocation of funding and priorities within the USFWS Division of Ecological Services; at this

point, it appears that a final listing decision may not occur for several years.

Golden-winged Warbler is a USFWS bird of Conservation Concern at the national scale; at the Regional scale in USFWS Regions 3, 4, and 5; and at the Bird Conservation Region (BCR) scale in BCRs 12, 13, 23, and 28 (USFWS 2008). It is also a focal species in the USFWS Focal Species Strategy program. Partners in Flight ranked Golden-winged Warbler as a Watch List Species in need of Immediate Action (Rich et al. 2004), and it was subsequently included in the joint American Bird Conservancy and National Audubon Society WatchList of Birds of Conservation Concern. The species is state-listed as Endangered in Connecticut, Georgia, Indiana, Massachusetts, and Ohio; is considered

Threatened in Kentucky; and is of Special Concern or a Species of Greatest Conservation Need in State Wildlife Action Plans for an additional 15 states (see also the state-level status reviews beginning on p. 1–46).

Like most other native songbirds, Golden-winged Warbler is also protected in the United States by the *Migratory Bird Treaty Act of 1918*, which makes it “unlawful at any time, by any means or in any manner, to pursue, hunt, capture, kill... any migratory bird, any part, nest, or egg of any such bird... included in the terms of the convention.” At a global scale, the International Union for Conservation of Nature (IUCN 2011) lists the species as Near Threatened (may be considered threatened with extinction in the near future).

## Legal Status in Canada

Golden-winged Warbler is protected under Schedule 1 of Canada’s *Species at Risk Act (SARA)* and by the *Migratory Birds Convention Act, 1994*. Under SARA, the species is listed as Threatened (likely to become an endangered species if nothing is done to reverse factors leading to its extirpation or extinction) throughout its Canadian range (Quebec, Ontario, Manitoba, and Saskatchewan), although provincial at-risk designations vary. The purpose of SARA is to prevent wildlife species, subspecies, and distinct populations from becoming extirpated or extinct; to provide for the recovery of wildlife species that are extirpated, endangered, or threatened as a result of human activity; and to encourage the management of species of special concern to prevent them from becoming endangered or threatened.

Under provincial species at risk legislation, Golden-winged Warbler is listed in Ontario as Special Concern (sensitive to human activities or

natural events which may cause it to become endangered or threatened) under the *Endangered Species Act, 2007*, and in Quebec as Likely to be Designated as Threatened or Vulnerable under the *Act respecting threatened or vulnerable species (Espèce susceptible d’être désignée menacée ou vulnérable)*. There is no current designation for Golden-winged Warbler in Manitoba or Saskatchewan under provincial legislation.

Currently, a Canadian multi-agency recovery team is developing the federal recovery strategy for Golden-winged Warbler in Canada with an estimated completion date of mid-2012. A landscape approach is being developed and tested for the identification of critical habitat necessary to maintain the current abundance of Golden-winged Warblers across the Canadian breeding range (see Chapter 2, pages 2–8-10 for more details).

## BREEDING SEASON DISTRIBUTION

### Historic Distribution

Lack of a fossil record makes discussion about prehistoric distributions largely conjectural. Short (1963) speculated that the advance and retreat of glaciers led to isolated populations of ancestral Golden-winged and Blue-winged warblers. A 3% (cytochrome B) to 4.5% (NDII) divergence between the mtDNA of these two species (Gill 1997, Dabrowski et al. 2005) suggests that isolation occurred about one to two million years before present. Short (1963) speculated that there was an east-west division after the last Ice Age, with Golden-winged Warbler restricted to the southeastern coastal plain and Blue-winged Warbler restricted to west of the Mississippi Embayment—a water barrier stretching several hundred kilometers from Illinois to the Gulf. The combination of the Mississippi Embayment and ice sheets to the north effectively separated the ancestral warbler species.

With the warming of the continent and the retreat of the glaciers, both species moved northward but likely remained isolated until after

European settlement. Extensive forest clearing in the Great Lakes states and Appalachians during the late 1800s and early 1900s undoubtedly increased habitat availability for Golden-winged Warbler in those regions. Golden-winged Warbler was first documented nesting in the northeastern U.S. during the mid to late 1800s, a period of extensive farm abandonment. Maximum abundance and extent of distribution peaked for Golden-winged Warbler in this region between 1930 and 1950. The conversion of native prairie to agriculture during European settlement may have facilitated first contact between Blue-winged and Golden-winged warblers in the Upper Midwest (Short 1963). Woodland and savanna on the southern Michigan, Wisconsin, and Minnesota landscape has been replaced with dairy farms, other forms of agriculture, and extensive suburban development. Since 1950 there has been a marked shift in distribution away from the developed southern portions of these states to the extensive wetland shrub communities farther north.

### Recent Changes

For nearly 150 years, the known breeding range of Golden-winged Warbler has been changing substantially. A range expansion was first documented into the northeastern U.S. where the species appeared in Massachusetts and Connecticut in the late 1800s before expanding northward into central New York and southern Michigan in the early 1900s. The breeding range expansion continues today into northern New York, eastern and northwestern Ontario, adjacent Quebec and Manitoba, and farther west in Canada, with one confirmed and several probable and possible breeding records for Saskatchewan (Smith 1996). In 2005, two male Golden-winged Warblers were found on territory in the Black

Hills National Forest in northeastern Wyoming (A. Panjabi, Rocky Mountain Bird Observatory, pers. comm.). Nesting was not confirmed, however, and subsequent surveys in 2006 and 2008 failed to detect Golden-winged Warbler in the Black Hills.

At least in the Upper Midwest, the Golden-winged Warbler range expansion is best described as a range shift: as the species occurs more frequently to the north and west, it has been disappearing along the southern limits of its range (Figure 1–4), where it appears to be experiencing steep population declines (Table 1–1) associated in part with the loss of shrubby

habitat as abandoned fields become reforested. Golden-winged Warbler now may be extirpated as a breeding species from Georgia, South Carolina, Connecticut, Massachusetts, Rhode Island, Illinois, Indiana, and Ohio. In some regions, locations that have hosted persistent

populations now see only scattered, occasional Golden-winged Warbler records, as has been the case in central New York (Figure 1–4). The species has declined in North Carolina, Tennessee, West Virginia, Maryland, Pennsylvania, New York, and Michigan.

Table 1–1. Golden-winged Warbler trend estimates from the North American Breeding Bird Survey 1966–2009 (Sauer et al. 2011). Significant trends (0.95 probability that the trend differs from zero) are indicated in bold font; numbers in parentheses are credible intervals from the hierarchical Bayesian model analysis method.

Region	Number Routes	1966–2009 Trends		1999–2009 Trends	
		Trend (%change/yr)	95% CI <sup>2</sup>	Trend (%change/yr)	95% CI <sup>2</sup>
Survey-wide	434	<b>-2.3</b>	<b>(-3.3, -1.4)</b>	1.5	(-1.3, 5.0)
United States	374	<b>-2.9</b>	<b>(-3.8, -1.9)</b>	0.3	(-2.2, 3.6)
Canada	60	2.4	(-1.0, 5.8)	6.2	(-2.1, 16.5)
<b>Bird Conservation Regions</b>					
Boreal Hardwood Transition	127	-0.6	(-1.7, 0.5)	1.3	(-1.8, 5.0)
Prairie Hardwood Transition	51	-2.7	(-4.7, 0.0)	0.0	(-5.5, 7.5)
Appalachian Mountains	164	<b>-8.3</b>	<b>(-9.6, -7.0)</b>	<b>-7.4</b>	<b>(-10.5, -3.4)</b>
<b>States/Provinces<sup>1</sup></b>					
Connecticut	5	<b>-23.5</b>	<b>(-43.6, -7.1)</b>	<b>-24.1</b>	<b>(-46.9, -3.1)</b>
Manitoba	6	<b>40.4</b>	<b>(11.9, 91.9)</b>	<b>41.5</b>	<b>(11.9, 96.4)</b>
Maryland	9	<b>-5.5</b>	<b>(-8.0, -3.0)</b>	<b>-5.8</b>	<b>(-11.4, -0.8)</b>
Massachusetts	9	<b>-8.7</b>	<b>(-17.0, -1.1)</b>	-8.9	(-25.3, 8.0)
Michigan	46	<b>-5.5</b>	<b>(-8.0, -3.3)</b>	-5.6	(-12.0, 0.1)
Minnesota	36	1.4	(-0.3, 3.1)	3.5	(-0.3, 8.8)
New Hampshire	6	-6.3	(-35.7, 19.9)	-6.3	(-75.0, 177.9)
New Jersey	6	<b>-9.2</b>	<b>(-16.2, -2.3)</b>	-9.3	(-19.2, 2.0)
New York	56	<b>-5.2</b>	<b>(-7.0, -3.4)</b>	-4.0	(-8.6, 1.6)
North Carolina	8	<b>-9.9</b>	<b>(-15.5, -4.4)</b>	<b>-10.0</b>	<b>(-17.9, -1.3)</b>
Ontario	49	1.8	(-1.6, 5.3)	2.9	(-5.1, 11.5)
Pennsylvania	56	<b>-6.8</b>	<b>(-8.7, -4.9)</b>	<b>-7.2</b>	<b>(-13.4, -0.9)</b>
Quebec	5	-1.2	(-10.8, 8.5)	-1.0	(-20.2, 23.6)
Tennessee	7	<b>-7.7</b>	<b>(-11.4, -4.5)</b>	-7.1	(-15.7, 4.4)
Virginia	9	<b>-8.6</b>	<b>(-12.6, -4.9)</b>	<b>-8.7</b>	<b>(-15.8, -0.7)</b>
West Virginia	44	<b>-8.9</b>	<b>(-10.7, -6.8)</b>	-7.8	(-12.8, 0.7)
Wisconsin	62	<b>-2.6</b>	<b>(-3.9, -1.4)</b>	-2.9	(-6.8, 1.0)

<sup>1</sup> Listed alphabetically. <sup>2</sup> Bayesian credible interval.

## Current Distribution

U.S. Geological Survey (USGS) Breeding Bird Survey (BBS) data provide a helpful but incomplete map of Golden-winged Warbler distribution since BBS routes do not consistently detect low-density populations. Overlays of data from BBS (1966 to 2010), state and provincial breeding bird atlases, Golden-winged Warbler Atlas Project (GOWAP) surveys of Golden-winged and Blue-winged warblers and their hybrids from 1999 to 2006 (Barker Swarthout et al. 2009), Golden-winged Warbler Conservation Initiative collaborative research, and citizen science observations reported in eBird provide the basis for estimating contemporary changes and current distribution of the species (Figure 1–4). Golden-winged Warbler now occurs in two largely isolated regions. The northern portion of the range—the Great Lakes population segment—extends from the extreme

eastern edge of Saskatchewan through west-central Manitoba, southern Ontario, and extreme southwestern Quebec and then southward into northern Minnesota, Wisconsin, Michigan, and the St. Lawrence River Valley, with a few individuals in Vermont and rarely New Hampshire. The eastern portion of the range—the Appalachian population segment—extends from the southern Appalachians (northern Georgia, western North Carolina, and eastern Tennessee) northeastward through eastern Kentucky, western Virginia, and West Virginia into Pennsylvania and southern New York, with a few scattered individuals in Connecticut. The Great Lakes population is now separated from the Appalachian population by the near complete absence of Golden-winged Warbler in Illinois, Indiana, Ohio, and central New York (Figure 1–4).

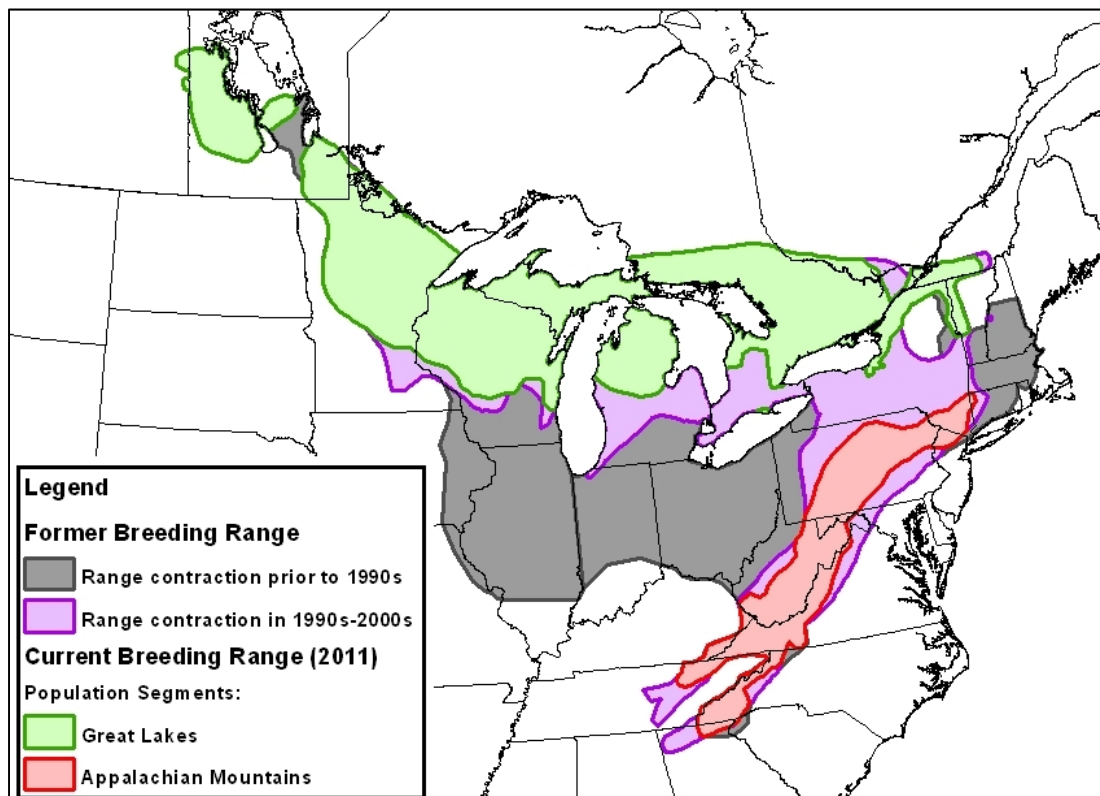


Figure 1–4. Contemporary Golden-winged Warbler breeding season range based on expert knowledge of persistent, breeding populations as of 2011. The current breeding range is divided into two geographically disjunct population segments—Great Lakes and Appalachian Mountains. The former breeding range is represented by two areas of range contraction in which birds no longer breed with temporal or spatial consistency but which potentially contain solitary individuals or sporadic breeding activity.

## POPULATION STATUS AND TRENDS

### Tracking Population Change: Data Sources

The BBS is the most comprehensive monitoring program tracking Golden-winged Warbler population change rangewide. Because the BBS is a roadside survey, however, it may not adequately monitor response to changing conditions across all habitat types in North America—particularly if higher probability of land development results in disproportionately greater habitat loss along roadsides. The BBS appears to accurately track Golden-winged Warbler population trends throughout the northeastern and north-central states but may not be adequate in the Appalachians and parts of Canada. GOWAP (Barker Swarthout et al. 2009) was designed to provide additional records of Golden-winged Warbler distribution and habitat associations; it supplements the BBS distribution data, but was not designed to track changes in population. As noted above, breeding bird atlas projects completed by many states and Ontario in the past ten years have helped to document recent distribution; these will serve as a baseline for comparison with future second-generation atlases to index range and population change. On-going atlas projects in Minnesota (2009–

2013), Quebec (2010–2014), and Manitoba (2010–2014) will further refine our understanding of Golden-winged Warbler distribution. The Breeding Bird Census (BBC), conducted since 1937, represents an additional potential source of information on Golden-winged Warbler population trends. These censuses enlist volunteer observers to map territories of individual birds within a specific habitat type. Although publication of BBC data has been irregular since 1996, surveys have continued, and results from the 2001–2004 surveys are now available (Gardali and Lowe 2006a, 2006b, 2007a, 2007b). Unfortunately, Golden-winged Warbler is rarely detected on sites monitored by BBC. From 1988–1995 and from 2001–2004, Golden-winged Warbler was recorded on only seven BBC sites, none of which had been monitored for more than ten years. Most recently, research partners coordinated through Cornell Laboratory of Ornithology have been developing and testing a spatially-balanced sampling design more suited to regions where Golden-winged Warbler is present in low abundance.

### Estimating Population Size

Although the BBS was designed to index population trend and not to estimate actual abundance, Partners in Flight (Rosenberg and Blancher 2005) devised a method to use BBS data from the 1990s decade to estimate current population size. Results were used by Rich et al. (2004) to estimate population size for most U.S. and Canadian landbirds, including Golden-winged Warbler, and the methodology was reviewed by Thogmartin et al. (2006). Some of the analyses

reported in this 2012 *Status Review* include Golden-winged Warbler population estimates based on the Partners in Flight method described in Blancher et al. (2007)—but with BBS data from the decade 1998–2007 (Blancher et al. *in prep.*) and with an average maximum detection distance of 125m (Golden-winged Warbler Working Group science team decision, June 2011) rather than the 200m value used in Rich et al. (2004).

## Population Trends and Probability of Population Persistence

Most population trends reported in this 2012 *Status Review* utilize BBS data from 1966–2009 (Sauer et al. 2011) and a hierarchical Bayesian analysis for estimating annual indices generally considered to offer a more robust analysis less susceptible to extreme deviations than the route regression analyses formerly reported on the BBS site. The Bayesian approach has the additional advantage of producing *credible intervals* (CIs) that are more intuitively interpretable than traditional confidence intervals; one can say simply, for example, that there is a 95% chance that a true parameter falls within the 95% CI. In general, the hierarchical Bayesian approach results in somewhat lower estimated rates of change for most geographic areas as compared with previous estimates derived using the route regression method.

As measured by the BBS, the rangewide Golden-winged Warbler population has been declining steadily since 1966 at an average annual rate of -2.3% (CI -3.3%, -1.4%)—one of the steepest declines of any U.S.-Canadian landbird (Figure 1–5). However, rates of decline differ substantially among regions across the species range and when comparing the period spanned by the

entire survey (1966–2009) and the last decade only (Table 1–1). Steep population declines occurred in the Appalachian Mountains BCR (-8.3%), West Virginia (-8.9%), Tennessee (-7.7%), Pennsylvania (-6.8%), Maryland (-5.5%), Michigan (-5.5%), New York (-5.2%), and Wisconsin (-2.6%). The steeply increasing trend of 40.4% (especially since 1980) in Manitoba is based on only six routes and a low credibility measure, although recent field surveys support significant recent population expansion and higher abundance than historical estimates.

When population trends are linked to regional (BCR) population estimates and declines are expressed in terms of proportional population loss (Table 1–2), the relative decline in the Appalachian Mountains BCR is especially alarming—a 97.8% population loss from 1966 to 2010 and a 61.7% loss over the last decade. The 1,740% population increase in the Boreal Taiga Plains (BCR 6) in the last ten years reflects new BBS detections in Manitoba, presumably the result of a recent Golden-winged Warbler range expansion.

Using the Partners in Flight method (Rosenberg and Blancher 2005, Rich et al. 2004, Blancher et al. 2007) for calculating population size *based on BBS data from the 1990s decade*—but with an average maximum detection distance of 125m for Golden-winged Warbler (Golden-winged Warbler Working Group science team decision, June 2011)—this means the species will have declined from an estimated 1.25 million breeding adults (95% CI: 950,000; 1.7 million) in 1967 to 386,000 birds

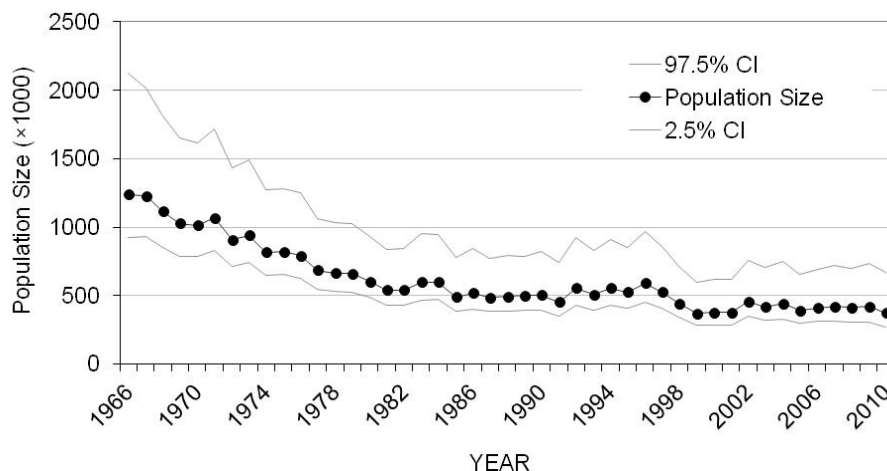


Figure 1–5. Annual rangewide breeding abundance of Golden-winged Warbler as predicted by a hierarchical Bayesian analysis of North American BBS data (1966–2010). Abundance estimates are derived from the Partners in Flight Population Estimates Database: version 2007 (Blancher et al. in prep).

Table 1–2. Percent change in Golden-winged Warbler abundance by Bird Conservation Region (BCR) over the entire period of the BBS (1966–2010) and between the 1990s and 2000s decades. Trend estimates are derived from the BBS (Sauer et al. 2011) and population estimates from the Partners in Flight Population Estimates Database: version 2007 (Blancher et al. in prep). Numbers in parentheses are credible intervals; significant change (0.95 probability that the percent change differs from zero) is indicated in bold font.

Bird Conservation Region	Whole Period	1990s vs. 2000s
Boreal Hardwood Transition (BCR 12)	<b>-27.5%</b> (-30.3, -25.9)	<b>-16.3%</b> (-17.8, -15.2)
Prairie Hardwood Transition (BCR 23)	<b>-70.7%</b> (-76.8, -46.3)	-11.8% (-27.0, +25.9)
Appalachian Mountains (BCR 28)	<b>-97.8%</b> (-97.9, -97.7)	<b>-61.7%</b> (-63.7, -60.5)
Great Lakes / St. Lawrence Plain (BCR 13)	<b>-16.0%</b> (-18.1, -10.9)	+0.9% (-5.5, +8.2)
Boreal Taiga Plains (BCR 6)		<b>+1,740%</b> (+850, +946,620)
Total Population Change	<b>-66.2%</b> (-67.0, -65.5)	<b>-17.9%</b> (-20.3, -15.4)

(95% CI: 290,000; 520,000) in 2000 and to 383,000 birds (95% CI: 275,000; 565,000) in 2010. Using the same methodology, but based on hierarchical Bayesian BBS annual indices from the decade 1998–2007, we would infer a population size of 370,500 in 2010 (95% CI: 267,000; 663,000). Using the average estimated population size for the 1998–2007 decade (413,560, Blancher et al. in prep.), and assuming

the 40-yr BBS trends continued, we would predict a population of only 37,000 adult birds (95% CI: 27,000; 67,000) by 2100. This would represent a predicted loss in population size of 1.2 million birds (97%) in 135 years.

Population size, trend, and variability in trend can be integrated in a count-based population viability analysis to predict the probability of

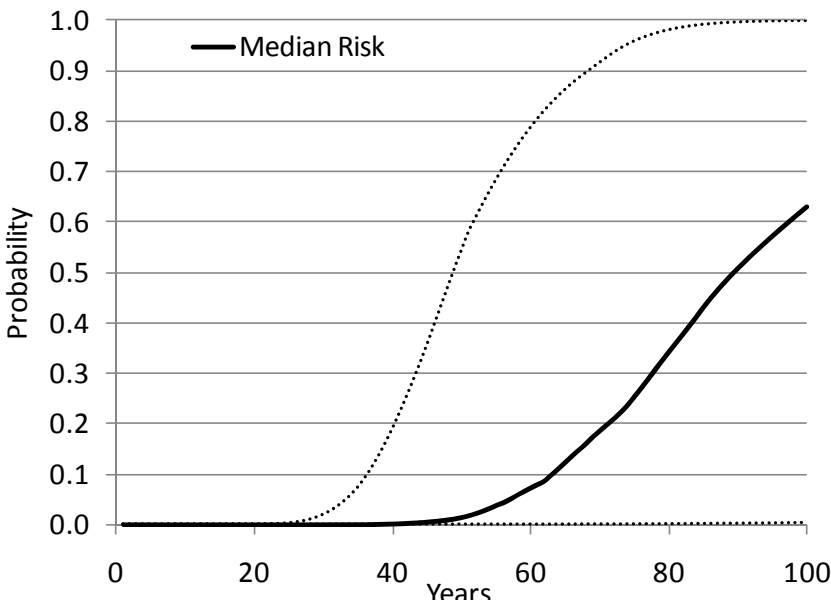


Figure 1–6. Survey-wide risk of quasi-extinction in Golden-winged Warbler, as determined by a 90% decline from the year 2000 population by year 2100. Dashed lines represent the 95% credible interval. See Appendix C for methods.

quasi-extinction (see Appendix C for a description of methods). According to this analysis, Golden-winged Warbler is at risk of extinction in many areas across its range. If observed trends and variability in trends persist as they have for the last 40 years into the next century, Golden-winged Warbler rangewide has a 63.1% (95% CI: 0.5%, 99.95%) risk of a further 90% loss in population by 2100 (Figure 1–6). For currently increasing populations at the state scale, the risk of quasi-extinction is negligible using this technique. For currently declining populations at the state scale, the risk of quasi-

extinction is considerable decline from the 2000 population was predicted included Wisconsin (65.9% risk of a 90% decline [0.5%, 99.97%]), Michigan (100% risk [100%, 100%]), Tennessee

(100% risk [100%, 100%]), and New York (100% risk [99.5%, 100%]) (Figure 1–7; see also individual state reports, pages 1–46-90).

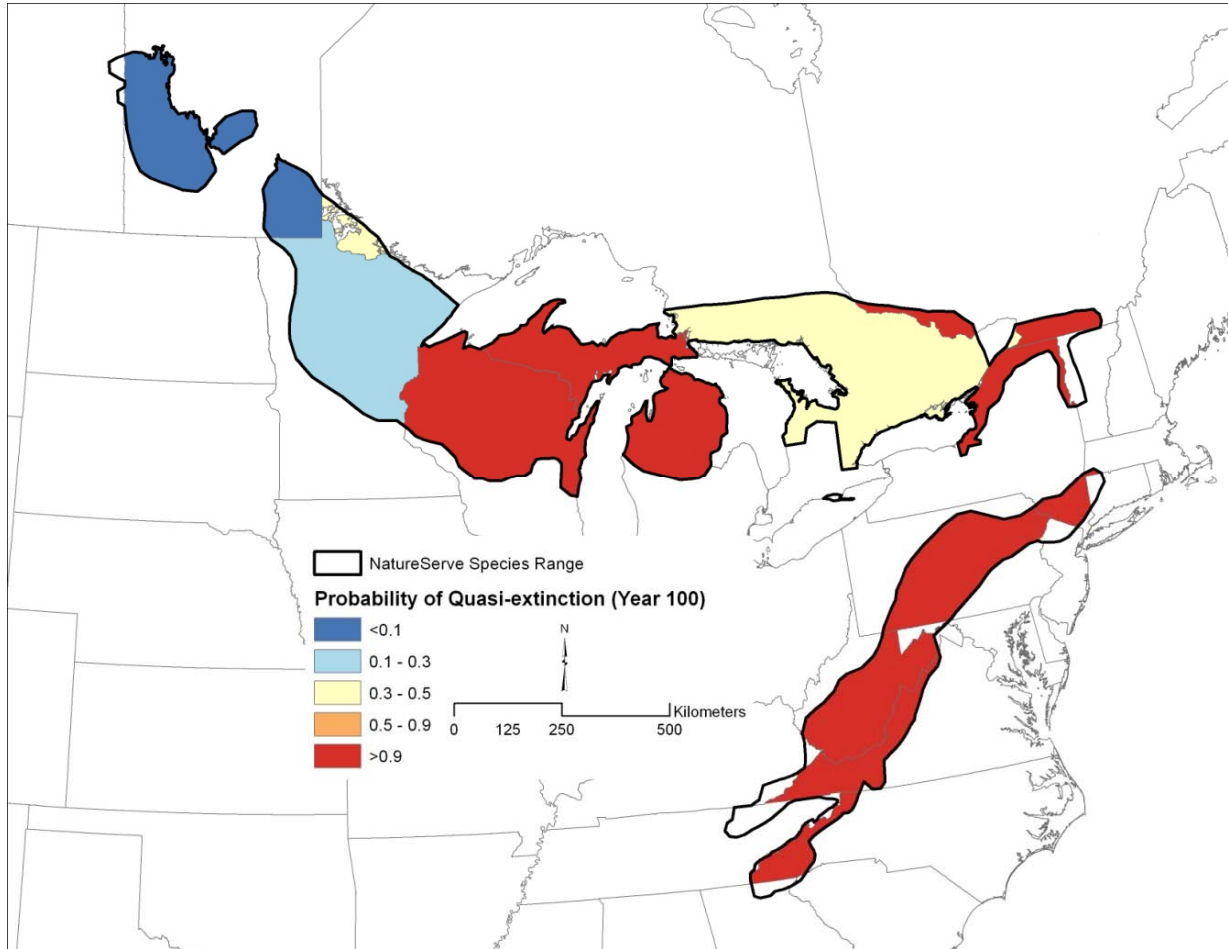


Figure 1–7. Risk of quasi-extinction of Golden-winged Warbler by state and province. See Appendix C for methods.

## BREEDING SEASON HABITAT

Golden-winged Warbler is a species of predominantly forested landscapes in which both natural and anthropogenic disturbance patterns create patches of early stages of regenerating forest and/or open areas dominated by shrubs and small trees.

Pre-European settlement breeding habitat of Golden-winged Warbler and other young forest associated species is not well documented (Hunter et al. 2001). Natural disturbances such as fire, wind-throw, ice, and flooding likely generated moderate to large areas of regenerating forest and shrublands that provided most of the breeding habitat for birds that utilized early forest successional stages (DeGraaf and Yamanski 2003). Intentional fires set by Native Americans to clear land undoubtedly also created a mosaic of suitable habitats on the landscape (DeGraaf and Yamanski 2003).

Wetland habitats are important to Golden-winged Warbler in some areas; natural swamps and flooded wetlands created by beaver (*Castor canadensis*) activity were formerly far more extensive and probably provided an important pre-settlement habitat for the species (but cf. Chandler et al. 2009 on scrub-shrub birds and beaver meadows). The chestnut blight also may have created appropriate habitat in some areas (Hall 1983).

During the last 140 years, Golden-winged Warbler has expanded into habitats created by human disturbance throughout much of the eastern U.S. and adjacent Canada (Confer et al. 2011). Old field succession on abandoned farmland and regenerating forest clearcuts have provided millions of hectares of forest/shrubland habitat (Lorimer 2001). However, over the past 50 years, especially in the eastern U.S., alteration of natural disturbance regimes coupled with ongoing natural succession to mature forest has resulted in an overall loss of breeding habitat (Hunter et al. 2001). Managed aspen forest with regenerating patches attractive to Golden-winged Warbler generally succeeds to northern hardwoods, eastern hardwoods, or coniferous forest types if it is not harvested on a 40-60 year rotation (Perala 1977, Frelich 2002). Where aspen forest is a climax community, as is generally the case in the Aspen Parklands of Manitoba, Golden-winged Warbler habitat is potentially perpetuated in stands for over a hundred years (Cumming 1998). In the absence of large-scale natural disturbance, human-induced disturbances will be critical for continued creation and maintenance of breeding habitat throughout much of the Golden-winged Warbler range.

## Nesting Habitat

Although Golden-winged Warbler utilizes mature forest throughout its annual cycle, even during the breeding season, disturbed patches of habitat within a forested matrix are important for nesting. There appear to be three essential components to Golden-winged Warbler nesting habitat—grassy and herbaceous openings, shrubs or tree saplings (generally <10 cm diameter), and taller deciduous trees (Confer et al. 2011).

Golden-winged Warbler habitat thus has a characteristic *gestalt* (Figure 1–8)—fairly open patches of herbaceous vegetation and shrubs of different heights either on the edge of a forested patch, associated with a group of trees in an opening of an otherwise forested landscape, or interspersed with forest trees—either young early successional trees or mature canopy trees (Confer et al. 2011).

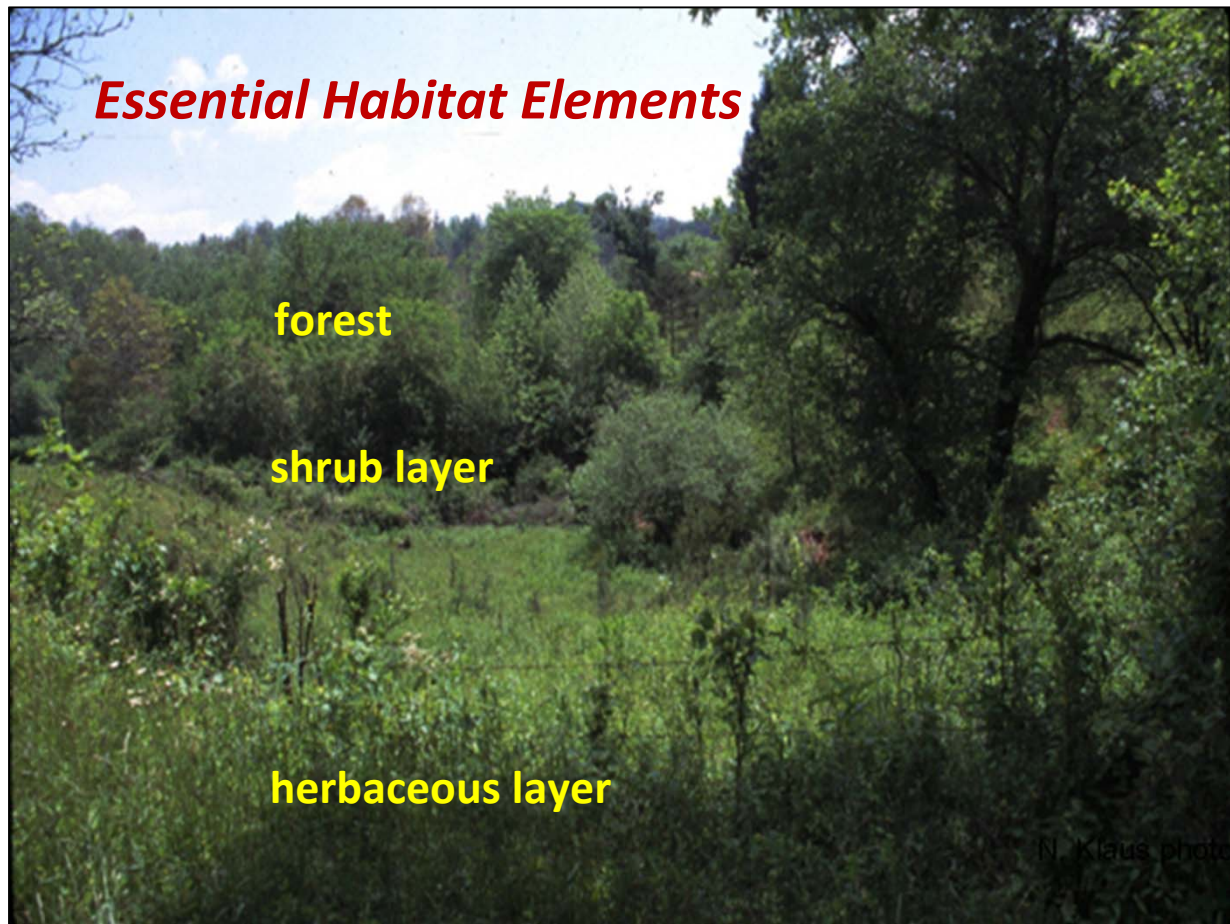


Figure 1–8. Structural components of Golden-winged Warbler nesting habitat—herbaceous vegetation, shrubs or small trees, and a more mature forested backdrop. Photo by Nathan Klaus.

Such a structural mosaic can be created in a variety of situations—in upland overgrown fields or pastures, along powerline rights-of-way that are maintained in a shrubby state, on recovering surface mine lands, along edges or openings of forests, in sedge meadows with scattered willows (*Salix* spp.), in moist areas with scattered clumps of alders (*Alnus* spp.), in swamp forests with partially open canopy, or in clearcuts densely stocked with young trees and shrubs and broken by herbaceous logging trails and log landings (Figure 1–9). The characteristic spatial pattern of vegetation structure is more important in defining suitability for Golden-winged Warbler than the general habitat type.

Geographic variation in habitat use was evident from the results of GOWAP (Barker Swarthout et al. 2009). These results reflected the range of habitats where positive occurrences of Golden-winged Warbler were recorded during population and hybrid-index surveys conducted by a large number of volunteer birders and regional biologists. To more clearly examine variation in habitat use, the sites with Golden-winged Warbler detections were divided into five regions, three in the Appalachians and two in the Great Lakes area; the results of this analysis are presented in the Regional Summary section beginning on page 1–46.



Figure 1–9. Golden-winged Warbler may be found nesting in a variety of habitat types that comprise the basic three structural components pictured in Figure 1–8. Habitat types include: (A) shrub-field (J. Lowe); (B) utility right-of-way (S. Barker Swarthout); (C) abandoned farm (C. Croy); (D) alder swamp (L. Johnson); (E) clear cut (M. Fowlds); (F) reclaimed mine (L. Bulluck); (G) tamarack bog (N. Nelson); (H) beaver wetland (J. Confer).

## Patch Size and Landscape Considerations

Little is known about sensitivity of Golden-winged Warbler to landscape-level habitat configuration, although it is typically considered to be a species of largely forested landscapes (but see analysis and models in Chapter 3). In the northeastern U.S., historical expansion of Golden-winged Warbler typically occurred where farmland predominated and subsequent old field successional growth was common (Confer et al. 2011). Golden-winged Warbler nests and defends territories in patches of early successional forest or shrubland habitat. Patches range in size from less than one hectare to 100s of hectares (e.g., Bulluck and Buehler 2008, Kubel and Yahner 2008). The species is often associated with forested edges (Klaus and Buehler 2001; Thogmartin 2010; Confer et al. 2003), and it may not occupy the interior portions of larger patches unless those patches contain embedded mature tree and shrub islands. For example, in Kentucky occupied Golden-winged Warbler sites had a higher percentage of canopy cover, but the sites were located within an early successional matrix (Patton et al. 2010), which is similar to other studies (Huffman 1997, Klaus and Buehler 2001). Roth (2012) found that in Wisconsin timber harvests, Golden-winged Warbler showed a spatial preference for large patches of habitat with scattered residual trees. Nest survival tended to be lower toward the center of large clearcuts. Aspen clearcuts with no or low residual tree densities had low male densities and low mating success. Residual trees, especially mature hardwoods (e.g., oaks), appeared to be critical for attracting groups of breeding birds and not just bachelor males.

Radio telemetry data from Minnesota (Streby et al. 2012) and Pennsylvania (Larkin, pers. comm.) indicated that adult male home ranges included substantial areas of surrounding mature deciduous or mixed forest, probably used primarily for foraging. The Minnesota study also showed that post-fledging habitat comprised these adjacent mature upland forests as well as

other community types, such as shrub and forested wetlands. Both studies suggested that breeding habitat for the species may in fact be too narrowly defined by classic studies when it is measured in terms of actual use for all activities throughout the entire breeding cycle from nest site selection through post fledgling.

Golden-winged Warbler probably has minimum area requirements (e.g., >1 ha) related to territory size but has not been shown to be strongly area sensitive. Likewise, patch shape has not been shown to be critically important—Golden-winged Warbler has been documented using linear habitats, such as powerline rights-of-way, and other linear features, like logging roads adjacent to clearcuts (Klaus and Buehler 2001). A minimum width of these linear openings may be important (e.g., a right-of-way >50 m plus additional appropriate adjacent vegetation) but generally has not been fully documented. Chapter 3 provides additional detail on landscape and habitat configuration from the perspective of management potential.

Golden-winged Warbler will not necessarily occupy all suitable breeding habitat patches. Bulluck and Harding (2010) hypothesized that the likelihood of patch occupancy may be dependent upon the distance to other occupied habitat patches because conspecifics indicate high quality habitat and/or provide greater opportunity for extra-pair copulations. Roth (2012) found that aspen clearcuts with low numbers of territorial males (1–2 per clearcut) were associated with low mating success (10%); clearcuts with four or more territorial males resulted in high mating success (~70%). Thus conspecific attraction may be an important consideration for habitat managers—to increase the likelihood of occupancy, new or improved habitat for Golden-winged Warbler should be managed in or near already occupied sites that have known or likely breeding activity. At least in some regions (e.g., New England), extensive

suitable habitat unoccupied by Golden-winged Warbler yet occupied by other early successional bird species suggests local population limitation by nonbreeding season factors (cf. Chandler et al. 2009).

As noted above, regional habitat analyses resulting from GOWAP are presented in the Regional Summary section beginning on page 1–46. More detailed, regionally-specific habitat analysis relevant to particular management actions can be found in Chapter 3.

## BREEDING SEASON BEHAVIOR AND ECOLOGY

### Territoriality

Territoriality is one of the most intensively studied components of Golden-winged Warbler behavior, and territorial boundaries often are used to infer habitat preference. Traditionally, territorial boundaries have been demarcated largely by mapping singing perches of territorial males, and consequently mapped boundaries of breeding territories frequently follow a forest edge or a row of taller trees along an old fence line. Perches, usually the tallest available trees, are used repeatedly for song display and foraging (Rossell 2001). Where scattered trees are available throughout shrubby habitat (as in aspen clearcuts with canopy tree retention), defended territories often do not include the stand edges (Roth 2012). Recent studies indicate that male Golden-winged Warblers are also highly territorial during the resident non-breeding (wintering) season in the Neotropics (Chandler 2011).

Mean mapped breeding territory size ranged from ~0.6 ha in central New York (Ficken and Ficken 1968), 0.9 ha in north-central New York (Confer and Larkin 1998), 0.9 ha in Tennessee (Bulluck 2007), 1.4 ha in upland habitats of central Michigan (Will 1986), 0.4–1.6 ha at a wetland site in North Carolina (Rossell et al. 2003), 1.9–2.7 ha at two wetland sites in Michigan (Murray and Gill 1976), and ~2.5 ha at a wetland site in southern New York (J. Confer, unpubl. data). In Wisconsin, mean territory size ranged from 0.18–0.82 ha in aspen forest stands and varied depending on tree size class; in older

stands, territory area was defined by the size and shape of openings within the regenerating aspen (Roth and Lutz 2004).

Breeding territories can vary in size depending on intraspecific competition. For example, Confer (pers. comm.) observed one color-banded male that responded to taped playbacks throughout an area of 300 x 200 m. The next season, the territory size of this same individual was halved when a new male established its territory in the same field. In an intensive study of Golden-winged and Blue-winged warblers in central Michigan, Will (1986) mapped weekly territories based on daily song perches of color-banded singing males. He found that such territories were dynamic, shifting constantly depending on the arrival of new males and the intensity of intraspecific and interspecific interactions. Particularly when males shifted their centers of activity with changes in the nesting cycle (especially during the escort of females searching for nest sites and the period immediately following incubation), territorial "boundaries" were highly fluid and territory sizes fluctuated enormously. In a recent study in Minnesota, Streby et al. (2012) found that male defended territories (defined by song perches) estimated using radio telemetry were as much as five times larger than territories derived from traditional spot-mapping; actual use areas (home ranges) covered areas as much as 25 times larger than spot-mapped song-defined territories.

## Reproduction

Confer et al. (2011) provides a general review of Golden-winged Warbler reproductive behavior. The species is single-brooded, with the exception of re-nesting after early failure of first nests or late second nests by bigamous males (Will 1986). Females appear to select the nest site—usually on the ground, often at the base of leafy herbaceous growth (e.g., *Solidago*) and well-

concealed by leafy vegetation or in some cases by tussock grass or sedge (Confer et al. 2011), and sometimes within dense patches of shrubby growth (e.g., *Rubus*). Often the nest site includes a taller and thicker stem on which the adults descend to the nest when visiting or feeding nestlings (Figure 1–10).



Figure 1–10. Male and female Golden-winged Warbler at a nest in Michigan. Photo by David Baker.

Data on clutch size and nest success from selected studies are summarized in Table 1–3. Mean clutch size has ranged from 4.0 in Pennsylvania (Kubel and Yahner 2008) to 5.06 in Ontario (Vallender et al. 2007a). Clutch size may be impacted by interspecific competition; Confer et al. (2003) found that clutch size in New York decreased as territorial overlap with Blue-winged Warbler increased ( $P < 0.01$ ; partial  $r^2 = 0.15$ ;  $n = 69$ ). Mayfield nest success estimates range widely depending in part on the prevalence of Brown-headed Cowbird parasitism. Lowest rates of nest success were reported from north-central New York (<40%), where relatively high rates of

hybridization and cowbird parasitism put Golden-winged Warbler below sustainable levels of reproduction; that north-central population is now virtually extirpated. In southern New York, nesting success was low in uplands (41%) but high in swamp forests (62%). The southern Appalachians reported higher rates of nest success—72.5% from North Carolina (Klaus and Buehler 2001), 49% from Tennessee (Bulluck and Buehler 2008), and 61% from West Virginia (Canterbury, unpubl. data)—that may be sufficient to sustain populations in the absence of hybridization.

Table 1–3. Nest success, clutch size, and Brown-headed Cowbird brood parasitism from selected Golden-winged Warbler nest studies.

Location	Sample Size	Years	Nest Success (% $\pm$ 2 SE)	Method	Average Clutch Size	% Parasitized
Manitoba <sup>1</sup>	25	2011–2012	42.3%	Raw Data	4.64	8
Ontario <sup>2</sup>	48	2001–2004	55.3%	Raw Data	5.06	4
Michigan <sup>3</sup>	13	1981–1983	85%	Raw Data	4.69	31
New York <sup>4, 5</sup>	69	1988–1994	38% (24–62) <sup>a</sup>	Mayfield	4.39	30
s. New York <sup>6</sup> (uplands)	61	2001–2010	41% <sup>a</sup>	Mayfield	4.79 <sup>c</sup>	11
s. New York <sup>6</sup> (swamp forest)	44	2001–2010	62% <sup>a</sup>	Mayfield	4.48 <sup>c</sup>	0
Pennsylvania <sup>7</sup>	32	2002–2003	37% (18–55) <sup>b</sup>	Mayfield	4.0	0
West Virginia <sup>8</sup>	347	1987–1996	61%	Mayfield		0
West Virginia <sup>9</sup>	77	2008–2011	39.9% <sup>b</sup>	Mayfield	4.5	0
Tennessee <sup>10</sup>	102	2004–2006	49% <sup>a</sup>	Mayfield	4.3	0
North Carolina <sup>11</sup>	23	1997–1998	72.5% <sup>b</sup>	Mayfield	4.5	0

<sup>1</sup>Moulton, unpubl. data; <sup>2</sup>Vallender et al. (2007b); <sup>3</sup>Will (1986); <sup>4</sup>Confer and Larkin (1998); <sup>5</sup>Confer et al. (2003); <sup>6</sup>Confer et al. (2010) and unpubl. data; <sup>7</sup>Kubel and Yahner (2008); <sup>8</sup>Canterbury (1996); <sup>9</sup>Aldinger and Wood, unpubl. data.; <sup>10</sup>Bulluck and Buehler (2008); <sup>11</sup>Klaus and Buehler (2001); a I + N: Nest success calculations include incubation and nestling stages; b L + I + N: Nest success calculations include laying, incubation, and nestling stages; c counting one warbler egg as part of clutch for every cowbird egg detected.

The impact of Brown-headed Cowbird brood parasitism varies greatly from region to region—perhaps depending on the ratio of agricultural and forest cover and thus the regional density of cowbirds (cf. Table 1–3). In north-central New York, where there is moderately extensive agriculture, cowbird parasitism occurred in 22 of 73 (30%) Golden-winged Warbler nests, with an average of 1.3 (SD = 0.6) cowbird eggs per parasitized nest (Confer et al. 2003). The number of eggs laid by parasitized and non-parasitized Golden-winged Warblers did not differ. The mean number of fledglings was reduced from 2.3 in non-parasitized nests ( $n = 50$ ) to 1.0 in parasitized nests ( $n = 22$ ), which reduced the total number of warblers fledged by an estimated 17%. Warblers fledged from 68% (34 of 50) of the non-parasitized nests and 32% (7 of 22) of the parasitized nests. All complete failures were due to predation. A mean of 3.3 warblers fledged from non-depredated, parasitized nests ( $n = 7$ ). Cowbird nest parasitism reduced the number of fledged warblers by about 7% for upland nests at Sterling Forest State Park in southern New York ( $n = 28$ ; J. Confer, unpubl. data). In central

Michigan (Will 1986), cowbird eggs were found in ten of 32 (31%) *Vermivora* (Blue-winged and Golden-winged warbler) nests, but two of these nests were abandoned by the warblers, and two of six parasitized nests that fledged warblers failed to fledge cowbirds. In west-central Minnesota (Streby, unpubl. data), rates varied from 9% in 2011 (five of 53 Golden-winged Warbler nests, with three failures, one nest fledging a cowbird and a warbler, and one fledging at least one warbler after the cowbird egg failed to hatch) to 2% in 2012 (two of 90 nests, both of which failed during incubation). In 2011–2012 in Manitoba, cowbirds parasitized four of 59 nests (6.8%); one failed during incubation, two during the nestling phase, and one successfully fledged a cowbird and two warblers (Moulton, unpubl. data; Peterson, unpubl. data). Cowbird brood parasitism was not observed in North Carolina (Klaus and Buehler 2001), West Virginia (Canterbury et al. 1996, Aldinger and Wood, unpubl. data), or Tennessee (Bulluck and Buehler 2008), and was minimal in Ontario (Vallender et al. 2007a).

## Dispersal

Other than that recently fledged birds wander widely and utilize many different habitat community types, including mature forest (Streby, unpubl. data), virtually nothing is known about dispersal behavior in Golden-winged Warbler (Confer et al. 2011). Out of 88 nestling *Vermivora* banded from 1981 to 1983 in central Michigan, none were ever seen in subsequent years (Will 1986). Similarly, none of 56 Golden-winged Warbler nestlings banded in northwestern Minnesota in 2010 were resighted the following year (Streby, pers. comm.). However, out of 288 nestlings banded in Ontario in 2001–2003, three females and nine males (4%) were relocated 2002–2004 from 300 m to 5 km from their natal sites (Vallender, unpubl. data). Out of 79 Golden-winged Warbler nestlings

banded in West Virginia from 2008–2011, eight (10%) were encountered the following year (Aldinger and Wood, unpubl. data). Only one of these West Virginia birds returned to the same (180 ha) habitat patch from which it fledged; the others dispersed as far as 4.5–5 km. Adult philopatry, on the other hand, is generally high—for example, in the Michigan study (Will 1986), of 24 banded territorial males that returned from the previous year, 18 (75%) established territories in the same area; and of the six which defended new areas, four established territories immediately adjacent to the areas defended the previous year. More research on dispersal is critical to future conservation and management efforts.

## BEHAVIORAL AND GENETIC INTERACTIONS WITH BLUE-WINGED WARBLER

### Interspecific Aggression and Territoriality

Will (1986) found that at one site in southern Michigan, Blue-winged Warbler replaced Golden-winged Warbler in upland habitat over a three-year period, but Golden-winged Warbler remained present in tamarack swamp at the same site. In upland habitat in central Michigan, Will (1986) found substantial overlap of Blue-winged and Golden-winged warbler territories, with no significant difference in nesting success between the two species. However, Will (1986) observed and coded 72 interspecific agonistic *Vermivora* behavioral interactions and documented social dominance of Blue-winged Warbler over Golden-winged Warbler—despite the fact that Golden-winged Warbler is slightly larger and heavier on average than Blue-winged Warbler.

During a five-year field study in north-central New York, Confer and Larkin (1998) observed 98

*Vermivora* males at 21 sites and found that male Golden-winged Warblers dominated 62% of the aggressive interactions ( $n = 87$ ) with male Blue-winged Warblers. In particular, they noted intense and extensive interspecific interactions between three pairs of males. Although substantial territorial overlap brings males of both species into frequent contact, interactions are infrequent or absent for most birds. However, male-female interactions may be more frequent. Male Blue-winged Warblers have been observed pursuing female Golden-winged Warblers of putative Golden-winged x Golden-winged Warbler pairs (Canterbury et al. 1996, Confer and Larkin 1998). Extra-pair copulation resulting from such pursuits may increase hybridization rates (Vallender et al. 2007a). Phenotypic hybrids currently occur in some areas of allopatry and in all areas of sympatry, sometimes accounting for 7–15% of singing males (Gill et al. 2001).

### Hybridization with Blue-winged Warbler

Northward range expansion of Blue-winged Warbler has led to widespread secondary contact with the Appalachian Mountains population of Golden-winged Warbler (except at higher elevations) and with the southern portion of the Great Lakes population range (see Figure 1–3). Golden-winged and Blue-winged warblers are genetically very similar (Gill 1997, Vallender et al. 2007b). Initially, Gill found no fixed difference between Golden-winged and Blue-winged warbler in allozymes from 40 loci and only a 3.5% divergence for cytochrome b sequences in mtDNA, a difference that is typical for closely-related bird species (Gill 1987, 1997). Gill's (1997) finding that more Golden-winged Warblers contained Blue-winged Warbler mitochondrial haplotypes than the reverse led to the conclusion that there was rapid and asymmetrical

introgression from Blue-winged to Golden-winged warbler and that cytonuclear extinction of Golden-winged Warbler might be inevitable. Shapiro et al. (2004) contradicted the Gill (1997) findings and suggested that introgression of mtDNA was occurring symmetrically between the two species. Dabrowski et al. (2005) found a significantly higher frequency of mtDNA introgression in Golden-winged Warbler than in Blue-winged Warbler in some samples (e.g., southern New York). Confer and Larkin (1998) in north-central New York and Confer (unpubl. data) in southern New York found that male Golden-winged Warblers mated more frequently with Brewster's Warbler females than did male Blue-winged Warblers—a prezygotic behavioral difference which might contribute to asymmetrical introgression.

Once pairing occurs, hybrid *Vermivora* do not appear to incur a fitness disadvantage relative to individuals in pure parental pairings. Clutch size and fledging rates from pure phenotype and hybrid pairs appear equal (Confer and Larkin 1998). Vallender et al. (2007a) used genetic analyses of parentage and found that hybrid males did not have a postzygotic disadvantage in terms of any measure of reproductive output compared to their Golden-winged Warbler counterparts. In a feeding rate study, Reed et al. (2007) determined that hybrid parents were as capable of raising and fledging young as were phenotypic Golden-winged Warblers. Finally, Neville et al. (2008) compared sex ratios of nestlings produced by Golden-winged Warbler pairs to those produced by pairs with at least one hybrid parent and concluded that females were not mitigating the cost of being mated to a hybrid male by either engaging in copulations with neighboring conspecific males or biasing the sex

ratio of their nestlings. On the other hand, hybrids do appear to be disadvantaged as a result of behavioral interactions that occur prior to mating. Ficken and Ficken (1968) described hybrids as having reduced pairing success at New York and Maryland sites and suggested that a prezygotic isolating mechanism lowered fitness of hybrids at these sites. Leichty and Grier (2006) found that Golden-winged Warbler males whose throat patch and facial mask were lightened experimentally lost territories and failed to obtain mates, suggesting sexual selection against the Brewster's facial pattern as an explanation for greater effect of hybridization on Golden-winged than on Blue-winged warbler. In New York, hybrid males were less likely to obtain mates than males of pure phenotypes (Confer and Tupper 2000).

To understand the geographic extent of present-day interactions between Golden-winged and Blue-winged warbler and the distribution of

phenotypic hybrids, GOWAP surveyed >7,200 points in 442 (roughly 30 min. x 30 min.) grid-squares throughout the range of both species from 1999–2005 (Barker Swarthout et al. 2009). The results clearly indicated a zone of overlap and hybridization with Blue-winged Warbler at roughly 44–45 degrees north latitude extending from central New York west through central Minnesota (Figure 1–11). At present, the only large phenotypically pure Golden-winged Warbler populations appear to exist north of this hybrid zone in Minnesota and Manitoba. The GOWAP hybrid atlas also indicated a second contact zone throughout the Appalachians where pockets of Golden-winged Warbler persist (usually at high elevations) surrounded by Blue-winged Warbler (Figure 1–11). In the

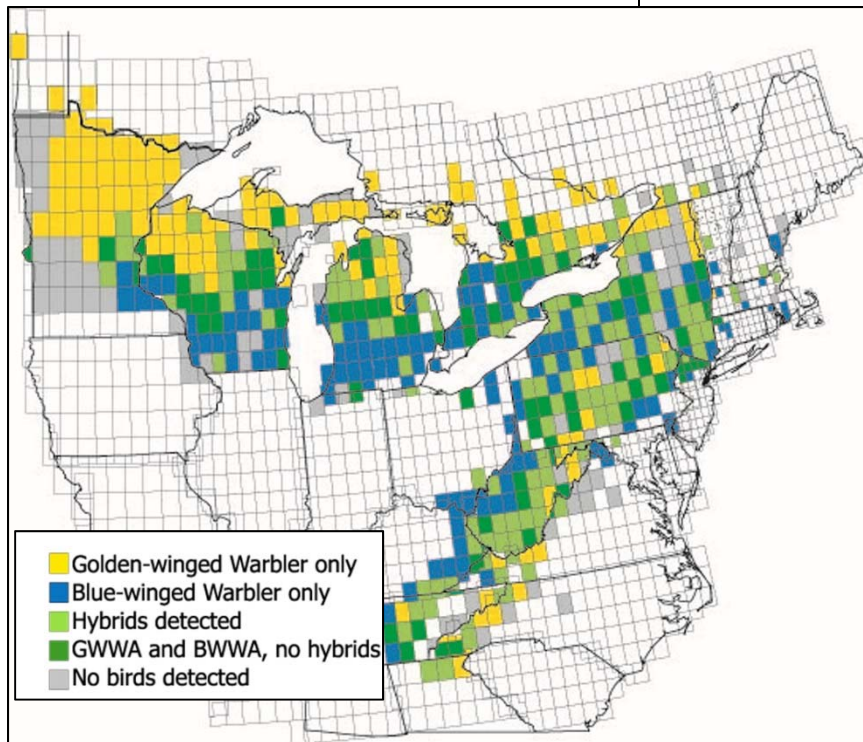


Figure 1–11. Distribution of phenotypic Golden-winged Warbler, Blue-winged Warbler, and zone of hybridization based on 1999–2005 Hybrid Index data from the Golden-winged Warbler Atlas Project, Cornell Lab of Ornithology (Barker Swarthout et al. 2009). Each colored grid rectangle represents a Delorme atlas page; twenty 10-minute point counts were conducted within each atlas page, with five point-counts distributed non-randomly in each quadrant of a page.

southern Blue Ridge region (e.g. North Carolina), a small phenotypically pure population of Golden-winged Warbler had been recorded until recently, but now hybrids are moving into this zone—indicating how dynamic the interaction is between these two species. Only 4% of the roughly 2800 warblers detected during this survey were phenotypic hybrids, distributed in 95 grid-squares throughout both zones of overlap. An additional 80 squares had both warbler species present, but no hybrids were detected, suggested that even in zones of overlap, hybrids are relatively rare.

In recent genetic work, Vallender et al. (2007b) screened samples of Golden-winged and Blue-winged individuals from regions of both historical and contemporary allopatry using a panel of nuclear markers (microsatellites, introns, and amplified fragment length polymorphisms) to

locate genetic differences between the species. In searches for private alleles and assignment test approaches that could differentiate the parental species, no combination of microsatellite or intron markers could separate the parental populations, and only seven of 4000 amplified fragment length polymorphisms weakly (but significantly) could differentiate the species. When used on samples of Golden-winged Warbler from a population in Ontario, these markers provided evidence for extensive cryptic hybridization. These findings suggest that far fewer genetically pure Golden-winged Warblers may remain than has previously been assumed.

Most recently, Vallender et al. (2009, unpubl. 2010 data) screened 1,464 phenotypic Golden-winged Warbler samples from throughout the breeding range with a recently developed mtDNA marker (Figure 1–12). As of 2010, analyses

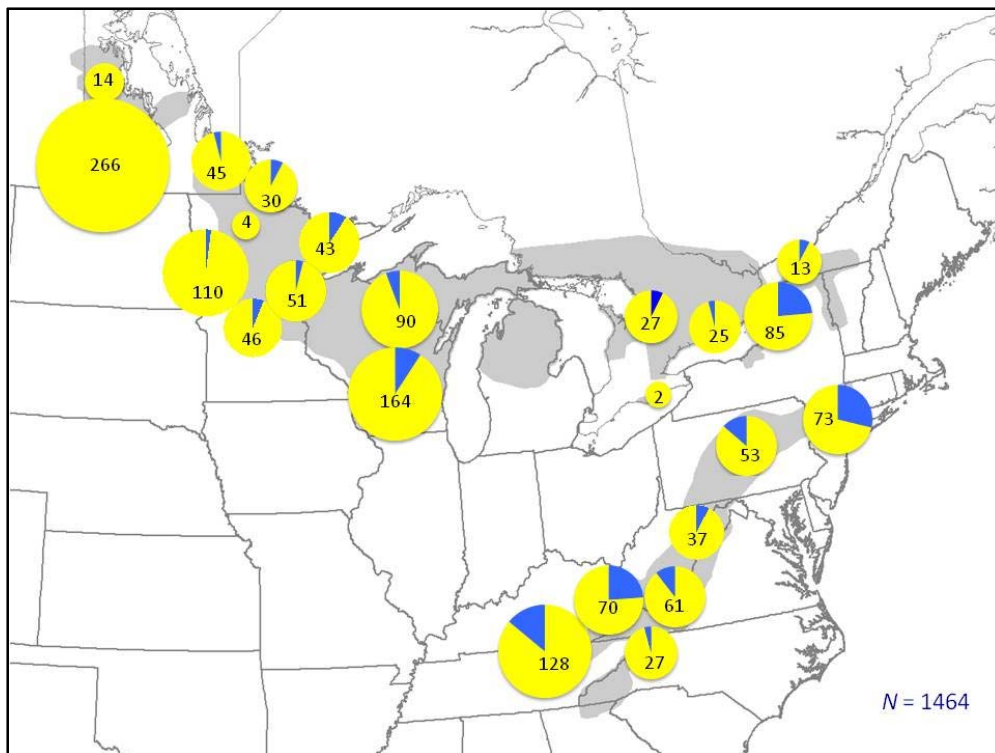


Figure 1–12. Mitochondrial DNA (mtDNA) screening results from 1,464 phenotypic Golden-winged Warblers collected in 8 states (NY, PA, MN, WI, WV, TN, NC, and KY) and 3 provinces (ON, QC, and MB). Numbers in the circles denote sample sizes. The amount of yellow in each circle represents the proportion of Golden-winged Warblers in the sample with Golden-winged Warbler mtDNA haplotypes; the blue represents the proportion of Golden-winged Warblers with Blue-winged Warbler mtDNA haplotypes (i.e., cryptic hybrids). Any circle with blue indicates samples collected in an area not comprised entirely of genetically pure Golden-winged Warblers (Vallender et al. 2009).

suggested that the only remaining genetically pure populations of Golden-winged Warbler breed in western Manitoba in both Riding Mountain National Park and the Duck Mountains. Other populations in this region of Manitoba remain to be sampled. All other populations—including those sampled in extreme southeastern Manitoba as well as in Minnesota—contained at least some Golden-winged Warblers with Blue-winged Warbler mtDNA (i.e., cryptic hybrids). Vallender and co-workers are continuing the rangewide screening of samples using the mtDNA marker; nDNA markers are being developed. If additional locations of genetically pure Golden-winged Warbler are identified, extensive sampling will be conducted to elucidate specific relationships between habitat and genetics.

Clearly, teasing apart the complex behavioral and genetic interactions between Golden-winged and Blue-winged warblers and their hybrids comprise one of the most intriguing scientific challenges provided by this sibling species complex. Observed inconsistencies from population to population highlight the importance for rangewide coordination of research. The fact that the cumulative data suggest prezygotic rather than postzygotic selection against hybrids underscores the importance of further elucidating mechanisms of behavioral interaction and social dominance between the two species. Documenting the rangewide extent of genetic introgression and projecting the long-term implications of introgression on population viability of both species remain important conservation research priorities.

### **Habitat Segregation between Golden-winged and Blue-winged Warbler**

The degree of similarity in the nesting habitat of Blue-winged and Golden-winged warbler may control the amount of interaction and rate of hybridization between the two species. For example, interspecific use of wet and dry habitats may be important; or different amounts of forested and non-forested habitat may affect local densities. In either case, proportional use varies considerably among regions and locations.

Berger (1958) summarized observations by many observers and noted relatively equal use of wet and dry habitats by Golden-winged and Blue-winged warbler in Michigan from the 1930s to the 1950s. A few study sites provide evidence that Blue-winged Warbler prefers wetlands (Eaton 1914, Forbush 1929, Short 1962, Canterbury et al. 1996). Ficken and Ficken (1968) observed that 26 of 29 Blue-winged Warblers used wetland habitats in New York. Fowlds (2010) found peak Golden-winged Warbler abundance in clearcuts and peak Blue-winged Warbler abundance in alder wetland /forest transitions in central Wisconsin. In dry hillside forest in the driftless area of southwestern Wisconsin, Blue-winged Warbler has completely

replaced Golden-winged Warbler; neither species appears to occupy bottomland hardwood forest (Paulios, pers. comm.) In West Virginia, Golden-winged Warbler won most interspecific aggressive encounters on dry, forested, sloped hillsides (contour mine edges in 15–60 years of secondary succession) whereas Blue-winged Warbler did better in flat, wet territories. Unmated male Blue-winged Warblers that invaded upland nesting territories of Golden-winged Warblers often harassed Golden-winged Warbler pairs nesting in the wetter situations (Canterbury et al. 1996, Canterbury and Stover 1999). Will (1986), on the other hand, found evidence that Blue-winged Warbler is more likely to interact with Golden-winged Warbler in uplands, particularly during later stages of succession (Confer and Knapp 1977).

Differences in the proportion of forested and non-forested habitat used by Golden-winged and Blue-winged warblers have been suggested as important in other regions. In Kentucky, Golden-winged Warbler sites were located at higher elevations and characterized by a greater percentage of canopy and grass cover compared

to Blue-winged Warbler sites, despite overlap in the location of territories between the species (Patton et al. 2010). In a New Jersey study, Golden-winged Warbler selected utility rights-of-way (ROWs) with high herbaceous cover, while Blue-winged Warbler seemed to prefer habitat with high shrub density farther from ROWs in more forested habitat (DeFalco and Dey 2003). In Virginia, neither ROWs nor wetlands were documented as important Golden-winged Warbler habitat; instead the species tended to select idle farmland surrounded by a forested matrix (Wilson et al. 2007). Blue-winged Warbler, on the other hand, was documented as occurring in ROWs and wetland habitats (Wilson et al. 2007). Differences in the habitat selected by Golden-winged and Blue-winged warblers in each of these studies may be due to differences in the relative importance of habitat factors at different spatial scales.

If sympatric coexistence is possible between the two species at the site scale, it may occur where habitat segregation occurs. In upland, secondary successional habitats of New York, Blue-winged Warbler used slightly later stages of succession with greater tree cover (Confer and Knapp 1981) and less herb cover than Golden-winged Warbler (Confer et al. 2003). However, the difference in habitat use at upland sites is slight, the range of vegetative characteristics in territories is broad, and the degree of habitat overlap is extensive. Stable coexistence of Golden-winged and Blue-winged warbler populations has been documented only in Hudson Highlands in southern New York (Eaton 1914, Confer and Tupper 2000), in the Appalachian Plateaus and

Ridge and Valley Physiographic provinces of Pennsylvania (Bakermans et al. 2011), and in southwestern West Virginia (Shapiro et al. 2004). In Sterling Forest State Park within the Hudson Highlands, both Golden-winged and Blue-winged warblers nested in uplands, and the interspecific nearest-neighbor distance between nests was often ~100 m (Confer et al. 1998). A portion of this Golden-winged Warbler population nesting in wetlands, however, was segregated from most Blue-winged Warblers. Golden-winged and Blue-winged warbler territories seldom overlapped in wetland areas, and Golden-winged Warbler nests were often >200 m from the nearest Blue-winged Warbler nest. A follow-up study confirmed the greater proportion of Golden-winged Warbler breeding pairs in lowland swamp forest compared with Blue-winged Warbler. Based on nine years of survey data at Sterling Forest State Park, the Golden-winged / Blue-winged warbler phenotypic ratio was 42:2 in hardwood swamp forest vs. 46:40 in uplands, and Golden-winged Warbler nest success was significantly higher in swamp forest (62.1%) than in dry uplands (40.8%) (Confer et al. 2010).

Chapter 3 of this document presents the results of habitat-based spatial modeling predicting areas where conservation action for Golden-winged Warbler might occur with lower probability of genetic interaction with Blue-winged Warbler. Analysis of factors that enhance habitat segregation between Blue-winged and Golden-winged warbler—at site, landscape, and regional scales—remains a critical area for additional research.

## NON-BREEDING SEASON ECOLOGY

Golden-winged Warbler spends the majority of the year in tropical forests extending from southern Mexico (Howell and Webb 1995) through Central America to the northern Andes of northwestern Venezuela, Colombia, and northwestern Ecuador (Ridgely and Tudor 1989)(Figure 1–1). In southern Mexico and Honduras, Golden-winged Warbler inhabits humid evergreen and semi-deciduous forest and edge (Howell and Webb 1995). In Costa Rica, the species uses forest canopy and edges, openings of tall second-growth or semi-open forests (Stiles and Skutch 1989), or mid-elevation undisturbed wet forest (Powell 1980). In Panama, Golden-winged Warbler occurs in young woodlands (e.g., Barro Colorado Island; Willis 1980) and forest borders (Ridgely and Gwynne 1989). The species has been reported from subtropical lower montane wet forest in northern Colombia (Johnson 1980), relatively high elevation (1600 m) transitional forest in southwestern Colombia (Orejuela et al. 1980), and undisturbed pre-montane rainforest (1000 m) on the Pacific slopes of western Colombia (Hilty 1980).

The resident non-breeding season (wintering season or Neotropical stationary non-breeding season) can last over seven months, with some individuals arriving as early as late September and maintaining territories until early May. Although the resident non-breeding season is the

longest portion of the annual cycle, until very recently very little was known about the ecology and conservation status of Golden-winged Warbler during this important period. Lack of information has hindered conservation efforts because it has not been possible to identify high quality habitat that should be conserved to ensure population viability. To begin to remedy the deficiency, Barker Swarthout et al. (2008) launched Priority Migrant eBird, a web-based system designed to elicit non-breeding season records of priority migrant species, including Golden-winged Warbler. Museum specimen records and records contributed through Priority Migrant eBird formed the basis for a preliminary predictive map of potential Golden-winged Warbler habitat in the Neotropics (Will et al. 2010). This map was used to prioritize areas for a broad-scale survey initiated in 2008 to document the distribution and habitat use of Golden-winged Warbler in Nicaragua, Costa Rica, Panama, Venezuela, and Colombia. The broad-scale survey results were then used to refine the model (see Distribution section below). In addition, an intensive and ongoing study of behavioral ecology and demographics was initiated in Costa Rica in 2006 (Chandler 2010, Chandler and King 2011). A third source of information comes from observations of Golden-winged Warbler reported from bird community-level studies.

## Migration

Very little is known about the migration of Golden-winged Warbler. The distribution of eBird records ([www.eBird.org](http://www.eBird.org)) during early spring (March–April) suggests a trans-Gulf of Mexico migration, with most records occurring in the western Gulf region of the U.S. and then continuing north through the Mississippi Valley and the Midwest. Fall (August–November) eBird records also suggest a trans-Gulf flight, with a greater concentration of records in Florida

compared to spring migration. There are virtually no records along the Gulf coast in central Mexico and very few from Gulf or Caribbean islands. Although Golden-winged Warbler is regularly encountered during migration throughout eastern North America south of the breeding range, there has been little effort to compile information about habitat use (Confer et al. 2011). Throughout the Caribbean region, a few individuals have been recorded as transients in

coastal, dry, and wet forests (Arendt 1992). More information about migratory connectivity between breeding season and non-breeding season locations is needed in order to delineate

population-specific migration routes, associated stopover habitat use, potential threats, and potential conservation actions during the migratory portion of the annual cycle.

## Distribution and Habitat use Segregation between Golden-winged and Blue-winged Warbler

Generalized maps of Golden-winged Warbler winter range (e.g., Figure 1–1) suggest that the entire area from southern Mexico to northern South America is occupied during the resident non-breeding season. Recent non-breeding season point count surveys in Nicaragua, Costa Rica, Panama, and Colombia (2009–2011) and consequent modeling, however, indicate that Golden-winged Warbler is selective in its habitat utilization and is therefore absent from large areas within this region (Figure 1–13). We

analyzed the point count data using N-mixture models (Royle 2004, Dail and Madsen 2011), which account for imperfect detection probability, and found that the best predictors of abundance were precipitation, temperature, latitude, and elevation. Predicted Golden-winged Warbler abundance increased with precipitation and temperature and was highest at intermediate elevations. The optimal elevation was higher in the southern portion of the non-breeding range than in the north. Because broadcast

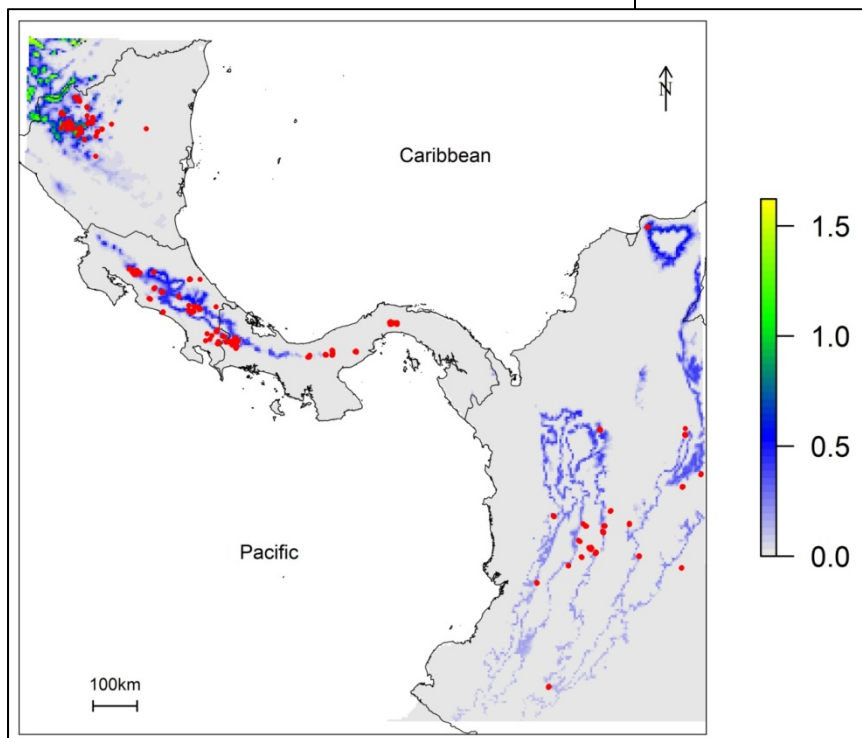


Figure 1–13. Modeled non-breeding season Golden-winged Warbler abundance using survey data from Nicaragua, Costa Rica, Panama, and Colombia. Red dots indicate survey locations. The colors indicate the predicted number of Golden-winged Warblers that would be detected at a survey point at locations within the study region during the resident non-breeding season.

vocalizations were used to attract Golden-winged Warblers, we did not know the effective area of the survey plots and thus could not reliably convert abundance estimates to density estimates. However, it may be possible to estimate effective survey area using the distance sampling data which were also collected as part of the survey protocol. Density modeling should be a priority for future analyses, as it would allow for the estimation of total population size in each country or for selected regions of the non-breeding range. In addition, more research is needed from the southern and northern extremes of the Golden-winged Warbler resident non-breeding range, and particularly from Honduras, which could host a large portion of the population.

Even within the core of its winter range, Golden-winged Warbler density is often low, and the species is patchily distributed (Johnson 1980, Morton 1980, Orejuela et al. 1980, Powell et al. 1992, Wallace et al. 1996, Komar 1998, Blake and Loiselle 2000). Preferred habitat appears to be wet evergreen forests at intermediate elevations (Bent 1963, Johnson 1980, Tramer and Kemp 1982, Blake and Loiselle 2000, Chandler and King 2011). Tropical dry forests and high elevations (>3000 m) are avoided altogether. This pattern

suggests that temperature and precipitation are important determinants of winter distribution. Elevation may also be important, as it can influence both temperature and precipitation, but it is not always an adequate surrogate for the other two variables. For example, in the Cordillera de Tilarán of Costa Rica, Golden-winged Warbler does not occur at 800 m (and below) on the dry Pacific slope, which receives < 2 m annual precipitation, but it is regularly encountered at 800 m on the Caribbean slope, which receives 3–6 m of precipitation annually (Chandler 2010).

Although precipitation and temperature are useful for predicting Golden-winged Warbler occurrence during the non-breeding season (Figure 1–13), these climatic variables are not likely the proximate factors influencing habitat selection; rather, temperature and precipitation influence the forest characteristics that are required by the species. Specifically, Golden-winged Warbler selects forests characterized by numerous hanging dead leaves and epiphytes, which it probes in search of insects (Rosenberg 1997, Chandler 2010 and Figure 1–14). These micro-habitat characteristics, especially epiphytes, are often absent from dry forests but are relatively common in premontane forests, especially those that have experienced some form of disturbance resulting in intermediate canopy height and numerous vine tangles (Figure 1–15). Its tendency to forage among epiphytes would suggest that Golden-winged Warbler would thrive in high elevation cloud forests which are covered in thick layers of moss; however, the species rarely occurs above 2500 m. It is possible that the moss covering the vegetation in these forests is too thick for the warbler to manipulate; indeed, many of the epiphyte-foraging species in these forests are equipped with specialized,

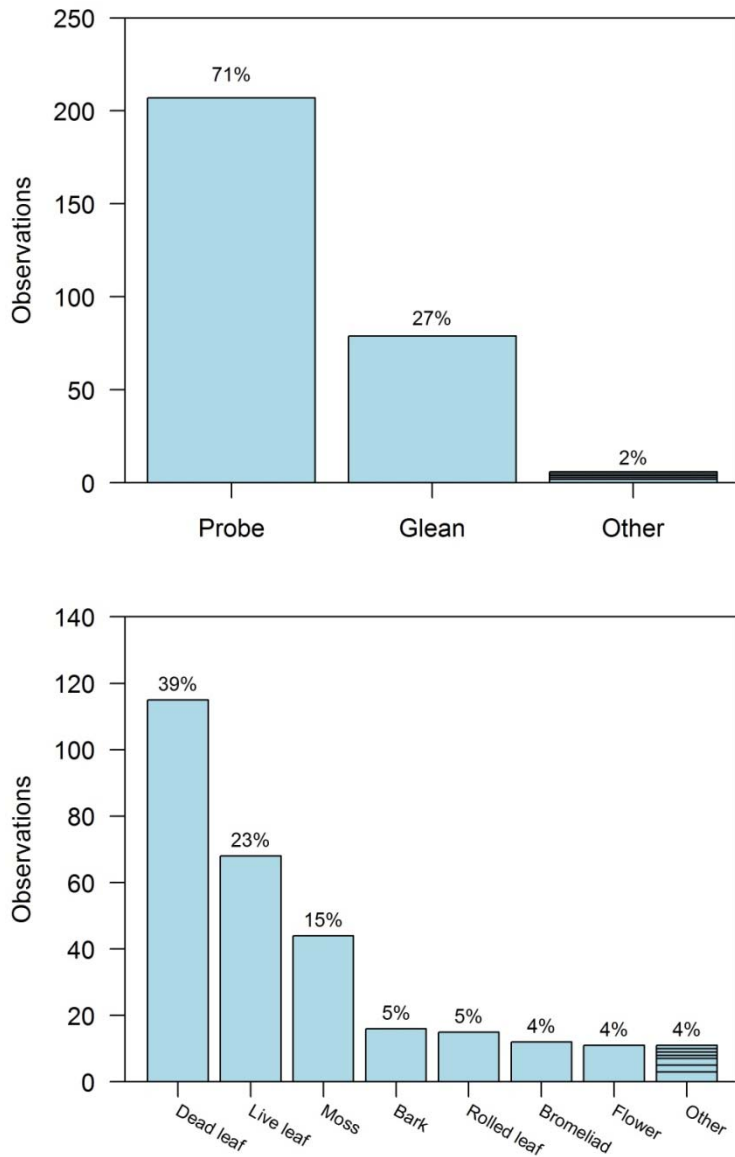


Figure 1–14. Foraging maneuvers and substrates observed for Golden-winged Warbler during the resident non-breeding season in Costa Rica (Chandler and King 2011).

long, powerful bills. Thus, ideal Golden-winged Warbler forests appear to be those with intermediate numbers of epiphytes and many hanging dead leaves (Figure 1–15) (Chandler and King 2011).

Although Golden-winged Warbler requires specific climatic conditions and micro-habitat features, it is encountered in a variety of habitat types in the tropics. During the 2008-2011 rangewide non-breeding season surveys, the species was found most often in secondary forests, followed by agroforestry systems, then primary forest. Species that utilize multiple habitat types are often regarded as generalist species tolerant of human-modified environments. However, it is easier to detect birds in more open habitats, so estimates of detection probability are needed to correct for observation error. Also, some birds encountered

in human-modified habitats may be displaced from better habitat or are making brief sojourns from nearby forest patches. For example, results of point count surveys in Costa Rica suggest that Golden-winged Warbler uses shade coffee (Komar 2006), but telemetry data show that Golden-winged Warbler uses shade coffee primarily in transit between forest patches (Chandler 2010). Thus, the inference that shade coffee provides non-breeding habitat for Golden-winged Warbler should be viewed with caution. Nonetheless, Golden-winged Warbler can establish territories and occur at high densities in advanced secondary forest, and its preferred micro-habitat characteristics are not restricted to primary forest. This habitat relationship is important, as it suggests that reforestation may be an effective conservation strategy during the resident non-breeding season.

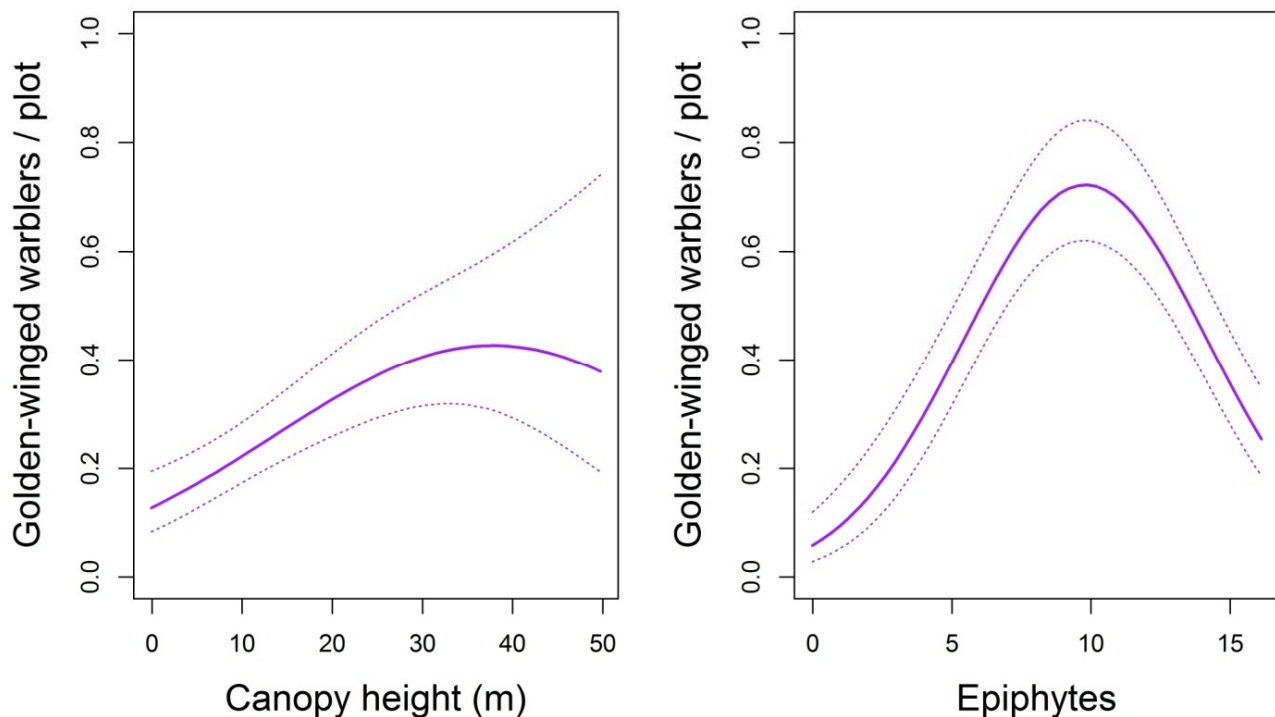


Figure 1–15. Estimated relationships between Golden-winged Warbler abundance and canopy height and between Golden-winged Warbler abundance and epiphytes during the resident non-breeding season in Costa Rica. Epiphytes were measured using an index from 0–16 (Chandler and King 2011).

## Non-breeding Foraging and Social Behavior

The specialized foraging behaviors of Golden-winged Warbler affect its social system during the non-breeding season, and this social system has important conservation implications. As with many other Neotropical species that forage in hanging dead leaves, Golden-winged Warbler spends the majority of its time with mixed-species foraging flocks (Rosenberg 1997, Chandler 2010). The association between flocking and dead leaf foraging is believed to result from the vulnerability to predation inherent in the foraging technique, which is noisy and often involves the forager inserting its entire head into a leaf or bromeliad. In most instances, only one Golden-winged Warbler is found with a foraging flock—probably due to prey availability in the foraging substrates and the forager's ability to

defend these resources. Golden-winged Warbler is highly territorial during the non-breeding season and aggressively responds to broadcast vocalizations and decoys (Chandler 2010). These behavioral characteristics result in large home range sizes (Table 1–4) and low densities—suggesting that large tropical areas need to be protected to support a population. Furthermore, specialized foraging requirements and association with mixed-species foraging flocks suggest that Golden-winged Warbler will be adversely affected by deforestation and habitat fragmentation, since numerous studies (e.g., Rappole and Morton 1985, Stouffer and Bierregaard 1995, Stratford and Stouffer 1999) have found that mixed-species flocks cannot persist in highly fragmented landscapes.

Table 1–4. Home-range size summary statistics for 20 Golden-winged Warblers radio-tracked during three non-breeding seasons (2006–2009) in the Cordillera de Tilarán, Costa Rica.

Estimator	Level	Mean	SD	Min	Max
Kernel	50%	1.99	0.95	0.44	4.00
	75%	4.13	1.98	1.00	8.75
	95%	8.77	4.69	2.31	19.50
Minimum convex polygon	50%	0.83	0.56	0.13	1.96
	75%	1.56	0.99	0.32	4.00
	95%	3.16	2.13	0.81	9.87

## FULL LIFE CYCLE POPULATION DEMOGRAPHY

In general, songbird populations are more sensitive to changes in adult and juvenile survival rates than to changes in reproductive parameters, although reproduction can still determine in part whether a population is increasing, decreasing, or stable (Donovan and Thompson 2001).

Golden-winged Warbler captures at Monitoring Avian Productivity and Survivorship (MAPS) banding stations—43 adults from four stations—

were insufficient to meet inclusion criteria for calculating lambda in a 15-year (1992–2006) analysis of MAPS data (D. DeSante, pers. comm.). However, the data could provide some information about adult apparent survival in time-constant capture-mark-recapture models: the 15-year program-wide (continental) time-constant adult apparent survival rate estimate was 0.664 (SE = 0.127, CV = 19.2%) (DeSante and Kaschube 2009). This a very high apparent survival estimate for a warbler, likely due to a

very low recapture probability estimate (0.222, SE = 0.124, CV = 55.7%) and high residency estimate (0.540, SE = 0.344, CV = 63.7%), both of which were poorly estimated due to the small sample size. Nevertheless, these limited data suggest that Golden-winged Warbler might not have a particularly low or deficient adult apparent survival rate (DeSante, pers. comm.). MAPS data collected over the same 15 years also provided some information about productivity: the program-wide time-constant MAPS reproductive index (young/adult) estimate for Golden-winged Warbler was 0.151 (95% CI: 0.068–0.334). This was the fourth lowest of 34 warbler species for which estimates were available. Since the mean reproductive index for the other 33 warbler species was 0.316, these limited data suggest that Golden-winged Warbler might be suffering from low productivity (DeSante, pers. comm.).

Studies involving marked *Vermivora* individuals are limited. In one Michigan study, 73% ( $n = 11$ ) of banded males returned to the same study area (Murray and Gill 1976). In another Michigan study (Will 1986), 52% ( $n = 41$ ) of males and 10% of females ( $n = 21$ ) returned. Recent estimates of minimum annual survival rates have been calculated from return rates of color-marked individuals to the breeding grounds in Tennessee and Ontario (Bulluck 2007, Bulluck et al. 2013). Adult male apparent annual survival, corrected for detectability, was 0.62 for both areas (2001–2005 in Ontario,  $n = 185$ ; 2003–2005 in Tennessee,  $n = 91$ ). Adult female survival was

0.48 ( $n = 107$ ) in Ontario and 0.43 in Tennessee ( $n = 51$ ). The different estimated survival between males and females may reflect either differential survival during migration or on the wintering grounds or differential site fidelity on the breeding grounds. Apparent survival within the breeding season was assumed to be relatively high. Bulluck (2007) concluded that these annual survival rates, especially for females, were insufficient to sustain the Ontario and Tennessee breeding populations over the long term without immigration of new individuals (i.e., they were population sinks).

Chandler (2010) reported a 0.53 annual apparent survival probability for males and females combined during the non-breeding season in Costa Rica (2006–2010,  $n=31$ ). Survival was lowest during the resident non-breeding season (6.5 months), with a 0.63 apparent within-season survival probability compared to a 0.85 apparent survival probability during the rest of the year (5.5 months including migratory and breeding periods) (Table 1–5). Habitat-specific demographics are needed, however, to evaluate non-breeding season habitat quality and to identify factors affecting survivorship. Density is not always positively correlated with survival probability; thus it is possible that tropical secondary forest could serve as an ecological trap, although Chandler (2010) found no evidence of lowered survivorship in secondary forests in Costa Rica. However, recruitment appeared to be low, as vacated territories were not always replaced in subsequent years.

Table 1–5. Estimates of survival and resight probabilities for Golden-winged Warbler from a Cormack-Jolly-Seber model. Data were collected on 31 individuals monitored for up to five years in the Cordillera de Tilarán, Costa Rica, 2006–2010.

Parameter	Mean	SD	95% CI	
			Lower	Upper
Within season apparent survival (monthly)	0.93	0.033	0.87	0.99
Within season apparent survival (1 Oct – 15 April)	0.63	0.14	0.37	0.90
Annual apparent survival	0.53	0.13	0.29	0.77
Resight probability	0.42	0.058	0.31	0.54

The Costa Rica study (Chandler 2010, Chandler and King 2011) indicated annual survival rates comparable to the Bulluck (2007) estimates; both studies suggest that survival during the resident non-breeding season may be a factor contributing to observed population declines measured during the breeding season. If non-breeding season conditioning and survival is

ultimately limiting Golden-winged Warbler population growth, establishing explicit migratory connectivity for Golden-winged Warbler populations will be essential for targeting appropriate conservation action—especially given the differential predicted population trajectories of the Appalachian and Great Lakes populations.

## POPULATION THREATS

Golden-winged Warbler population declines have been attributed to a variety of potential sources, including loss of breeding season habitat, interactions with Blue-winged Warbler (both competition and hybridization), Brown-headed Cowbird brood parasitism, and land use changes on the Neotropical wintering grounds. All of these threats, with the possible exception of cowbird parasitism, likely contribute to

population-level declines, and the relative impact of each as a limiting factor remains unclear. Threats to the species appear to vary considerably across regions, although loss of early successional habitat has been identified as the principal rangewide breeding season threat, compounded in some areas by hybridization with Blue-winged Warbler.

## Past, Present, and Projected Future Breeding Season Habitat

Habitat loss during all stages of the Golden-winged Warbler annual cycle is likely a primary contributor to the decline of the species. Widespread declines in the early successional component of breeding habitat has been noted by numerous authors (e.g., Litvaitis 1993, Hunter et al. 2001, Lorimer 2001, Thompson and DeGraaf 2001, Trani et al. 2001, Confer and Pascoe 2003). The loss of suitable breeding habitat has likely been a factor leading to local extirpations of Golden-winged Warbler, particularly in the eastern United States and southern Ontario.

The U.S. Forest Service (USFS) Forest Inventory and Analysis (FIA) program (Bechtold and Patterson 2005, Woudenberg et al. 2010) can be used to portray coarse-scale patterns in forest composition and structure over large geographic extents. Although these data were not intended to predict wildlife population carrying capacity, we estimated abundance of potential Golden-

winged Warbler breeding habitat over the approximate span of the BBS by assessing changes in hardwood forest trees in the small diameter size class (sapling/seedlings <5 in [12.5 cm] DBH) in two regions: the Great Lakes (Minnesota, Wisconsin, Michigan, and New York) and the northern Appalachians (Pennsylvania, Virginia, and West Virginia). Historical FIA estimates refer to timberland, a subcategory of forested land that excludes reserved (e.g., wilderness) or non-productive forests. In the Midwest and Northeast, timberland comprises the vast majority of all forest lands (typically more than 90–95%) and was therefore assumed to be representative of all forested habitat. Area of forest land with small diameter hardwood trees has decreased both in the Great Lakes states (22%) and in the northern Appalachian states (43%) since the mid-1960s; the decrease varies substantially among states within each region (Figure 1–16).

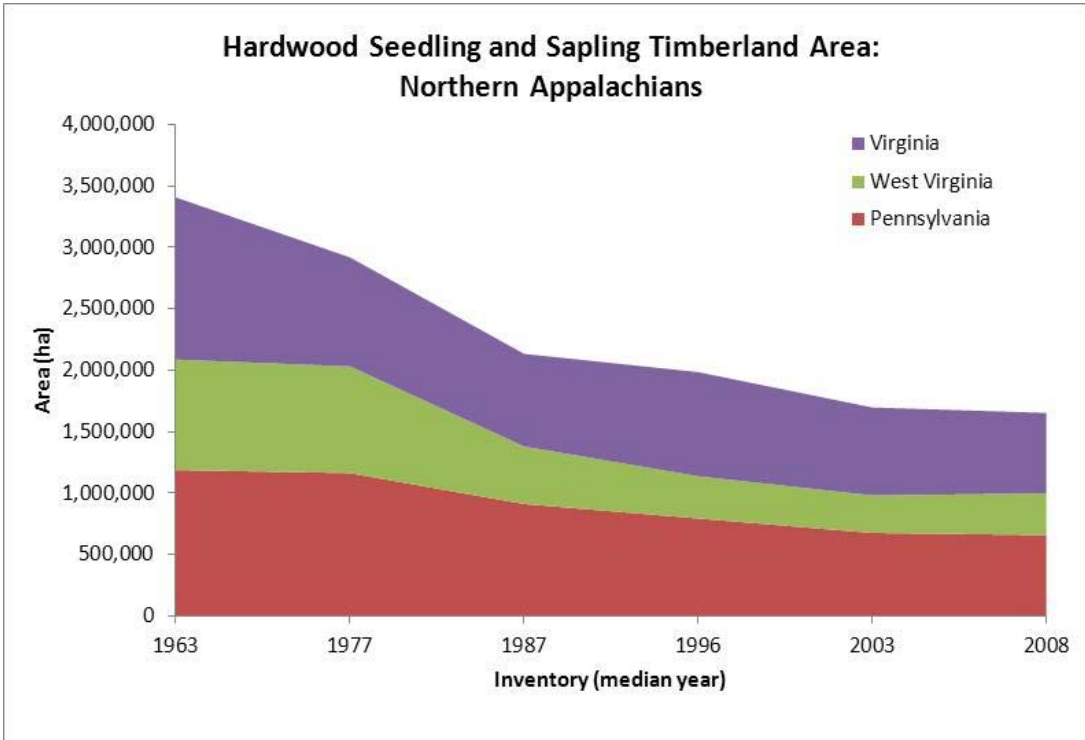
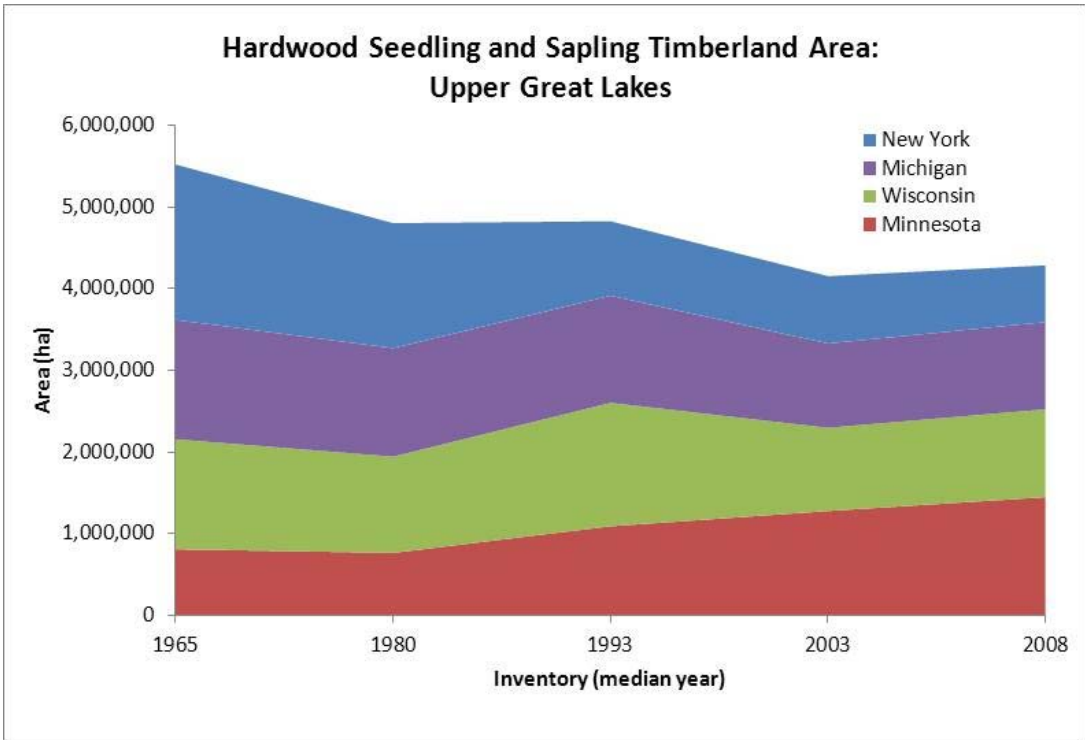
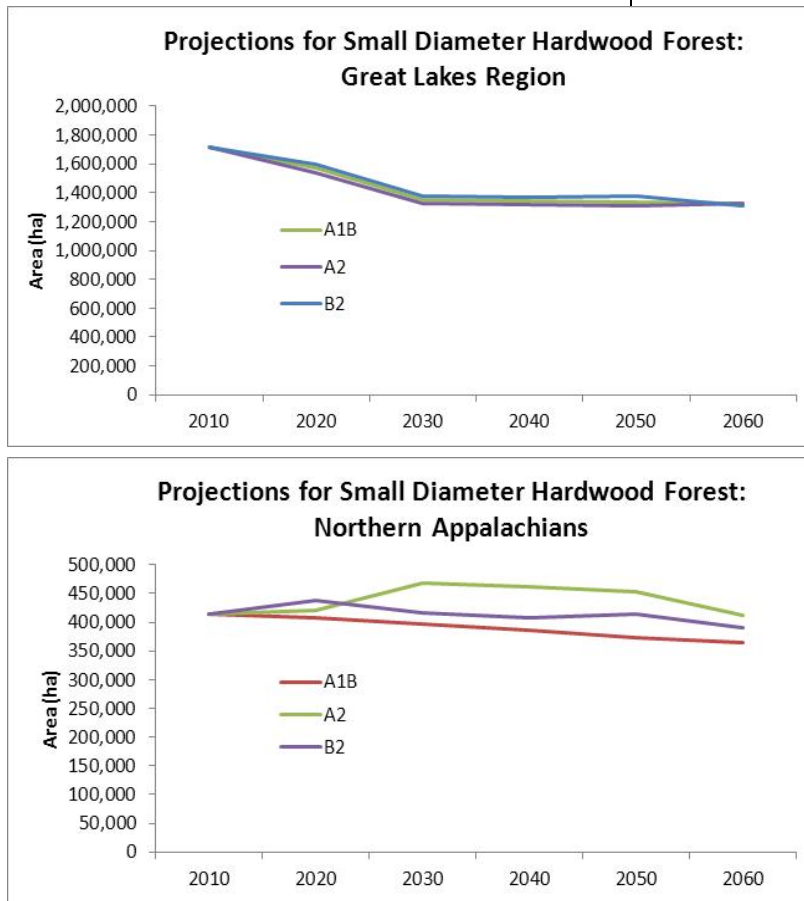


Figure 1–16. Estimates of recent (40–45 year) changes in potential Golden-winged Warbler breeding habitat in Great Lakes and northern Appalachian states using U.S. Forest Service FIA data. Standard forest land area estimators (Scott et al. 2005) were used for small diameter (<12.5 cm DBH) hardwood timberland (FIA forest type codes  $\geq 40$ ). FIA’s online EVALIDator tool (Miles 2010) was used for timberland area dating back to the late 1970s or mid 1980s; estimates from prior decades came from multiple published state FIA reports.

Projections of future abundance of potential Golden-winged Warbler habitat were derived from the USFS Forest Futures project (U.S. Forest Service 2012a), which projects a range of plausible future forest conditions in the U.S. Midwest and Northeast resulting from changing patterns of land use and climate (represented by Intergovernmental Panel on Climate Change [IPPC] storylines A1B, A2, and B2) (U.S. Forest Service 2012b). We used ecological classification system land units (Cleland et al. 2007) to match areas for future projections as closely as possible

with the current Golden-winged Warbler range (Figure 1–4). Total area of forest land is projected to decline by 2–3% in the Great Lakes region and by 6–13% in the northern Appalachian region. Potential future Golden-winged Warbler habitat abundance (again estimated by the small diameter hardwoods class) is projected to decrease under all three scenarios, ranging from a 0.5–12% decline in the in the Great Lakes region and 6–13% in the northern Appalachian region. Potential future Golden-winged Warbler habitat abundance (again estimated by the small



diameter hardwoods class) is projected to decrease under all three scenarios, ranging from a 23% decline in the Great Lakes region to a 0.5–12% decline in the northern Appalachian region (Figure 1–17).

In addition to projected loss in the overall amount of suitable dynamic forest habitat, habitat quality may also decline with advancing forest succession. Birds presumably respond by nesting or feeding in marginal or poor habitat where nest success and fledgling survival can be poor. Site abandonment and even low adult survival might then lead to local population declines. We currently know little about Golden-winged Warbler juvenile survival or the proportion of this age class that perishes each year on migration; however, first-year mortality can be high for Neotropical migrants, and loss of appropriate stopover habitat also likely contributes to lower survival during the bird's critical first long-distance journey. For other warbler species, we also know that the quality of winter habitat affects adult breeding condition and nesting success the following spring (Marra et al. 1998, Reudink et al. 2009).

Figure 1–17. Projected declines in potential Golden-winged Warbler habitat in the Great Lakes and northern Appalachians derived from the USFS Northern Forest Futures Projection project (U.S. Forest Service 2012a). Potential habitat was estimated using the small diameter hardwood forest class under three different land use and IPCC GCGM31 storylines (U.S. Forest Service 2012b). The two regions for future projections were based on ecological units (Cleland et al. 2007): Great Lakes included portions of Province 212 in Minnesota, Wisconsin, and Michigan, and Section 212E in New York; the Northern Appalachians region included Pennsylvania, Maryland, and West Virginia portions of Province M221.

Quality Golden-winged Warbler breeding habitat is being lost as a result of several causes:

### ***Natural Succession and Disturbance Regime Change***

Although much loss of young forest habitat is undoubtedly related to changes in human land use, loss can also be attributed to advancing succession due to reduced natural disturbance, especially disturbance due to fire. Succession in the absence of historical natural disturbance regimes leads to closed-canopied forests incapable of supporting species that require imbedded patches of early-successional habitat for some part of their annual cycle. Estimates for New York (Confer and Pascoe 2003) and New Hampshire (Litvaitis 1993) suggest that the loss of natural disturbance-dependent habitat already exceeds the current acreage of early-successional habitat added by anthropogenic disturbance—and the rate of anthropogenic early-successional habitat creation continues to decline.

Wetland loss and removal of beavers (with their ability to create wetland shrub communities within forests) from widespread areas throughout the eastern U.S. may be responsible for significant loss of Golden-winged Warbler nesting habitat (but cf. Chandler et al. 2009). Although lowland shrub community habitats embedded in dynamic forested landscapes in the Upper Midwest may be sufficient to prevent extirpation of Golden-winged Warbler populations (Hanowski 2002), these populations may still decline to a fraction of current levels if wetland habitat suitability diminishes due to natural succession (e.g., over-mature *Alnus*), development impacts, or altered hydrologic regimes resulting from changing climate patterns.

### ***Development and Land Use Change***

In some areas, especially the Upper Midwest, second home development may be compromising some Golden-winged Warbler habitat, especially in deciduous forests and near lakeshores (Gonzalez-Abraham et al. 2007). Housing development in forests rangewide is fragmenting the forest at a landscape scale and leads to potential habitat degradation. Housing development is projected to be high in and near protected areas such as national forests (Stein et al. 2007); such development can result in multiple threats to bird habitat and conservation efforts—reducing fire frequency and scale, increasing brood-parasitic cowbird populations, and increasing introduction of invasive plants (Radeloff et al. 2010). Additionally, mammalian

mesopredator populations may increase in both range and abundance due to landscape fragmentation by human development—resulting in decreased nest survival of ground-nesting birds and increased adult bird mortality (Crooks and Soule 1999, Rogers and Caro 1998). Larivière (2004) suggested that northward range expansion of raccoons was attributable in part to increased food availability resulting from changing climate patterns. Direct human activities can also increase local nest predation rates; for example, Roth (pers. comm.) observed people relocating problem raccoons to a Golden-winged Warbler study site while nests were still active.

## Public and Private Forested Land Policy

Reduced aspen and other forest management on public lands will reduce the amount of suitable habitat available to Golden-winged Warbler (Roth and Lutz 2004). Public pressure to reduce clearcutting on national forests has led to a gradual decline of young forest habitat on these lands. Additionally, some national forests currently are harvesting aspen at rates below the goals set in their forest plans. Typically, clearcuts provide ephemeral habitat that remains suitable for Golden-winged Warbler for fewer than ten years, so the species is reliant on regular timber harvest regime on a landscape scale more often typical of industrial forests.

Most of the forested lands capable of supporting breeding Golden-winged Warbler are in private ownership—ranging between 38% and 93% of forests as presented in the Subregional analyses in Chapter 3. As increasingly smaller holdings of private forest land are owned by growing numbers of individual land owners

(parcelization), it becomes increasingly difficult to reach goals of creating dynamic forests at landscape scales due to administrative challenges in coordinating many individual forest landowner plans, decreasing willingness of landowners to allow timber harvest, and increasing operational expenses when harvesting smaller landholdings. Golden-winged Warbler utilizes different forest seral types throughout its breeding cycle and is essentially a species of dynamic forested landscapes; thus a piecemeal approach to forest management for the species is unlikely to achieve objectives at the population scale. Even if alternative forest product and forest management scenarios arise—e.g., removal of woody biomass (and subsequent forest regeneration) to serve bioenergy markets—private lands management incentive programs may still be necessary to achieve goals at regional scales. Coordination of efforts to achieve dynamically functional forested landscapes will continue to be a challenge.

## Interactions with Blue-winged Warbler

Much research attention has focused on understanding the mechanisms underlying the local replacement of Golden-winged Warbler by Blue-winged Warbler in areas of secondary contact (Confer and Knapp 1977, Gill 1980, Confer and Knapp 1981, Will 1986, Confer et al. 1991, Gill 1997, Confer and Larkin 1998, Confer et al. 1998, Confer et al. 2003). Debate continues, however, regarding whether these relationships are causal or at least partly coincidental in nature. Virtual extirpation of Golden-winged Warbler has been documented at well-studied locations (e.g., in Massachusetts, Connecticut, central New York, and at lower elevations in West Virginia) despite the presence of apparently suitable habitat. Blue-winged Warbler has increased in many of these areas coincident with the decline of Golden-winged Warbler. In the southern Appalachians, Golden-winged Warbler has declined in the absence of Blue-winged

Warbler, although hybrids do occur; in these situations, habitat loss is likely the limiting factor.

The decline of Golden-winged Warbler following Blue-winged Warbler expansion and the local extirpation of Golden-winged Warbler could be caused by competition, direct behavioral aggression, or hybridization; or the respective range changes may be the result of some other correlated factor, such as climate change, that affects both species. In north-central New York, Golden-winged Warbler dominated Blue-winged Warbler in aggressive interactions; availability of suitable nesting habitat did not appear to limit breeding densities (Confer and Larkin 1998). In contrast, Will (1986) reported behavioral dominance by Blue-winged Warbler over Golden-winged Warbler in central Michigan, and Canterbury (unpubl. data) reported that dominance relationships between the two

species varied among habitats. Confer et al. (2002) found that proximity with Blue-winged Warbler accounted for 15% of all variation in Golden-winged Warbler clutch size; going from no overlap to complete overlap with Blue-winged Warbler reduced Golden-winged Warbler clutch size by 0.5 eggs.

Some researchers have suggested that hybridization may be more disadvantageous for Golden-winged Warbler than Blue-winged Warbler for two reasons. Male Blue-winged Warblers occasionally harass female Golden-winged Warblers of putative Golden-winged x Golden-winged warbler pairs, whereas the converse had not been reported (Confer and Larkin 1998). This may lead to extra-species copulation by male Blue-winged Warbler but not by male Golden-winged Warbler, which in turn would increase the frequency of hybrid young for a Golden-winged x Golden-winged warbler pair in comparison to a Blue-winged x Blue-winged warbler pair. In addition, Confer and Larkin (1998) found evidence that male Golden-winged Warblers were more likely to form pair bonds and raise young with Brewster's Warbler females than male Blue-winged Warblers and thus were more likely to produce hybrids than Blue-winged Warbler. In samples from areas of recent secondary contact, introgression of mtDNA

appeared symmetrical (Shapiro et al. 2004, Dabrowski et al. 2005). In contrast, in samples from southern New York taken after nearly a century of coexistence, only two of 15 (13%) Blue-winged Warblers had Golden-winged Warbler mtDNA while 12 of 28 (43%) Golden-winged Warblers had Blue-winged Warbler mtDNA (Dabrowski et al. 2005).

In summary, interactions between Blue-winged and Golden-winged warblers are complex, regionally variable, and related to differential habitat use that also varies regionally. Whereas virtually all researchers would agree that introgression of Blue-winged Warbler genes (whether visually apparent or cryptic) into the Golden-winged Warbler population threatens the continued existence of a pure Golden-winged Warbler phenotype, many researchers and conservationists are transitioning from a position of regarding Blue-winged Warbler as a direct threat to Golden-winged Warbler per se to a position that recognizes a strategy of maintaining, to the greatest extent possible, the full genetic diversity represented within the *Vermivora* complex. Such a strategy includes maintaining populations of pure Golden-winged Warbler genotypes where allopatry or habitat segregation in sympatry appears to facilitate genetic isolation.

## Brood Parasitism

Golden-winged Warbler populations experience moderate rates of brood parasitism by Brown-headed Cowbird (Confer et al. 2001), especially in more agricultural landscapes. Based on a survey of several hundred nests from across the range of the species, about 30% of nests had at least one cowbird egg (Coker and Confer 1990). In north-central New York, 22 of 73 nests (30%) in 1988–1994 contained at least one cowbird egg or chick (Confer et al. 2003). This rate of parasitism was estimated to reduce fledging by 17%. However, cowbird parasitism in many areas is not presently a problem (cf. Table 1–3) and probably has not contributed to declines of the species. Cowbird

parasitism was not recorded during nesting studies in the mountains of North Carolina (Klaus and Buehler 2001) nor in the Cumberland Mountains of Tennessee (Bulluck and Buehler 2008), was not a problem for Golden-winged Warbler populations in West Virginia (Canterbury et al. 1996), and was minimal in Ontario (Vallender et al. 2007a). In a forested landscape in northern Wisconsin, only one of 50 nests (2%) was parasitized (Roth, unpubl. data). Brood parasitism in Manitoba, where Golden-winged Warbler appears to have recently expanded its range, also appears to be relatively low (~7% from two 2011–2012 studies combined: Moulton,

unpubl. data; Peterson, unpubl. data). As indexed by the BBS, Brown-headed Cowbird populations are generally declining in forested regions (Sauer et al. 2011), so the current moderate to minimal

reproductive threat posed by cowbirds is likely to diminish even more over time in forested landscapes.

## Disease and Predation

Although Golden-winged Warbler is susceptible to a variety of avian diseases, the incidence of disease is probably not responsible for recent declines. West Nile virus has not been documented in Golden-winged Warbler but has been documented in 16 other warbler species (CDC 2007).

There are few data on predation rates for Golden-winged Warbler and virtually no data on how population declines may have changed relative to predation rates. Potential mammalian nest predators include raccoon (*Procyon lotor*), coyote (*Canis latrans*), striped skunk (*Mephitis mephitis*), various weasel species (*Mustela* spp.), opossum (*Didelphis marsupialis*), red fox (*Vulpes fulva*), gray fox (*Urocyon cinereoargenteus*), Eastern chipmunk (*Tamias striatus*), red squirrel (*Tamisciurus hudsonicus*), gray squirrel (*Sciurus carolinensis*), mice (*Peromyscus* spp.), voles (*Microtus* spp.), and unrestrained house cats (*Felis catus*). Potential avian nest predators include American Crow (*Corvus brachyrhynchos*) and Blue Jay (*Cyanocitta cristata*). There are many potential herpetofaunal predators, especially snakes; Will (pers. comm.) and Roth (pers. comm.), for example, described sequential

predation of Golden-winged Warbler nestlings by eastern garter snake (*Thamnophis sirtalis*).

Nest predation is generally considered to be the leading cause of nest failure in this species (Confer et al. 2011), yet there is no clear indication of how recorded rates of nest predation contribute to overall population change. In some populations (e.g., North Carolina, Klaus and Buehler 2001), nest success was high (72.5%) compared to other passerines, and nest predation was not likely responsible for overall population declines. Following a large mast production, chipmunks and squirrels may increase to the extent that predation significantly impacts nest success. One artificial nest study in Ontario suggested relatively equal predation pressure exerted by mid-sized mammals, squirrels/chipmunks, and mice/voles (Demmons 2000). Kubel and Yahner (2008) speculated that a chipmunk irruption resulted in the high predation rates observed during one year of their study in Pennsylvania. Based on nine years of surveys in Sterling Forest, New York, nest success was significantly higher (62.1%) in swamp forests than in dry uplands (40.8%), possibly due to the more abundant chipmunk populations in the uplands (Confer, unpubl. data).

## Overutilization

Golden-winged Warbler is not used consumptively in any known way that would contribute to its population decline, nor are

shooting or other forms of intentional human-caused mortality likely to have population-scale impacts.

## Climate Change

Price and Root (unpubl. data) have suggested that the northward shift in the distribution of both Golden-winged and Blue-winged warbler in Wisconsin and Minnesota is consistent with patterns of climate change in the region. Under two climate model scenarios, the Golden-winged Warbler breeding range is expected to contract northward and to higher elevations in the Appalachians; tracking range shifts of birch and aspen, the species is expected to disappear from much of its current breeding range in the Midwest. Price and Glick (2001) found that a 2 °C increase in temperature resulted in a predicted extirpation of Golden-winged Warbler from Minnesota and Wisconsin. The Canadian Climate Center Model predicts extirpation from the western portions of the breeding range and reduced populations in the eastern U.S. (Matthews et al. 2004). The Hadley Centre Coupled Model Version 3 used by the Wallace Initiative also predicts a northward shift in the breeding range—if suitable habitat exists (Price pers. comm.). Prasad et al. (2009) describe an online database and mapping tool (Matthews et al. 2007-ongoing) in which users can display projected range shifts for bird species under different climate change models and scenarios; results for Golden-winged Warbler corroborate the range shifts described above.

Collectively, the available future climate change projections are concerning, as a majority of the Golden-winged Warbler population breeds in the western half of the range, and the only genetically pure Golden-winged Warbler population in Manitoba is in part associated with an aspen-dominated ecosystem. Range shift and range contraction of the western Great Lakes and Manitoba population, in addition to further

## Migratory Obstacles

Recent analysis suggests that Golden-winged Warbler, for reasons unknown, may be considerably more vulnerable to collisions during the migratory period than most small passerines

reduction of the eastern population, would likely result in local extirpations of small populations and doubtful long-term viability of the global breeding population. In addition, the Hadley Centre Coupled Model Version 3 used by the Wallace Initiative predicts that with a 2 °C increase in temperature, much of the wintering grounds in Central America may become unsuitable (Price pers. comm.) From a habitat management perspective, if the pattern of transition from Golden-winged to Blue-winged warbler phenotypes is driven largely by climate change, then habitat manipulations to support pure Golden-winged Warbler populations may not be effective.

Irrespective of future climate scenarios and the uncertainty inherent in their predictions, it seems more likely that the well documented historical pattern of Blue-winged Warbler expansion into the range occupied by Golden-winged Warbler will continue. Blue-winged Warbler has been expanding northward over the last century at a rate of about 4 km/year in New York and 2.4 km/year in Wisconsin (Confer pers. comm.). While the Golden-winged Warbler range has also been shifting generally northward and westward, so has the zone of hybridization following secondary contact with Blue-winged Warbler. Local extirpation of phenotypic Golden-winged Warbler appears inevitable unless habitat segregation can provide refugia to facilitate coexistence in sympatry. It remains unclear whether large amounts of appropriate habitat will continue to be available in Canada to accommodate continued range expansion of genetically pure Golden-winged Warbler populations along the leading edge of a north and northwestward shifting *Vermivora* range.

(Figure 1–18). Golden-winged Warbler was reported killed at 15 of 33 communication towers monitored east of the Mississippi River (Shire et al. 2000). Arnold and Zink (2011) listed Golden-

winged Warbler as second only to Bay-breasted Warbler for being at-risk for tower collisions. The study corrected for species population size and range overlap with 39 sites throughout eastern North America; risk was calculated per capita relative to an average landbird. Golden-winged Warbler was 196 times more vulnerable to tower collisions than the average among 188 species of Eastern landbirds in the analysis. The majority of Golden-winged Warbler mortalities were at three sites: Eau Claire, Wisconsin—428 Golden-winged Warbler records out of 118,126 total bird mortalities (Kemper 1996); northwestern Florida—72 records out of 44,007 mortalities (Crawford and Engstrom 2001); and central Illinois—12 records out of 5,465 mortalities (Seets and Bohlen 1977).

For building collisions in the Arnold and Zink (2011) analysis, Golden-winged Warbler ranked 28 out of 147 species with a vulnerability six times greater than average. Of the three cities examined for building collisions, there were 35 Golden-winged Warbler mortalities in Chicago, none in New York City, and only one in Toronto (Arnold, Zink, and Willard, pers. comm.). Without the per capita correction in Chicago, Golden-winged Warbler mortalities ranked 81<sup>st</sup> of 154 species at the McCormick Place Conference Center (17 of ~35,000 birds over 33 years) and 76<sup>th</sup> of 130 species for downtown Chicago (18 of 19,000+ birds over 30+ years) (Willard, pers. comm.). An additional eight live Golden-winged Warblers were recovered from downtown Chicago during a 5.5 year period (2006–2011) and taken to a rehabilitator; of five that survived, at



Figure 1–18. Golden-winged Warblers killed from collision with a tall (>300 m) guyed communications tower near Madison, Wisconsin, during a single night in September 2005. Five Golden-winged Warblers represented 2.4% of the 206 total bird mortalities detected from this event (Travis, pers. comm.).

least four were successfully released (Prince, pers. comm.).

Apart from the data on migratory collisions, little else is known about threats specific to Golden-winged Warbler during its migratory period. Explicit connectivity between breeding and non-breeding subpopulations has yet to be established, but it is possible that some individuals may make round-trip annual flights of over 9,000 km. Survival rates during migration are therefore likely to be important determinants of population growth. As noted in the Migration section on page 1–30, most Golden-winged Warblers are probably trans-Gulf migrants, so loss of stopover habitat along the Gulf coast may comprise a significant threat. Over the past 30 years, human development of coastal stopover habitat has probably increased risk (decreased survival) during migration, and such development in coastal areas is likely to continue into the future.

## Non-breeding Season Habitat Loss

Since rates of deforestation have been well documented for Central and South America (FAO 2001, 2011), winter habitat availability is very likely declining within the tropical residency range of Golden-winged Warbler. For example, Golden-winged Warbler has been reported from the foothills and lower elevation montane forests of western Panama, a zone that receives considerable human disturbance (Ridgely and Gwynne 1989); considerable disturbance and fragmentation has occurred throughout the non-breeding season range in Nicaragua, Costa Rica, and Colombia as well (Rosenberg, pers. comm.). The little demographic information available (see section on demography, page 1–34) points to low annual survival as a limiting factor, particularly for females, so it is reasonable to hypothesize that forest loss in the tropics directly impacts Golden-winged Warbler population trends measured during the breeding season. We know little about non-breeding season habitat quality, however, or how habitat quality of different Neotropical forest types directly influences non-breeding season survival or conditioning.

In Integrated Open Canopy (IOC) coffee production systems (e.g., Figure 1–19), farmers protect or restore forest patches equal to or greater than the size of their coffee plantations (Arce et al. 2009). IOC coffee has been utilized by Golden-winged Warbler (Chandler 2010) and thus could be an important tool for protecting and restoring habitat in human-modified landscapes. If coupled with environmental certification programs and carbon credit payments, IOC coffee production could affect large landscapes through market forces alone, thus reducing dependence on top-down conservation approaches and governmental policy cooperation. The Smithsonian Migratory Bird Center is currently contemplating the inclusion of IOC coffee farms under its Bird Friendly coffee label. However, such strategies do require continual outreach efforts on the part of conservation organizations

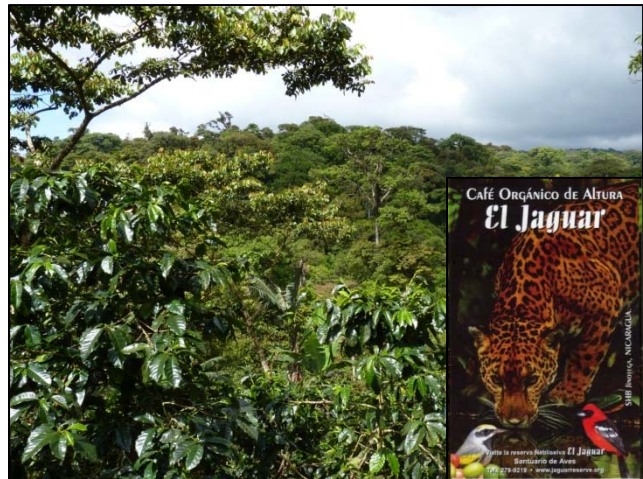


Figure 1–19. An example of an Integrated Open Canopy coffee production system: Reserva el Jaguar, Jinotega, Nicaragua. Due to the frequency of cloud cover and fog in this mountain environment, coffee (foreground) is grown in the open, but 100 ha of cloud forest (65% of the total property area) are preserved in a pristine state (background). Wintering Golden-winged Warbler is one of 280 resident and migrant species recorded at the site.

aimed at maintaining and increasing global consumer market demand for coffee production that benefits birds (cf. Reynolds et al. 2007).

Interactions with Blue-winged Warbler during winter have not been well documented, so it is not known whether hypothesized threats due to competition continue into the non-breeding season. Winter distributions of Blue-winged and Golden-winged warbler are generally allopatric since Blue-winged Warbler winters farther north in northern Central America and Mexico (Gill et al. 2001). Substantial overlap of the two species may be limited to Guatemala, northern Honduras, and Nicaragua (Confer 1992, Gill et al. 2001); Blue-winged Warbler is scarce in Costa Rica (Stiles and Skutch 1989) and rare in Panama (Ridgely and Gwynne 1989). Little is known about non-breeding season habitat segregation between the two species. Thus it is not known whether differential habitat loss or degradation during the non-breeding season might affect non-breeding season survivorship or linked breeding season productivity leading ultimately to different population trajectories for Golden-winged and Blue-winged warblers.

## REGIONAL, STATE, AND PROVINCIAL SUMMARIES

Following the format of previous status assessments for other species, we compiled state- and province-specific information relative to conservation status, historic and current distribution, population trends, habitat use, current research and monitoring efforts, and potential threats. State Heritage ranks were derived from those reported in the NatureServe database (NatureServe 2011) and are defined in Table 1–6. We also summarized BBS, Breeding Bird Atlas (BBA), and BBC data (see page 1–12 for a discussion of BBS). Note that when we reported the total number of BBS routes within a state on which Golden-winged Warbler has been detected over the lifetime of the survey, we included specially designated BBS routes (e.g., 300 or 900 series routes) which may have been excluded for various statistical reasons from BBS trend

analyses reported online (Sauer et al. 2012) or elsewhere in the text. In addition to individual published state BBAs, two sources of compiled state atlas data were particularly useful—the USGS North American Breeding Bird Atlas Explorer (cited as USGS BBEA 2012) and the Cornell Lab of Ornithology's [bird.atlasing.org](http://bird.atlasing.org) online atlas management tool (cited as CLO BBA 2012).

Many of the research and conservation strategies outlined in Chapter 2 of this document—and especially the management guidelines articulated in Chapter 3—were developed in response to the initial habitat analyses and conservation vulnerabilities compiled for these state and regional summaries.

*Table 1–6. NatureServe State Heritage ranks (NatureServe 2011).*

Ranking Code	Definition
SX	Presumed extirpated from state.
SH	Possibly extirpated from state.
S1	Critically imperiled in the state because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation.
S2	Imperiled in the state because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation.
S3	Vulnerable in the state due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
S4	Uncommon but not rare; some cause for long-term concern due to declines or other factors.
S5	Common, widespread, and abundant in the nation or state.
SNR	State conservation status not yet assessed.
SNA	A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

The state summaries are grouped by USFWS Region and arranged more or less geographically within Regions, west to east and/or north to south. Golden-winged Warbler population size estimates for states and provinces are presented in Table 1–7, following the Partners in Flight

methodology described on page 1–13. Note that these estimates are particularly sensitive to the average maximum detection distance assumption (Thogmartin et al. 2006); reducing the detection distance value from 125m to 80m, for example, would more than double the estimates.

Table 1–7. State and province population estimates for Golden-winged Warbler derived from BBS data for the 1998–2007 decade and the Partners in Flight Population Estimates Database, Version 2.0 (PIF Science Committee 2013) using an average maximum detection distance of 125m.

Province/State	Country	Rounded Population Estimate	% Total Breeding Population	SE BBS Average <sup>1</sup> (birds/rte)	SE Population Estimate <sup>2</sup>
Minnesota	USA	194,500	47.0%	0.32	±23%
Wisconsin	USA	109,900	24.4%	0.12	±17%
Ontario	Canada	63,500	15.3%	0.06	±27%
Michigan	USA	19,700	4.8%	0.08	±58%
New York	USA	9,400	2.3%	0.06	±56%
Pennsylvania	USA	7,100	1.7%	0.03	±36%
West Virginia	USA	5,700	1.4%	0.04	±39%
Tennessee	USA	3,900	0.9%	0.09	±93%
Manitoba	Canada	3,700	0.9%	0.03	±73%
Vermont	USA	1,500	0.4%	0.05	±83%
North Carolina	USA	1,200	0.3%	0.03	±49%
Quebec	Canada	800	0.2%	—	—
Virginia	USA	700	0.2%	0.01	±73%
Maryland	USA	500	0.1%	0.06	±50%
Ohio	USA	200	0.05%	—	—
New Hampshire	USA	100	0.03%	—	—
New Jersey	USA	100	0.02%	—	—

<sup>1</sup>Estimated standard errors for BBS data, using only BCR regions within states in which Golden-winged Warblers were detected.

<sup>2</sup>Estimated standard errors for population estimate, assuming that BBS is the only source of error and that there is no roadside bias. Sensitivity analysis suggests, however, that relatively small errors in estimating maximum detection distance (e.g., SE of ±15m) can have an effect equivalent to the SE of the BBS (e.g., in MN BCR 12)

## USFWS Midwest Region 3 Summary

### Minnesota, Wisconsin, Michigan, Iowa, Missouri, Illinois, Indiana, Ohio

The three northern states in Region 3 currently harbor an estimated 76% of the total global population of breeding Golden-winged Warbler (PIF Science Committee 2013, Table 1–7). Generally, the species now commonly occurs to the north of a line through the center of the Prairie Hardwood Transition Bird Conservation Region (BCR 23) in a band that also includes virtually the entire U.S. portion of the Boreal

Hardwood Transition (BCR 12) with the exception of the northeastern-most tip of the "Arrowhead" in northeast Minnesota. Densities increase dramatically from southeast to northwest across BCRs 23 and 12, with 5%, 24%, and 47% of the estimated population in Michigan, Wisconsin, and Minnesota, respectively (Table 1–7). Wetland shrub communities are more extensive in the northwestern U.S. portion of BCR 12 and provide

a population stronghold for Golden-winged Warbler. Golden-winged Warbler has been extirpated as a breeding species from Missouri, Iowa, Illinois, and Indiana, where habitat loss has been more concentrated, is virtually extirpated from Ohio, and risks extinction from Michigan and Wisconsin by 2100 (Figure 1–7). Across Region 3 from 1966 to 2010, Golden-winged Warbler declined by -1.48% per year (95% CI: -2.47, -0.45;  $n = 145$  routes). Across the Boreal Hardwood Transition from 1966 to 2010, the species declined by -1.09% per year (95% CI: -2.18, -0.04;  $n = 127$  routes) (Sauer et al. 2012).

In the Upper Midwest, Golden-winged Warbler habitat falls into two very broad classes—upland young forest communities and wetland shrub

communities, both in predominantly forested landscapes. Upland communities include both succeeding old fields and pastures (5–30 years after abandonment) and regenerating clearcuts, primarily aspen, from two to ten years after cutting. The Golden-winged Warbler Atlas Project (GOWAP, Barker Swarthout et al. 2009) sampled 1,824 sites from the Upper Midwest region (Michigan, Wisconsin, Minnesota, and Manitoba). Wetland habitats appeared to be the most frequently used of those sampled—wetland shrub sites alone accounted for 25% of sites recording Golden-winged Warbler and all wetland habitats combined accounted for 44% of sites (Figure 1–20). Clearcuts also appeared to be very important, accounting for 20% of all sites with Golden-winged Warbler.

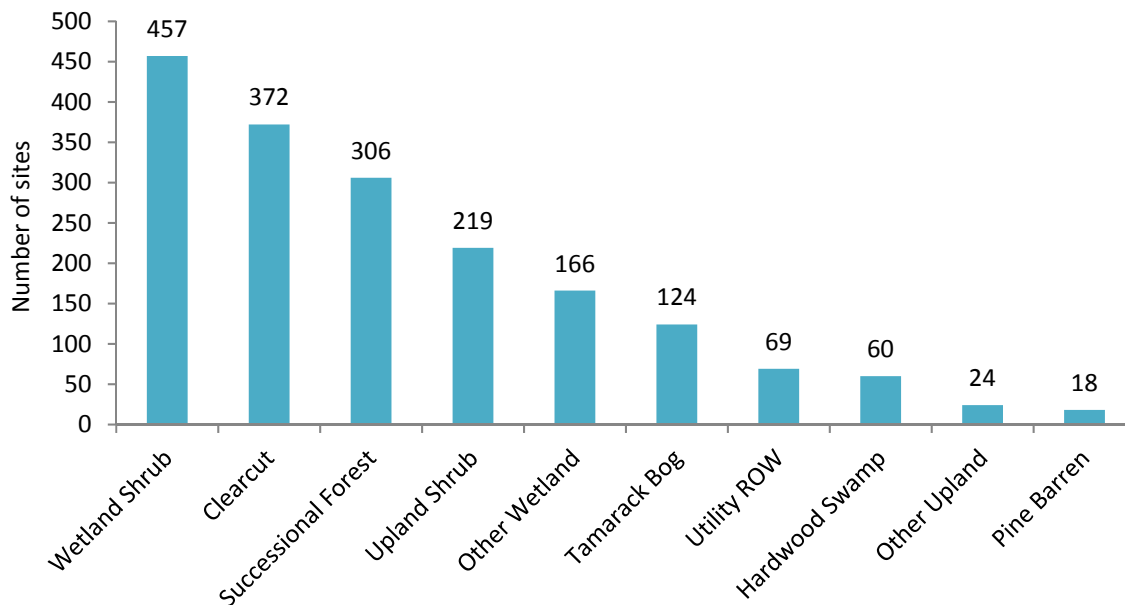


Figure 1–20. Distribution of habitat types at sites in the Upper Midwest region where Golden-winged Warbler was detected. Since sampling was non-random, these data represent only habitats where the species was detected and therefore do not characterize use versus availability of habitat. See Appendix F for habitat definitions. In this figure, Upland Shrub = upland shrubby field + upland abandoned farm; Wetland Shrub = alder swamp + beaver wetland + shrub wetland.

GOWAP collaborators in Minnesota, Wisconsin, and Michigan conducted additional, more quantitative surveys at 1,458 sites to determine finer level habitat associations and to estimate habitat utilization vs. habitat availability (Barker Swarthout et al. 2009). Overall, Golden-winged Warbler was detected at roughly 50% of all sites surveyed. A significantly higher proportion of sites in wetland shrub and clearcut habitats supported at least one Golden-winged Warbler, whereas significantly fewer sites in upland shrub and successional forest habitats supported the species. In the GOWAP survey, sites with a mosaic of habitat types in close proximity were less likely to record Golden-winged Warbler than sites made up of a single habitat type classification. Both aspens in clearcuts and alders in wetland shrub habitats were positively associated with Golden-winged Warbler detections, whereas mixed-conifer and northern hardwood forest vegetation types were negatively associated with warbler presence. Detection rates were 2.68 times greater at sites described as "wetland" (and having "alder" as the primary vegetation type) than at other habitat types. Overall, wetter sites were significantly more likely to record Golden-winged Warbler, as were sites with sparser tree cover and denser shrub and herbaceous layers.

Over the last century, aspen has increased as a forest type across the northern Midwestern landscape and may now exist outside its historic range of variation in this region (Frelich 2000, Host et al. 2001). Golden-winged Warbler has been documented at high densities in aspen clearcuts in northern Wisconsin (Roth and Lutz 2004), although there was no comparison in the same study with densities in other habitat types. Recent research (Roth et al. 2013) in north-central Wisconsin suggested that Golden-winged Warbler reproductive success and adult return rates from aspen clearcuts (with deciduous legacy tree retention) were comparable to those recorded from other habitats elsewhere in the breeding range that are considered optimal for the species. Industrial rotations that would provide substantial acreage in seral stages

appropriate for Golden-winged Warbler will likely require fairly large amounts of aspen on the landscape. However, the vast majority of such aspen would be in uplands, where the probability of secondary contact with Blue-winged Warbler might be greater. Some researchers and forest managers have suggested that replacement of Golden-winged Warbler by Blue-winged Warbler may potentially be facilitated by a strategy of extensive upland forest cutting in areas of northern Wisconsin and especially in areas of northern Minnesota not currently heavily populated by Blue-winged Warbler (cf. Hanowski 2002). On the other hand, Fowlds (2010) found that Blue-winged Warbler reached its highest relative abundance in central Wisconsin in swamp edge (e.g., alder/willow shrub) and wetland transitions to mature forest. Research is needed to develop a management strategy for Golden-winged Warbler in areas where Blue-winged Warbler either currently occurs or is likely to occur in the near future. Other researchers (e.g., Streby et al. 2011a, 2011b) have provided evidence that young forest habitat in the context of dynamically changing forest landscapes will benefit suites of both mature and young forest breeding species, including Golden-winged Warbler. Consequently, some researchers and conservationists in the region stress the importance of facilitating management for seral diversity at landscape scales.

To the extent that Golden-winged Warbler makes use of the shrub layer and associated understory within forests—both when nesting in forest openings or during the post-fledging period (Streby, unpubl. data)—deterioration of understory and shrub layer vegetation caused by invasive non-native earthworms poses a potential threat to Golden-winged Warbler populations in the region. Such understory effects of earthworms have been tied to both local and regional reductions in the abundance of ground-nesting Ovenbirds (Loss and Blair 2011, Loss et al. 2012). Most previous earthworm research has focused on maple and basswood forests (cf. Frelich et al. 2006). However, invasive earthworms could negatively affect Golden-

winged Warbler habitat since they are widespread throughout the hardwood woodlands of Region 3 (Holdsworth et al. 2007) and since invasive earthworm habitat impacts have been documented in aspen woodlands (Scheu and Parkinson 1994).

Wetland shrub communities may be particularly important for conservation of Golden-winged Warbler in the region (Hanowski 2002). Upland young forest communities are relatively transient, whereas northern wetlands have slower rates of succession such that lowland herbaceous and shrubby habitat persists for a longer period of time. However, there have been no studies of Golden-winged Warbler persistence relative to lowland shrub community succession; alder wetland stands can become "over-mature" for Golden-winged Warbler, and cutting management may still be necessary to increase herbaceous and smaller shrub cover. There is

some evidence that wetland habitat such as tamarack (*Larix laricina*) swamps and sedge (Cyperaceae spp.) meadows with woody islands may provide a refuge in which Golden-winged Warbler may persist in the zone of overlap with Blue-winged Warbler (cf. Will 1986 for southern Michigan) well beyond the 50 years for replacement after secondary contact originally documented by Gill (1980). Thus one of the biggest threats to Golden-winged Warbler in the Upper Midwest may be continued wetland drainage and loss of associated lowland shrub communities, invasion by exotic wetland plants, and lack of lowland shrub community management to remedy disturbed hydrology or to replicate suppressed natural vegetation disturbance regimes. More research is needed to evaluate the role of wetland shrub communities as refugia for Golden-winged Warbler in areas of secondary contact with Blue-winged Warbler in the Upper Midwest.

## Minnesota

**State Legal Status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** SNR

**Summary:** Historically, Golden-winged Warbler apparently was never abundant in Minnesota. Roberts (1932) reports that during migration "even in the old days, the seeing of 10 or 12 was a rare event." At the beginning of the 20th century, Golden-winged Warbler was found as far south as Fillmore County in the southeast to Itasca County in north-central Minnesota (Roberts 1932 in Hanowski 2002). During the last century, Golden-winged Warbler expanded beyond Itasca Park and Cass Lake (47°30' latitude) to the Canadian border in Lake of the Woods and Koochiching counties (Janssen 1987, GOWAP) and virtually disappeared as a breeder from Hennepin, Wright, and Stearns counties. Blue-winged Warbler was first recorded breeding in southeastern Minnesota (Fillmore County) in 1885 and 1893 (Roberts 1932). Blue-winged Warbler now breeds primarily in the two tiers of counties along the Mississippi River north to

Dakota County; has expanded from the 1940s to 1960s northward into Washington, Hennepin, Anoka, and Scott counties (Janssen 1987); and has more recently reached as far westward as Stearns County. Allopatric phenotypic Golden-winged Warbler populations (outside the range of expanding Blue-winged Warbler) still remain in the far north (Shapiro et al. 2004), but Vallender et al. (2009, unpubl. 2010 data) have found Blue-winged mtDNA (i.e., cryptic hybrids) in some of the phenotypic Golden-winged Warblers in this region (Figure 1–12).

**BBS:** Golden-winged Warbler has been detected on 38 BBS routes in Minnesota over the length of the survey (1966–2010). Analyses of long-term BBS data (1967–2010) suggest that population trends for Golden-winged Warbler have remained relatively stationary in the state at +0.5%/year (95% CI: -1.2, +2.1; n = 36; Sauer et al.

2012, Figure 1–21). Despite a stationary population trend estimate, the median relative

abundance in Minnesota has increased by nearly 50% over the length of the BBS (Figure 1–21).

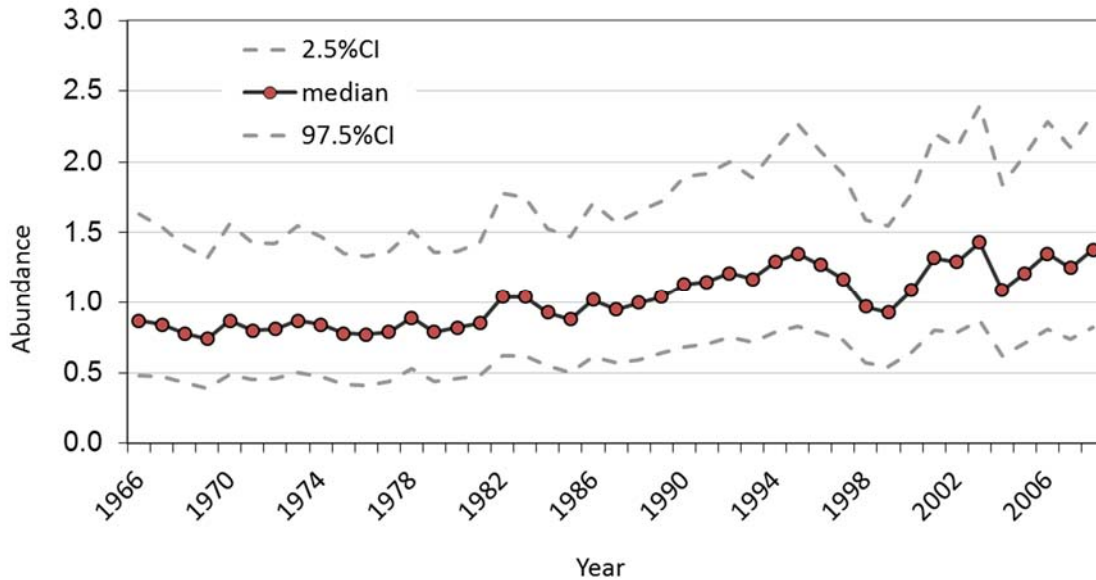


Figure 1–21. Changes in relative abundance of Golden-winged Warbler in Minnesota based on hierarchical Bayesian analyses of BBS data (1966–2009).

Results from a population viability analysis for Minnesota suggest a 4% probability (95% CI: <0.01%, 87.6%) of a 90% decline of Golden-winged Warbler by 2100 from 2000 population levels if current trends were to continue into the future (Figure 1–22).

**BBA:** Minnesota’s first Breeding Bird Atlas project is currently underway; the data collection period is 2009–2013. The atlas will include spatially balanced point counts as well as the typical volunteer survey of priority township blocks.

**BBC:** Censuses have been conducted in potentially suitable habitat (e.g., young aspen stands), and Golden-winged Warbler was recorded on Minnesota census plots in 1993. However, sites have not been monitored long enough to document population trends.

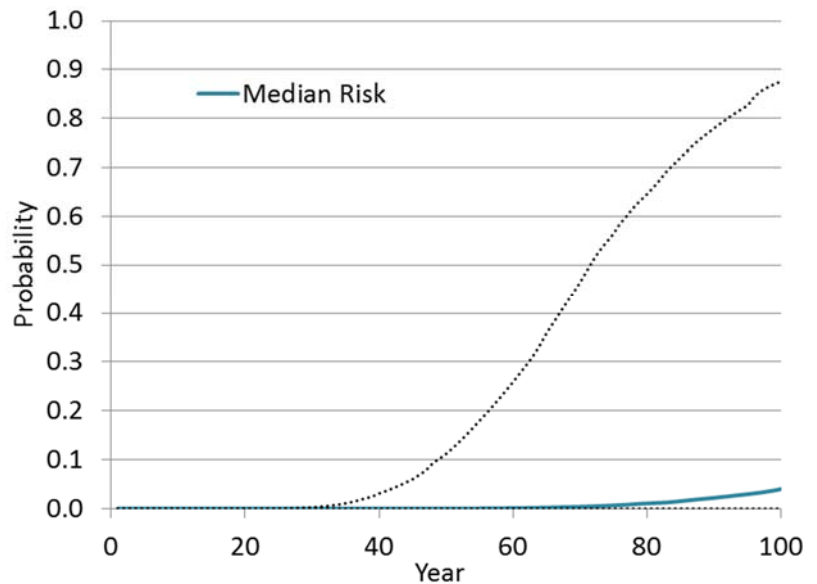


Figure 1–22. Risk of quasi-extinction for Golden-winged Warbler in Minnesota as determined by a 90% decline from the year 2000 population by year 2100. Dashed lines represent the 95% credible interval. See Appendix C for methods.

**Habitat Use:** Habitat use varies by region. Hanowski (2002) documented habitat associations of the species in Minnesota and Wisconsin national forests; percent lowland shrub cover with a 100 m buffer was the best predictor of Golden-winged Warbler presence, and sites with >10% lowland shrub cover were three times more likely to record Golden-winged Warbler. In Chippewa National Forest, birds were observed in young (<11 year-old) stands of aspen and aspen/mixed forest, white spruce (*Picea glauca*)/balsam fir (*Abies balsamea*) forests, and swamp conifer forests. Alder habitats were not sampled on the Chippewa, but Streby and Andersen (pers. comm.) observed and captured Golden-winged Warbler in mist-nets in alder habitats on the Chippewa in 2009. In the St. Croix region, Golden-winged Warbler similarly used young aspen regeneration areas and swamp conifer forests; alder was also an important habitat type (Hanowski 2002). In Sherburne and Isanti counties, Golden-winged Warbler was recorded in barrens savanna, oak openings, and aspen or willow-dominated wetlands (Au, pers. obs.).

Huffman (1997) documented vegetative characteristics of Golden-winged Warbler territories in young aspen clearcuts at Tamarac National Wildlife Refuge (NWR) in west-central Minnesota. More recently at Tamarac, Streby and Andersen (unpubl. data) found that most females nested in upland early successional stands, and most females initially netted in shrubby wetland sites ended up nesting in uplands (Streby, pers. comm.). Most breeding pairs used every cover type available at some time during the season; for example, a female nesting in a shrubby upland might forage in nearby mature forest or wetland edges and then accompany fledglings through extensive mature forest and forested wetland edges throughout the post-fledging period (Streby et al. 2012, Streby pers. comm.); whether the fledgling was in a clearcut, mature forest, or along a wetland edge, it usually perched in dense cover (e.g., hazelnut *Corylus* spp.) for the first weeks after fledging, and after about three weeks, spent more time in taller

understory trees and in the canopy of mature forest (Streby pers. comm.). In 2011, (Streby and Andersen unpubl. data) also found that some (~15%) radio-marked females nested in single tree-fall gaps in mature forest and in closed-canopy mature forest with sparse shrub-layer vegetation >50 m from edges at both Tamarac and Rice Lake NWRs.

Golden-winged Warbler landscape models have been developed from Minnesota and Wisconsin national forest data by Howe and Jones (2002) and from BBS data in BCRs 12 and 23 by the USGS Upper Midwest Environmental Sciences Center (UMESC 2003).

**Current Research and Monitoring:** Minnesota conducts a systematic County Biological Survey. Through 2011, 84 of 87 counties have been surveyed, 26 of which have recorded Golden-winged Warbler (Stucker, pers. comm.). Annual off-road surveys have been used to monitor forest birds in the Chippewa and Superior national forests and along the St. Croix River in northern Minnesota since 1991. An analysis of these data suggested that neither site-level population trends nor the composite regional trend had changed significantly through 2001 (Hanowski 2002).

Tamarac NWR was one of the eight study sites that comprised the 2008–2010 collaborative research project of the Golden-winged Warbler Rangewide Conservation Initiative (Appendix D). Also at Tamarac, Streby et al. (2012 and ongoing) radio-tracked both adult and fledgling birds and found that adult birds utilized much larger areas than those defined by traditional spot-mapping of singing males, especially in the late morning and afternoon, and that parent-fledgling groups were frequently encountered in mature forest away from shrubby edges within a few days of fledging and throughout the remainder of the post-fledging period. Streby and Andersen are currently conducting an intensive study of Golden-winged Warbler reproductive success through the post-fledging period along a climate and hybridization gradient that includes Tamarac,

along with Rice Lake NWR to the southeast and provincial forests to the northwest in southeastern Manitoba. An international team (Roth and Flaspohler, Michigan Tech; Hobson, Vallender, and VanWilgenburg, Environment Canada; and multiple cooperators in Latin America) is currently using stable isotopes and DNA to investigate migratory connectivity between Golden-winged Warbler breeding and wintering areas, elucidate patterns of juvenile dispersal on the breeding grounds, and fill gaps in Golden-winged Warbler genetic atlas coverage along a transect from southwest Wisconsin to Manitoba.

**Threats:** The last ten years of BBS data suggest that Golden-winged Warbler remains relatively common in the state, with stable or even increasing populations. Competition and hybridization with Blue-winged Warbler still is not pronounced in Minnesota, as the zone of contact between these two species appears to be more limited than elsewhere in the Golden-winged Warbler range. Recent work by Vallender et al. (2009), however, documents cryptic mitochondrial introgression in some birds even in the northwestern portion of the state (see Figure 1–12).

Minnesota has seen considerable debate regarding the relative role of increasing upland aspen regeneration acreage versus preserving and enhancing wetland shrub communities as a focus for Golden-winged Warbler conservation; essentials of the discussion are summarized above in the Midwest Regional summary section. Recent revisions of national forest management plans have proposed reductions in the amount of

young aspen forest on national forests, and some biologists have assumed that such policies will inevitably lead to decreases in Golden-winged Warbler. In response, collaborative conservation efforts like the Young Forest Initiative (cf. Wildlife Management Institute 2009) have developed strategies for working with private forest landowners to increase young forest acreage for American Woodcock, Golden-winged Warbler, and associated wildlife species. Many state biologists believe that Golden-winged Warbler can be sustained primarily through protection of lowland shrub habitats and that additional loss of early successional upland habitat is not a threat to Golden-winged Warbler population viability in Minnesota (e.g., Richard Baker, MN Department of Natural Resources [DNR], pers. comm.; Bruce Johnson, Leech Lake Band of Ojibwe, pers. comm.). Preliminary results from radio-telemetry research in northern Minnesota suggest that where upland and wetland habitats are both abundant, Golden-winged Warbler forages extensively along edges of wetlands during the nesting and post-fledging periods, but breeds more densely and more successfully in shrubby upland habitats (Streby and Andersen unpubl.data). Preliminary results from the Minnesota demographic study suggest that a landscape including a mix of early successional upland, shrubby wetland, and mature-forest habitats may optimize Golden-winged Warbler productivity; as a result, current management discussions are focusing on strategies for maintaining dynamic forest landscapes that include appropriately balanced mosaics of both mature and regenerating forest habitats, including early seral lowland shrub and forested wetland communities.

## Wisconsin

**State Legal Status:** Special Concern

**Natural Heritage Rank (see Table 1–6 for definitions):** S4

**Summary:** Historically, Golden-winged Warbler was broadly distributed across Wisconsin (Robbins 1991). Extensive clear-cutting during the mid-19<sup>th</sup> to early 20<sup>th</sup> century created ample suitable habitat for a species dependent on young forest within forested landscapes. More recently, the Golden-winged Warbler breeding range has contracted northward, and the species is now largely extirpated from most historical breeding areas in the southern regions of the state (Cutright et al. 2006). Loss of shrubby habitat to succession and development, genetic introgression with northward-expanding Blue-winged Warbler, and possibly climate change may have played a role in this range shift.

The first Blue-winged Warbler specimen in Wisconsin was taken in 1867, but the species was not reported regularly in the southern tier of

counties until the turn of the 20<sup>th</sup> century (Robbins 1991). By the 1920s, Blue-winged Warbler was numerous in the Wisconsin and Mississippi river watersheds; by the 1950s, it was found consistently in the southern tier of counties. Blue-winged Warbler is now firmly established throughout most of southern Wisconsin.

**BBS:** Golden-winged Warbler has been recorded on 62 BBS routes in the state, primarily in the northern two-thirds of Wisconsin. Analysis of long-term BBS data (1966–2010) suggests that Golden-winged Warbler populations have declined significantly (-2.8% per year, 95% CI: -4.1, -1.5;  $n = 62$ ; Sauer et al. 2012)—a decline of approximately 60% over the length of the BBS (Figure 1–23).

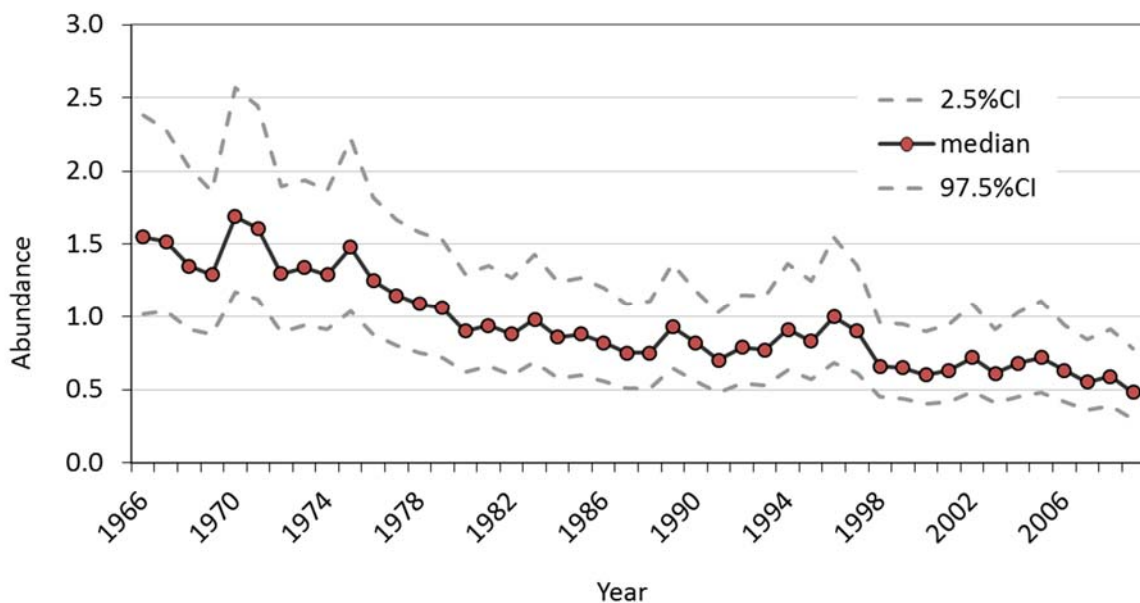


Figure 1–23. Changes in relative abundance of Golden-winged Warbler in Wisconsin based on hierarchical Bayesian analyses of BBS data (1966–2009).

By 2100, if trends and variability in trends persist as they have for the last 40 years, Golden-winged Warbler has a 65.9% (95% credible level: 0.5%, 99.9%) risk of a further 90% loss in Wisconsin's population (Figure 1–24).

**BBA:** A Breeding Bird Atlas was conducted in Wisconsin from 1995–2000. Golden-winged Warbler was confirmed breeding in a broad band across northern and central Wisconsin, with few blocks reporting the species in the southern third of the state (Cutright et al. 2006). Golden-winged Warbler was detected in 402 priority blocks in Wisconsin, and breeding was confirmed in 161 of those blocks.

**BBC:** No Golden-winged Warblers have been recorded in Wisconsin Breeding Bird Census plots, although none have been conducted in suitable habitat during the past 30 years.

**Habitat Use:** Golden-winged Warbler occurs in a wide variety of early successional habitats within forested landscapes in Wisconsin. It often inhabits brushy clearcuts, shrubby swamps, overgrown abandoned agricultural fields, and edges of deciduous forests, especially aspen (Cutright et al. 2006). Roth and Lutz (2004) found that Golden-winged Warbler densities in aspen clearcuts in northern Wisconsin dropped significantly around ten years after cutting. One to ten year-old aspen stands harbored a higher abundance of Golden-winged Warbler than other early seral habitats in north-central Wisconsin (Martin et al. 2007). In central Wisconsin, Fowlds (2010) found higher abundances of Golden-winged Warbler in aspen clearcuts less than ten years old and also in lowland shrub edges adjacent to mature forest (relative to young hardwood stands under 20 years of age). Tall (>0.5 m) forb cover was associated with higher abundances of Golden-winged Warbler in the aspen clearcuts and the lowland shrub/mature

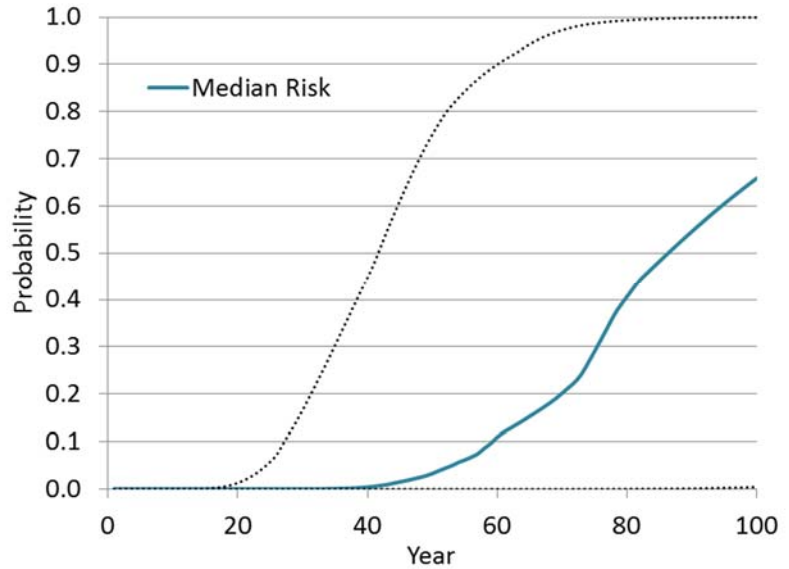


Figure 1–24. Risk of quasi-extinction for Golden-winged Warbler in Wisconsin as determined by a 90% decline from the year 2000 population by year 2100. Dashed lines represent the 95% credible interval. See Appendix C for methods.

forest edge sites. Fowlds (2010) also found that in shrub/mature forest edge sites, Golden-winged Warbler territories had more ground cover than did Blue-winged Warbler territories; in clearcuts, Golden-winged Warbler territories had a lower mature tree density than did Blue-winged Warbler territories. In the national forests of Minnesota and Wisconsin, Golden-winged Warbler presence was best predicted by the amount of lowland shrub cover within a 100 m buffer area of the survey point (Hanowski 2002). Consistent with observations of radio-tagged birds in Minnesota (Streby et al. 2012, see pages 1–20 and 1–21)—and underscoring the importance of landscape context over patch characteristics only—are two observations from Wisconsin. Golden-winged Warbler has been consistently observed in patches of alder with scattered trees contiguous to a wooded corridor along the Kakagon River in northwestern Wisconsin but has not been found in similar alder patches adjacent to more open areas in the Kakagon Sloughs (Matteson, pers. comm.). Also, at Empire State Wildlife Area in Douglas County, Golden-winged Warblers were found in alder patches containing a few scattered trees adjacent to mature forest stands, while no individuals

were detected in alder swamps connected with open sedge meadows or very young forest (Hoffman, pers. comm.).

**Current Research and Monitoring:** Wisconsin contributed data from two study sites to the 2008–2010 collaborative research project of the Golden-winged Warbler Rangeland Conservation Initiative (see Appendix D)—one from north-central forests (Roth, unpubl. data) and one from the Central Sand Plains (Fowlds 2010). Roth (Michigan Technological University) plans to continue monitoring male Golden-winged Warbler survival on nine additional study sites initially surveyed in 2007 in north-central Wisconsin. Unbanded birds will continue to be color-banded until all sites are abandoned by Golden-winged Warblers. (In 2012, six sites that were still occupied included several males that were at least six years old.) A 2012 study in Langlade and Marathon counties is evaluating alder management as a tool for increasing Golden-winged Warbler use of lowland shrub habitat (Roth and American Bird Conservancy). An international team (Roth and Flaspohler, Michigan Tech; Hobson, Vallender, and VanWilgenburg, Environment Canada; and multiple cooperators in Latin America) is currently using stable isotopes and DNA to investigate migratory connectivity between Golden-winged Warbler breeding and wintering areas, elucidate patterns of juvenile dispersal on the breeding grounds, and fill gaps in Golden-winged Warbler genetic atlas coverage along a transect from southwest Wisconsin to Manitoba.

Monitoring by BBS, BBA, Wisconsin DNR, and the U.S. Forest Service (USFS) appears to be adequate for tracking status in the state. Data have been collected since 1987 for the Nicolet National Forest under a monitoring program coordinated by the University at Wisconsin-Green Bay (UWGB 2002). Analyses from 1987–2001 did not indicate significant population declines (UWGB 2002, as reported by Hanowski 2002). In addition to these monitoring programs, Golden-winged Warbler landscape models have been developed from Minnesota and Wisconsin national forest data by

Howe and Jones (2002) and from BBS data in BCRs 12 and 23 by the USGS Upper Midwest Environmental Sciences Center (UMESC 2003).

**Threats:** Hybridization with Blue-winged Warbler is considered a significant threat to the future genetic integrity of Golden-winged Warbler in Wisconsin because the ranges of the two species overlap substantially in the state (see Figures 1–11 and 1–12). During the last half-century, Blue-winged Warbler has expanded into areas formerly occupied by Golden-winged Warbler, especially in the southern and western portions of Wisconsin (Robbins 1991). Other threats include wetland loss, land development (Kreitinger and Paulios 2007), reduced frequency of natural disturbance regimes, potential overall loss of forested habitat due to climate change, and advancing succession and fragmentation of early seral woodlands—e.g., acres of young aspen/birch (0–19 years) have declined by 38% from 1983 to 2007/2011 in Wisconsin (U.S. Forest Service 2012c, but cf. Figure 1–16 for all hardwood seedling/sapling timberland).

Early seral forest habitat loss has occurred across most ownership types in the Wisconsin portion of BCR 12 despite a strong emphasis on aspen management on state- and county-owned forests. The biggest declines have occurred on private lands, which make up a substantial portion of the forested landscape in the region. In order to address these declines, Wisconsin DNR has partnered with the Wildlife Management Institute to implement the habitat goals of the Young Forest Initiative (WMI 2009). The state's Wildlife Action Plan calls for maintaining large blocks of northern forest that contain a mosaic of upland and lowland shrub communities, especially alder and willow thickets, and, where appropriate, stands of young aspen—in general, a strategy likely to benefit Golden-winged Warbler. In addition, Wisconsin has been a leader (through the Wisconsin Bird Conservation Initiative and with some state DNR support) in efforts to protect and/or restore habitat for long-distance migrants on the Neotropical non-breeding grounds.

## Michigan

**State Legal Status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** S5

**Summary.** Golden-winged Warbler was fairly common in the state by the early 1900s (Berger 1958), but its distribution has shifted northward over the past century. Although this shift has coincided with the arrival in Michigan of Blue-winged Warbler, it is uncertain to what extent this arrival has influenced the northward expansion of Golden-winged Warbler. Some observers attribute the Golden-winged Warbler range shift to habitat changes related to logging (Brewer et al. 1991), although increased urbanization and inadequate management of private lands are also likely factors in the conversion of early successional habitats (K. Cleveland, Michigan DNR, pers. comm.). The most recent BBA effort documents continued disappearance of Golden-winged Warbler from southern Michigan and continued expansion of the Blue-winged Warbler range into northern portions of lower Michigan. Golden-winged

Warbler is reported to occur across the Upper Peninsula (Brewer et al. 1991), although none have been reported on Ottawa National Forest in the western part of the Upper Peninsula in spite of recent surveys of apparently suitable habitat (B. Bogaczyk, pers. comm.). Habitat loss from forest maturation and negative interactions with Blue-winged Warbler are the major threats to Golden-winged Warbler in the state (R. Adams, Kalamazoo Nature Center, pers. comm.).

**BBS.** Golden-winged Warbler has been detected on only 11 BBS routes in the last 10 years (2001–2010) compared to 25 routes during the 1990s. Analyses of long-term BBS data (1966–2010) suggest that Golden-winged Warbler has experienced relatively steep declines of -5.1% per year in Michigan (95% CI: -7.3, -3.0;  $n = 46$  routes; Sauer et al. 2012; Figure 1–25).

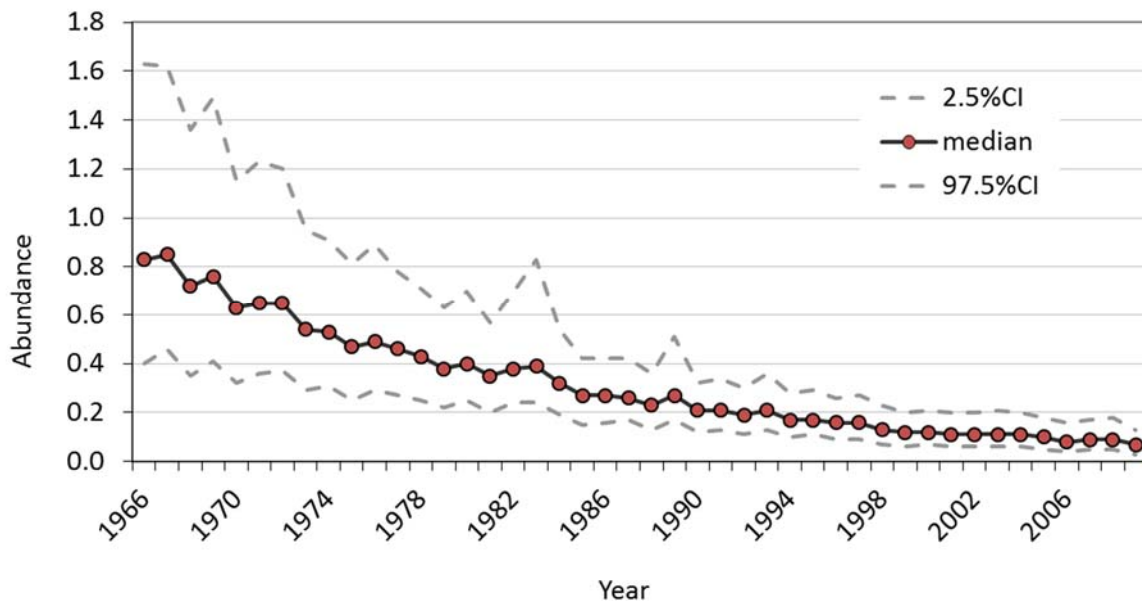


Figure 1–25. Changes in relative abundance of Golden-winged Warbler in Michigan based on hierarchical Bayesian analyses of BBS data (1966–2009).

By 2100, if trends and variability in trends persist as they have for the last 40 years, Golden-winged Warbler has a 100% (95% CI: 100%, 100%) risk of a further 90% loss in Michigan's population (Figure 1–26).

**BBA:** Field work was conducted from 1983–1988 for Michigan's first Breeding Bird Atlas (Brewer et al. 1991) and from 2002–2008 for the second atlas effort (Chartier et al. 2011). Despite the fact that fewer priority blocks were surveyed in the second atlas, with less overall effort involving fewer volunteers, the results suggested a considerable decline in Golden-winged Warbler breeding activity. Golden-winged Warbler was detected in 508 blocks during the first atlas and in only 298 blocks in the most recent atlas. Blue-winged Warbler, in contrast, does not appear to have experienced substantial change; it was detected in 724 blocks during the first atlas and in 731 blocks during the second (Chartier et al. 2011, R. Adams, pers. comm.). In the southern three tiers of counties in the southern Lower Peninsula, Golden-winged Warbler was recorded in 37 townships during the first atlas and in only seven townships during the second (Payne 2011). In the southern Lower Peninsula as a whole they were found in 15% of the townships in the first atlas and in only 4% during the second. In the northern Lower Peninsula, Golden-winged Warbler appeared in 33% of the townships in the first atlas and in 26% in the second. In the Upper Peninsula, the proportion of townships recording Golden-winged Warbler was 16% in the first atlas and 12% in the second; the decrease in distribution occurred mainly in central and western Upper Peninsula in Delta, Marquette, and Ontonagon counties (Payne 2011).

**BBC:** Although censuses have been conducted in potentially suitable habitat (e.g., tamarack bog), Golden-winged Warbler has not been recorded on Michigan census plots since 1983.

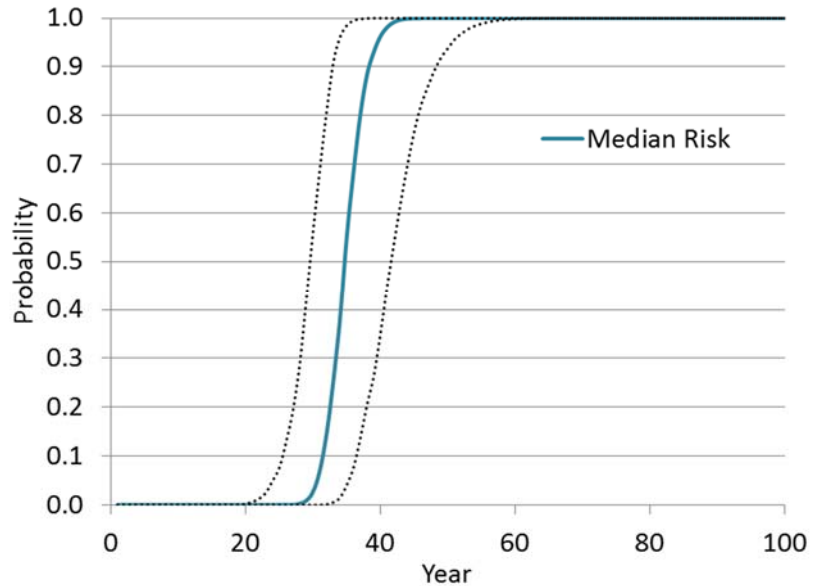


Figure 1–26. Risk of quasi-extinction for Golden-winged Warbler in Michigan as determined by a 90% decline from the year 2000 population by year 2100. Dashed lines represent the 95% credible interval. See Appendix C for methods.

**Habitat Use:** In Michigan, Golden-winged Warbler inhabits moist swampy woodlands, willow and alder thickets, and upland sites covered with aspen and fire cherry (*Prunus pensylvanica*) saplings (Ewert 1981). In south-central Michigan, it occurs in habitat mosaics with woodland and open areas. In southern Michigan (Washtenaw and Jackson counties north to southern Clinton and Shiawassee counties), the species has been documented nesting in tamarack swamps. In Tuscola County, Golden-winged Warbler occurs in second-growth woodland edges and clearings and dry to poorly drained fields overgrown with aspen and alder. In a study of behavior and nesting ecology of Golden-winged and Blue-winged warbler in southern and central Michigan, Will (1986) found both species in both wetland and upland habitats; however, continued presence of Golden-winged Warbler in tamarack swamps in southern Michigan and relative absence of Blue-winged Warbler from very wet clearcuts overgrown with shrubs or saplings in central Michigan (northern Midland County) suggested that wetland habitat might provide refugia for Golden-winged Warbler phenotypes. Kahl (2003) associated changes in landscape to changes of

Golden-winged and Blue-winged warbler populations in the state.

**Current Research and Monitoring:** Other than the BBS, there are currently no research and/or monitoring projects currently underway in the state.

**Threats.** Loss of habitat due to forest maturation may be the principle cause for population declines in Michigan. Golden-winged Warbler tends to be segregated from Blue-winged Warbler in wetter habitats, but where the two species co-occur, hybridization likely contributes to Golden-winged Warbler population decline (R. Adams, pers. comm.). Encroachment by autumn olive (*Elaeagnus umbellata*) has destroyed formerly suitable Golden-

winged Warbler habitat in the south. In such areas, Blue-winged Warbler has not replaced Golden-winged Warbler, and thus suitable habitat could be restored by managing autumn olive (Payne *in* Brewer et al. 1991). The Golden-winged Warbler decline in the Upper Peninsula detected during the second Michigan Breeding Bird Atlas could not be explained by interaction with Blue-winged Warbler, which was recorded in only four Upper Peninsula township localities as compared to 77 township localities for Golden-winged Warbler (Payne 2011). Other factors may be implicated, such as widespread climatic warming in the region over the last century and increases in more mature forest cover (Payne 2011).

## Iowa

**State Legal Status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** S1

**Summary:** Golden-winged Warbler is a regular but uncommon migrant in the state, primarily in eastern Iowa (Dinsmore et al. 1984). Possible breeding was reported from Lee County in southeastern Iowa (Jackson et al. 1996). Roberts (1932) claimed that Golden-winged Warbler formerly bred south to southern Iowa, although Kent and Dinsmore (1996) document only three nests in the state, one in the southeast (1888) and two in central Iowa (1898). Blue-winged Warbler also has been reported from Lee County (BBS data), so a recent record could have been a hybrid or a Blue-winged Warbler singing a Golden-winged Warbler song.

**BBS:** No Golden-winged Warblers have been recorded on BBS routes.

**BBA:** A Breeding Bird Atlas was conducted from 1985–1990. There was only one possible record of breeding reported from Lee County in southeastern Iowa (Jackson et al 1996).

**BBC:** Golden-winged Warbler has not been recorded in Iowa Breeding Bird Census plots, although none have been conducted in suitable habitat during the past 30 years.

**Habitat Use:** Golden-winged Warbler is associated with deciduous forest, edge, and brushy areas (Dinsmore et al. 1984).

**Current Research and Monitoring:** No research or monitoring specific to Golden-winged Warbler is known to be occurring in Iowa.

**Threats:** No specific data.

## Missouri

**State Legal Status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** SNA

**Summary:** Golden-winged Warbler is an uncommon migrant in Missouri (Robbins and Easterla 1992). There is one confirmed 1890 historic nesting record from Mississippi County in the southeast and unconfirmed reports in 1884 from Audrain County in the northeast at a site adjacent to a possible nesting location in Lee County, Iowa (Robbins and Easterla 1992).

**BBS:** Golden-winged Warbler has not been recorded on Missouri BBS routes.

**BBA:** A Breeding Bird Atlas conducted from 1986–1992 did not record Golden-winged Warbler (Jacobs and Wilson 1997).

**BBC:** Golden-winged Warbler has not been recorded in Missouri Breeding Bird Census plots, although none have been conducted in suitable habitat during the past 30 years.

**Habitat Use:** No specific data.

**Current Research and Monitoring:** No research or monitoring specific to Golden-winged Warbler is known to be occurring in Missouri.

**Threats:** No specific data.

## Illinois

**State Legal Status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** S1S2

**Summary:** Golden-winged Warbler is a fairly common migrant and rare summer resident in northern Illinois (Bohlen 1989). In the late 1800s, breeding was reported from Richland County in southern Illinois (Ridgway 1889) and in the Mississippi River bottoms (Butler 1897). Contemporary records during the breeding season (1980s) are generally from the northern part of the state, including Lake and Will counties (Bohlen 1989) and Henderson County (BBS data). There are no contemporary records from southern Illinois during the breeding season (Robinson 1996). Golden-winged Warbler was reported from three sites (one as confirmed breeder) from Lake and Cook counties during BBA work from 1986–1991 (Kleen et al. 2004). Illinois Natural History Survey currently considers Golden-winged Warbler to be a breeding species in the state.

**BBS:** Only three Golden-winged Warblers have been recorded on BBS routes: one in Henderson County along the Mississippi River in 1979 and two in Lake County in 1991 and 1995. There have been no subsequent detections on BBS routes through 2010 and thus data are insufficient to determine population trends.

**BBA:** A Breeding Bird Atlas project was conducted from 1986 to 1991. Confirmed breeding was documented in Cook County in 1986; two other possible breeding records came from Cook and Lake counties in 1991 (Kleen et al. 2004).

**BBC:** Golden-winged Warbler has not been recorded in Illinois Breeding Bird Census plots, although few censuses have been conducted in suitable habitat during the past 30 years.

**Habitat Use:** Habitat has not been described in detail from Illinois. Bohlen (1989) characterized habitat generally as deciduous woodlands with thick undergrowth. During the early 1960s, breeding birds in Cook County could be found in abandoned agricultural land converted to mesic hawthorn (*Crataegus* spp.) /crab tree (*Malus*

spp.) /plum (*Prunus* spp.)savanna with substantial *Rubus* ground cover (B. Russell, pers. comm.).

**Current Research and Monitoring:** No research or monitoring specific to Golden-winged Warbler is known to be occurring in Illinois.

**Threats:** No specific data.

## Indiana

**State Legal Status:** Endangered

**Natural Heritage Rank (see Table 1–6 for definitions):** S1

**Summary:** Historically, Golden-winged Warbler was considered a migrant in Indiana and a locally common summer resident in northern Indiana. Mumford and Keller (1984) claimed that almost every large swamp in northern Indiana had its pair of nesting Golden-winged Warblers during the late 1800s, and Butler (1897) reported them breeding "in some numbers" in that region. By the 1980s it was reported as an uncommon to rare migrant statewide and very rare summer resident, primarily in northern Indiana. Nesting records had been reported up until 1983. Little evidence of breeding has been noted in the past 30 years, however, and thus Golden-winged Warbler may be extirpated from the state as a breeding species (J. Castrale, Indiana DNR, pers. comm.).

**BBS:** One Golden-winged Warbler was recorded in 1993 from Porter County near Lake Michigan. Blue-winged Warbler was also recorded on this route in the 1990s. Data are insufficient to estimate population trends.

**BBA:** Indiana's first Breeding Bird Atlas, conducted from 1985 to 1990, contained only six records of Golden-winged Warbler, five of which were from northwestern Indiana. Breeding was not confirmed in any block but was listed as probable in three blocks (Castrale et al. 1998). Field work for the second atlas effort from 2005

to 2011 produced two records in the possible category that may represent late migrants. One Golden-winged Warbler was observed and heard singing a Blue-winged Warbler song on multiple occasions from 10 May through at least 20 June 2008. This record was in a non-priority block on the north-west side of Indianapolis (J. Castrale, pers. comm.).

**BBC:** Golden-winged Warblers has not been recorded in Indiana Breeding Bird Census plots, although few have been conducted in suitable habitat during the past 30 years.

**Habitat Use:** Until the 1970s, Golden-winged Warblers nesting across the northern tier of counties utilized scrubby marsh edges, burns, and overgrown fields (Castrale et al. 1998).

**Current Research and Monitoring:** No research specific to Golden-winged Warbler is known to be occurring in Indiana. This species is occasionally detected on annual May Day counts (Werner 2008) and summer bird censuses (Detamore and Castrale 2008).

**Threats:** Loss of early successional forested habitats and fens in northern Indiana are likely responsible for decline of this species in the state.

## Ohio

**State Legal Status:** Endangered

**Natural Heritage Rank (see Table 1–6 for definitions):** S1

**Summary:** Golden-winged Warbler was described by several ornithologists as locally common in the early 1900s in northwestern Ohio (Ashtabula, Lucas, and Cuyahoga counties) and rare elsewhere (Peterjohn and Rice 1991). Breeding Golden-winged Warbler populations were probably already declining by the late 1930s (Peterjohn 1989), and the species is now at best a casual summer resident in the state (Peterjohn 1989, Peterjohn and Rice 1991). Blue-winged Warbler has expanded into areas formerly occupied by Golden-winged Warbler (Peterjohn and Rice 1991) and has likely contributed to its decline in Ohio. Golden-winged Warbler was not confirmed as a breeding bird in the state during either Ohio's first (Peterjohn and Rice 1991) or second Breeding Bird Atlas (M. Shumar, pers. comm.).

**BBS:** Golden-winged Warbler has been recorded on three BBS routes in southeastern Ohio—in 1979, 1983, and 1999. During the most recent decade (2000–2010), there have been no Golden-winged Warbler detections (Sauer et al. 2011). BBS data are insufficient to estimate population trends.

**BBA:** During Ohio's first Breeding Bird Atlas, with field work conducted 1982–1987, 14 singing male Golden-winged Warblers were reported as

possible or probable breeders in seven priority blocks and seven supplemental blocks (Peterjohn and Rice 1991). Of seven Golden-winged Warbler observations in the Ohio Breeding Bird Atlas II during 2006–2011, only one occurred in July; the others were from late May to 10 June and may have been migrants. None of these observations confirmed breeding for the species in the state (M. Shumar, pers. comm.).

**BBC:** Although censuses have been conducted in potentially suitable habitat, including one site that was monitored for 48 years, Golden-winged Warbler has not been recorded on Ohio census plots since 1983.

**Habitat Use:** Historically, Golden-winged Warbler occupied shrub/sapling stage successional habitats in Ohio. Nests were located on the ground in dense, herbaceous cover (Peterjohn and Rice 1991).

**Current Research and Monitoring:** No research or monitoring specific to Golden-winged Warbler is occurring in Ohio.

**Threats:** Main threats to the species are habitat loss in the Oak Openings region and range expansion of potentially competing Blue-winged Warbler (C. Caldwell, Ohio Division of Wildlife, pers. comm.).

## USFWS Northeast Region 5 Summary

### New York, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, Pennsylvania, New Jersey, West Virginia, Maryland, Virginia

Region 5 supports an estimated 6% of the global Golden-winged Warbler breeding population. Eleven states have historical or current breeding records; Maine and Delaware are not included because they lack recent breeding records for the species. Golden-winged Warbler still breeds in substantial numbers at higher elevations (>700 m) in the southern and eastern mountains of West Virginia, in central Pennsylvania, and in southeastern and northern New York. It has been extirpated as a breeding species from Rhode Island and Massachusetts, and it breeds in small numbers in southwest Virginia, northeast New Jersey, northwest Connecticut, central and western New York, west-central Vermont, and southeast New Hampshire. Given the predominant pattern of replacement of Golden-winged Warbler by Blue-winged Warbler over the last 150 years, these small local populations might soon disappear; the remaining areas of Golden-winged Warbler abundance in the Region are also at risk. As measured by the BBS from 1966 to 2010, Golden-winged Warbler has declined across Region 5 by -7.70% per year (95% CI: -8.94, -6.51;  $n = 193$  routes) (Sauer et al. 2012). According to a population viability analysis, Golden-winged Warbler risks extinction throughout the Region during the next 100 years (see Figure 1–7 and the state summaries below).

A long-term regional decline in early successional habitat over the last 100 years (Lorimer 2001) continues into the present (Trani et al. 2001) and probably has been a major contributor to the steep regional warbler population decline—at least in some areas. The Northeast region, as a whole, currently has about 10% of its land cover in early successional habitat, but the distribution of that habitat is not uniform. Due to its active forest industry, approximately 20% of Maine's land cover consists of early successional habitat, but the rest of the New England states have less

than 10% (some states less than 5%) of their land in early successional habitat (Trani et al. 2001). Mid-Atlantic states are at or below the regional average of 10% early successional cover. With current trends toward increasing loss of contiguous forested habitat to human development and relatively low rates of timber harvest (except for Maine), availability of early successional habitat is likely to remain low for the immediate future in much of the region. However, local extirpation of the species from areas that still have apparently suitable habitat—for example on utility rights-of-way in Massachusetts (Confer et al. 2003, Confer and Pascoe 2003)—suggest that habitat limitation is not the only factor in the continuing decline of Golden-winged Warbler in Region 5. Studies by Gill (1980) and Confer et al. (2003) demonstrated that interactions with Blue-winged Warbler are correlated with population declines of Golden-winged Warbler in this region. The pattern of Golden-winged Warbler disappearance from local areas within 50 years of arrival of Blue-winged Warbler (Gill 1980) continues to be observed in the Northeast (see state reports, especially New York and Pennsylvania). Non-breeding season habitat loss may also be a factor, but to date little is known about explicit migratory connectivity between this region and Neotropical wintering areas.

According to GOWAP (Barker Swarthout et al. 2009), a majority of the Golden-winged Warblers detected in the Northeast region (northern New York, New England, Ontario, Quebec) were in upland shrub (48%) and successional forest (23%) habitats (Figure 1–27). Only 15% of sites on which Golden-winged Warbler was detected were in wetland type habitats. In contrast to regions to the south, most of these birds were still found at low elevations. In the Mid-Atlantic region of southern New York to Virginia and eastern West

Virginia, a majority of the 526 sites with Golden-winged Warblers also were in upland shrub (37%) and early successional forest (19%)—in a variety of habitats representing ecological succession after farmland abandonment (Figure 1–28). Utility rights-of-way and wetland shrub habitats each accounted for 13% of sites. The importance to Golden-winged Warbler of hardwood swamp

forest habitat in the Hudson Highlands of southern New York was not reflected in the GOWAP surveys; Confer and Tupper (2000) and Confer et al. (2010) documented high nesting success and persistence of Golden-winged Warbler in hardwood swamps in close proximity to expanding Blue-winged Warbler populations in adjacent upland habitats.

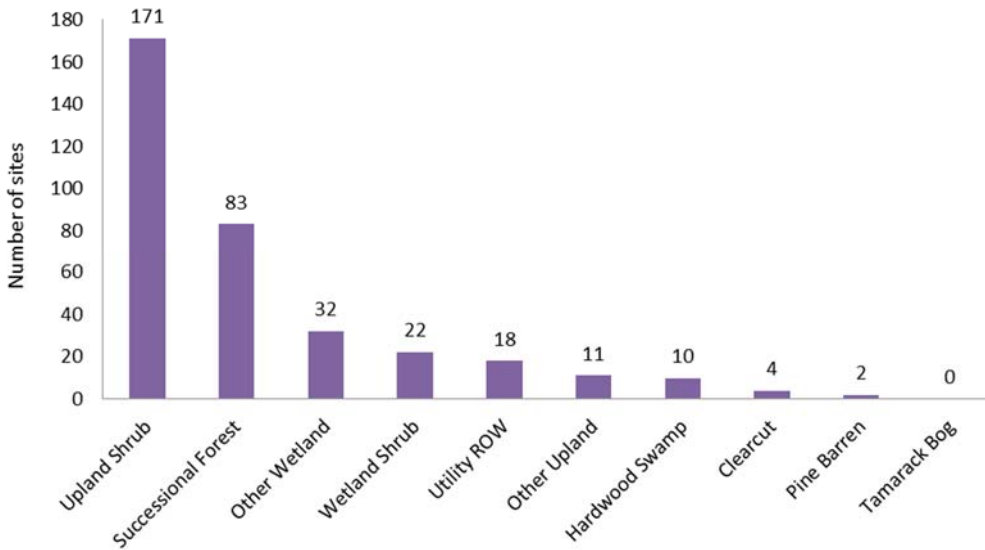


Figure 1–27. Distribution of habitat types at sites in the Northeast region where Golden-winged Warbler was detected. Since sampling was non-random, these data represent only habitats where the species was detected and therefore do not characterize use versus availability of habitat. See Appendix F for habitat definitions. In this graph, Upland Shrub = upland shrubby field + upland abandoned farm and Wetland Shrub = alder swamp + beaver wetland + shrub wetland.

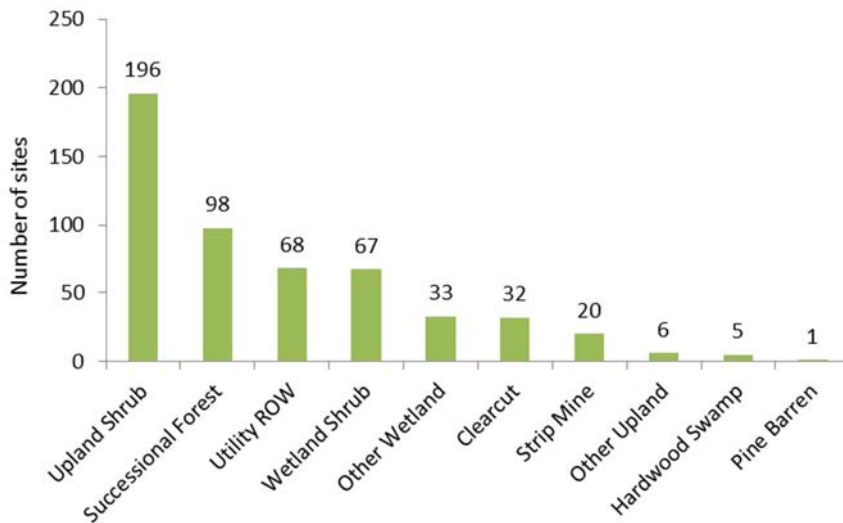


Figure 1–28. Distribution of habitat types at Mid-Atlantic region sites with Golden-winged Warbler detections. Since sampling was non-random, data represent only habitats where the species was detected and therefore do not characterize use versus availability of habitat. See Appendix F for habitat definitions. In this figure, Upland Shrub = upland shrubby field + upland abandoned farm and Wetland Shrub = alder swamp + beaver wetland + shrub wetland.

To supplement Golden-winged Warbler detections on the BBS, a spatially-balanced monitoring program for Golden-winged Warbler is currently being

coordinated by the Cornell Lab of Ornithology and implemented throughout the Appalachian region.

## New York

**State Legal Status:** Special Concern

**Natural Heritage Rank (see Table 1–6 for definitions):** S4

**Summary:** Golden-winged Warbler was first documented in southeastern New York in 1867, but breeding was not confirmed until 1897 (Andrle and Carroll 1988). By the early 1900s it was common on western and northern Long Island and in the lower Hudson Valley, uncommon or local on southern and eastern Long Island and the central Hudson and Delaware valleys, and extremely rare in central and western New York (Eaton 1914). By 1950, the species occurred in moderate abundance throughout the Finger Lakes region and the central and western portions of the state (Andrle and Carroll 1988). Golden-winged Warbler expanded northward in the 1980s and bred in localized clusters throughout most of the state with the exception of the Central Adirondacks, Western Adirondack Foothills, and Coastal Lowlands. Although Golden-winged Warbler may be increasing in the Eastern Ontario Plain, Indian River Lakes, and St. Lawrence Plains regions (Confer et al. 1991, McGowan and Corwin 2008), it has declined in the central and southern portions of the state and is now virtually absent from the Finger Lakes region (McGowan and Corwin 2008). In the western portion of the Hudson Highlands in the southeast, a moderately dense Golden-winged Warbler population has co-occurred with Blue-winged Warbler for over a century (Confer 1998, Confer and Tupper 2000). However, Confer (2005) questioned the continuing coexistence of this population due to increased introgression. In the Confer (2005) study, 13 of 15 Blue-winged Warbler phenotypes retained ancestral Blue-winged Warbler mtDNA, whereas a lower proportion of Golden-winged Warbler phenotypes, 16 of 28, retained ancestral Golden-winged Warbler mtDNA. Genetic introgression is also a threat in northern New York, which raises concerns about the viability of Golden-winged Warbler as a persisting phenotype in the state.

**BBS:** Golden-winged Warbler has been recorded on 10 BBS routes across New York in the last 10 years (2001–2010) as compared to 24 routes in the 1990s decade. Analyses of long-term BBS data (1966–2010) suggest that populations of Golden-winged Warbler in New York have experienced significant declines of -5.1% per year (95% CI: -7.0, -3.3;  $n = 56$  routes; Sauer et al. 2012; Figure 1–29).

By 2100, if trends and variability in trends persist as they have for the last 40 years, Golden-winged Warbler has a 100% (95% credible level: 99.5%, 100%) risk of a further 90% loss of New York's population (Figure 1–30).

**BBA:** The first New York Breeding Bird Atlas was conducted from 1980 to 1985. Golden-winged Warbler was reported from 576 blocks and confirmed breeding in 110 blocks (Andrle and Carroll 1988). The second atlas project was conducted from 2000–2005. Golden-winged Warbler was reported from 270 blocks and breeding was confirmed on only 51 blocks. This change represents a 54% decline in the number of blocks with confirmed breeding (McGowan and Corwin 2008).

**BBC:** Golden-winged Warbler was recorded on seven different New York Breeding Bird Census plots from 1977 to 1994—in abandoned orchard (3 pairs per 16.2 ha); abandoned upland pasture (1 pair per 8 ha, 2 pairs per 30 ha); maple (*Acer* spp.)-oak forest (2 pairs per 72.8 ha, 4 pairs per 72.8 ha); mixed upland forest (1 pair per 142 ha); young mixed forest (1 pair per 4.4 ha); and young white ash (*Fraxinus americana*)/red maple (*A. rubrum*) forest (1 pair per 16.2 ha).

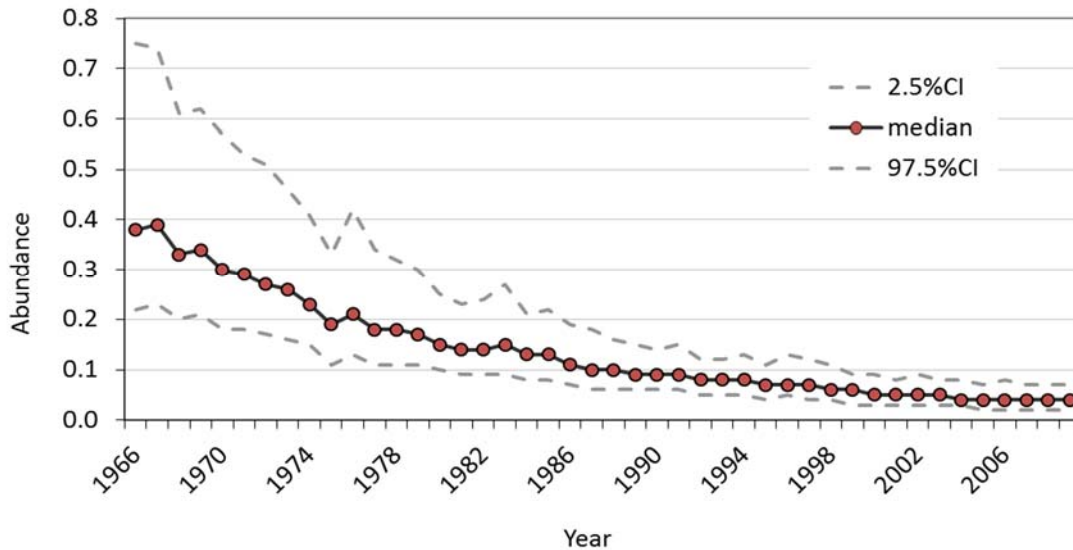


Figure 1–29. Changes in relative abundance of Golden-winged Warbler in New York based on hierarchical Bayesian analyses of BBS data (1966–2009).

**Habitat Use:** Golden-winged Warbler inhabits regenerating old fields, abandoned pastures, powerline rights-of-way, and forested wetlands—including alder swamps, beaver meadows, and tamarack swamps. In the Hudson Highlands, exclusive use of natural swamp forests by Golden-winged Warbler seems to be an important component of its local coexistence with Blue-winged Warbler, which occupies adjacent upland sites. Similarly, wetland sites at Fort Drum are occupied solely by Golden-winged Warbler, whereas dry upland shrubby habitats support both Golden-winged and Blue-winged warblers (C. Dobony, pers. comm.).

**Current Research and Monitoring:** Sterling Forest State Park in Orange County in southeastern New York was one of the eight study sites that comprised the 2008–2010 collaborative research project of the Golden-winged Warbler Rangewide Conservation Initiative (Appendix D). Research on reproductive ecology, behavior, competitive interactions with Blue-winged Warbler, habitat use, and response to management activities has been ongoing since 1977 in New York under the direction of J. Confer, Ithaca College. More recently, extensive surveys and studies of habitat

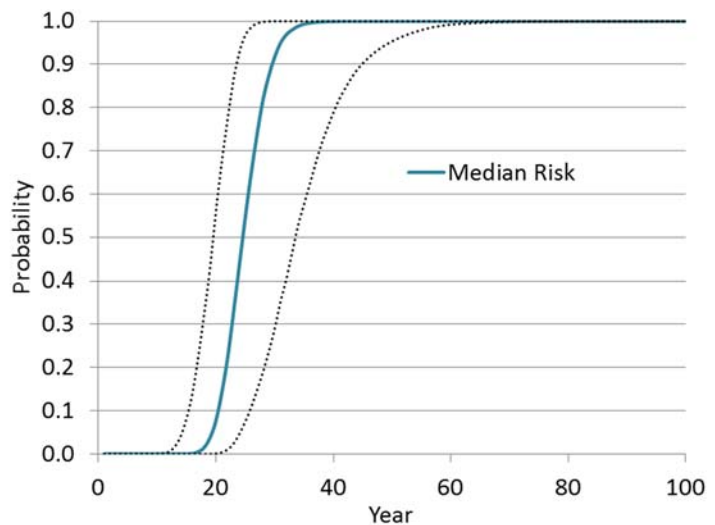


Figure 1–30. Risk of quasi-extinction for Golden-winged Warbler in New York as determined by a 90% decline from the year 2000 population by year 2100. Dashed lines represent the 95% credible interval. See Appendix C for methods.

use have been carried out in northern New York by the New York Department of Environmental Conservation, Fort Drum, and Cornell Lab of Ornithology. In addition, R. Vallender (Environment Canada) is studying genetic introgression with Blue-winged Warbler in northern New York in association with I. Lovette (Cornell Lab of Ornithology) as part of a range-wide genetic atlas; 17% of the Golden-winged Warblers sampled showed evidence of genetic introgression.

**Threats:** The decline of Golden-winged Warbler in New York correlates with the expansion of Blue-winged Warbler into the state. Studies indicate a continual northward movement of Blue-winged Warbler over the last 90 years, with a recent expansion rate of about 8 km per year. In north-central New York, Golden-winged Warbler appears to show behavioral dominance over Blue-winged Warbler, and habitat availability does not appear to limit breeding densities of either species (Confer and Larkin 1998). A recent decline in dairy farming in the St. Lawrence Valley has created a pulse of abandoned farmland, providing a modest boost

in available shrubland habitat. However, the recent appearance of Blue-winged Warblers in these areas and signs of genetic introgression in remaining Golden-winged Warblers does not bode well for the future of the Golden-winged Warbler phenotype, even in northern New York. In key wetland habitats, particularly in southeastern New York, invasive phragmites (*Phragmites australis*) is a threat, and some form of invasive control might become necessary to maintain the viability of these wetlands for breeding Golden-winged Warbler (J. Confer, pers. comm.).

## Vermont

**State legal status:** Special Concern

**Natural Heritage Rank (see Table 1–6 for definitions):** S2S3

**Summary:** Golden-winged Warbler was first reported from Vermont in 1893 (Stearns and Coues 1893), and the species continued as a rare and local breeder throughout the first half of the 20th century (Laughlin and Kibbe 1985). Breeding was reported from southeastern Vermont near the Connecticut River and from Rutland and West Haven at the southern tip of Lake Champlain (Laughlin and Kibbe 1985). Today, Golden-winged Warbler appears to remain as a very rare breeder in the Lake Champlain area and adjacent portions of the Taconic Mountains.

**BBS:** Golden-winged Warbler has been recorded on two BBS routes in the last 10 years (2001–2010; Sauer et al. 2011). BBS data are insufficient to estimate population trends.

**BBA:** The first Vermont Breeding Bird Atlas was conducted from 1976–1981 (Laughlin and Kibbe 1985). Golden-winged Warbler was reported from 15 priority blocks and was confirmed

breeding in four of those blocks. Field work for a second atlas effort was completed in 2007. Golden-winged Warbler was reported from 14 priority blocks, and breeding was confirmed in five of those blocks (Renfrew *in press*, USGS BBEA 2012).

**BBC:** The only detection in the past 30 years consisted of one Golden-winged Warbler observed in old field habitat in 1994.

**Habitat Use:** Golden-winged Warbler inhabits abandoned fields and pastures, forested wetlands, and powerline rights-of-way.

**Current Research and Monitoring:** No research or monitoring specific to Golden-winged Warbler is known to be occurring in Vermont.

**Threats:** Loss of available habitat through forest maturation on abandoned farmland is the major threat in Vermont.

## New Hampshire

**State legal status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** S2

**Summary:** In southern New Hampshire, Golden-winged Warbler occurred as far north and west as Manchester and Concord in the 1930s and eastward to just across the border in southwestern Maine (Bent 1963), but breeding was limited to the coastal lowlands by the 1960s (Foss 1994). During the 1990s, Golden-winged Warbler began disappearing from the coastal plain but continued to breed in the central Connecticut Valley near Hanover. The species has since disappeared from that region and may be extirpated from the state (Suomala 2005).

**BBS:** Golden-winged Warbler has been recorded on six BBS routes, primarily in southern New Hampshire, including only one in the last 10 years, in 2003 (Sauer et al. 2012). Figure 1–31 illustrates a non-credible population trend (-6.3%/year; 95% CI: -35.7, +18.5) derived from hierarchical Bayesian analyses of long-term BBS data (1966–2010; Sauer et al. 2012). The data are insufficient to allow confident inference of the New Hampshire population trend based on BBS data alone.

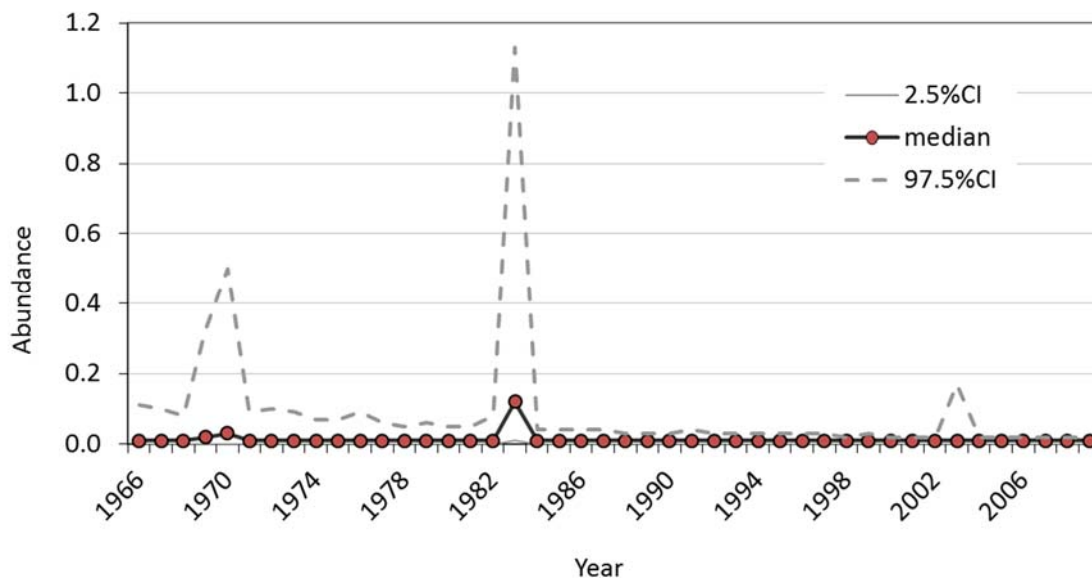


Figure 1–31. Changes in relative abundance of Golden-winged Warbler in New Hampshire based on hierarchical Bayesian analyses of BBS data (1966–2009).

**BBA:** A Breeding Bird Atlas was conducted in New Hampshire from 1981–1986 (Foss 1994). Golden-winged Warbler was reported from five priority blocks and was confirmed breeding on one of those blocks (Foss 1994, USGS BBEA). Blue-winged Warbler was reported from 10 priority blocks and confirmed breeding in one block.

**BBC:** Golden-winged Warbler has not been recorded recently in New Hampshire Breeding Bird Census plots, although few have been conducted in suitable habitat during the past 30 years.

**Habitat Use:** No specific data.

**Current Research and Monitoring:** No research or monitoring specific to Golden-winged Warbler is known to be occurring in New Hampshire.

**Threats:** Primary threats include forest maturation on abandoned farmland and hybridization with Blue-winged Warbler.

## Massachusetts

**State legal status:** Endangered

**Natural Heritage Rank (see Table 1–6 for definitions):** S1

**Summary:** Brewster (1906) recorded breeding in eastern Massachusetts (approx. 16 km west of Boston) in 1874, but Petersen and Meservey (2003), citing Allen (1870), reported 1869 as the first year of documented nesting in the state. Golden-winged Warbler subsequently increased throughout eastern Massachusetts through the early 1900s (Veit and Peterson 1993) and remained fairly common and widely distributed throughout most of the last century. Highest numbers (i.e., 40) were recorded in the early 1940s in Essex County (Bailey 1955, Veit and Petersen 1993), although breeding records existed throughout most of the state with the exception of the southern coastal plain, Cape Cod, Martha's Vineyard, and Nantucket (Griscom and Snyder 1955). By the 1950s, most breeding locations were in eastern Massachusetts; the species had begun to decline elsewhere, with the exception of the Berkshires, where it continued to increase (Bailey 1955).

Golden-winged Warbler continued to decline in much of the state from the 1960s to the early 1990s, by which time the species was considered a very uncommon, local, and declining breeder (Veit and Petersen 1993). Based on data from 1974–1979 (Petersen and Meservey 2003), Essex County in the northeast and Berkshire County in the west were considered to be the last breeding strongholds for the species in Massachusetts. Since 1990, the only confirmed records of breeding activity were of a male and female observed together in Hampden County in 1991, a male and hybrid female provisioning young in Essex County in 1991, a female carrying nesting material in Essex County in 1999, and a male and hybrid female provisioning young in Essex County in 2002. Thus, Golden-winged Warbler may be

extirpated as a breeder from the state—or at least reduced to extremely low numbers.

**BBS:** Golden-winged Warbler has been recorded on ten BBS routes in west-central Massachusetts, but there have been no detections since 1994. Blue-winged Warbler is now detected on routes that formerly recorded Golden-winged Warbler. Analysis of long-term BBS data (1967–2010) suggest a very steep decline in Massachusetts (-9.1% per year; 95% CI: -18.0, -1.9;  $n = 9$ ; Sauer et al. 2012). However, there are insufficient data to draw conclusions confidently regarding trends in Massachusetts based on BBS data alone.

**BBA:** The first Breeding Bird Atlas was conducted from 1974–1979 (Petersen and Meservey 2003). Golden-winged Warbler was reported from 67 priority blocks and breeding was confirmed in five of those blocks. Blue-winged Warbler, in contrast, was recorded on 259 priority blocks and breeding was confirmed in 73 of those blocks. Field work for a second atlas effort (2007–2011) resulted in one probable and three possible detections, with no confirmed breeding of Golden-winged Warbler in the state (USGS BBEA 2012).

**BBC:** No Golden-winged Warblers have been recently recorded in Massachusetts Breeding Bird Census plots, although few have been conducted in suitable habitat during the past 30 years.

**Habitat Use:** In Massachusetts, documented habitats have included edges and open areas with scattered patches of grasses, forbs (e.g., purple loosestrife, *Lythrum salicaria*; *Solidago* spp.), brambles (e.g., *Rubus* spp.), vines (e.g., *Vitis* sp.), shrubs (e.g., *Cornus* spp.; winterberry *Ilex*

*verticillata*; staghorn sumac, *Rhus typhina*; *Spiraea* spp.; *Vaccinium* spp.; *Viburnum* spp.), and small trees (e.g., gray birch, *Betula populifolia*; quaking aspen, *Populus tremuloides*). Bordering forests tended to consist of eastern white pine (*Pinus strobus*), oak, red maple, and a variety of additional deciduous tree species (Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife [NHESP-MADFW], unpubl. data). Broader habitat types have consisted of abandoned fields and orchards, old gravel pits, vegetated wetlands (swamps and wet meadows), and utility rights-of-way.

**Current Research and Monitoring:** Point count surveys conducted from 1998–2000 at six utility right-of-way locations throughout Massachusetts were designed specifically for *Vermivora*, incorporating 10-minute taped vocalizations of song and alarm notes of both Golden-winged and Blue-winged warblers (J. Confer, unpubl. data). In 258 point counts, there were no Golden-winged Warbler detections. No other ongoing research and monitoring specific to Golden-winged Warbler is known to be occurring.

**Threats:** Approximately 85% of Massachusetts forests were cleared for agricultural and logging in the 19th century; early stages of subsequent farmland abandonment and forest regeneration

provided a large amount of suitable Golden-winged Warbler habitat statewide (Petersen and Meservey 2003). Since the mid-1900s, available habitat in Massachusetts has been reduced substantially by ecological succession (Griscom and Snyder 1955) and development, following similar patterns observed throughout much of the eastern United States (Askins 2001, Lorimer 2001, Trani et al. 2001). Several known breeding sites were lost to housing developments and a golf course (NHESP-MADFW, unpubl. data). Public resistance to timber harvesting, prescribed fire, and other management activities that would increase habitat availability and/or suitability is a continuing threat in Massachusetts (J. E. Kubel, MADFW, pers. comm.).

Coincident with habitat loss, expansion of Blue-winged Warbler and genetic introgression has likely contributed to the decline of Golden-winged Warbler in the state. As Blue-winged Warbler became increasingly common in the mid-1900s, Golden-winged Warbler populations began to decline (Petersen and Meservey 2003). Habitat loss on the wintering grounds and nest parasitism by Brown-headed Cowbirds also may have contributed to decline of Golden-winged Warbler (Confer 1992, Confer et al. 2003), but the significance of these factors in Massachusetts is unknown.

## Connecticut

**State Legal Status:** Endangered

**Natural Heritage Rank (see Table 1–6 for definitions):** S2

**Summary:** The first Connecticut record of Golden-winged Warbler breeding was in 1875 at Suffield near the Connecticut River and about 8 km from the Massachusetts border. This record was followed by observations during the late 1800s of populations scattered throughout northern and southern Connecticut, especially along the Connecticut and Naugatuck river valleys (Gill 1980, Bevier 1994). Golden-winged Warbler was also common historically near the Connecticut coast (Gill 1980). During the 1980s,

the Connecticut atlas project reported confirmed breeding only from northwestern Connecticut (Bevier 1994). The species is now disappearing from most of these northwestern sites and is currently known from only three locations.

**BBS:** Golden-winged Warbler has been recorded on five BBS routes in Connecticut, but there have been no detections since 1988. Figure 1–32 shows the population trend (-23.6%/yr; 95% CI: -54.8, -6.7) derived from hierarchical Bayesian

analyses of 1966–2010 BBS data (Sauer et al. 2012). However, low abundance along BBS routes

do not permit confident inference regarding the Connecticut trend based on BBS data alone.

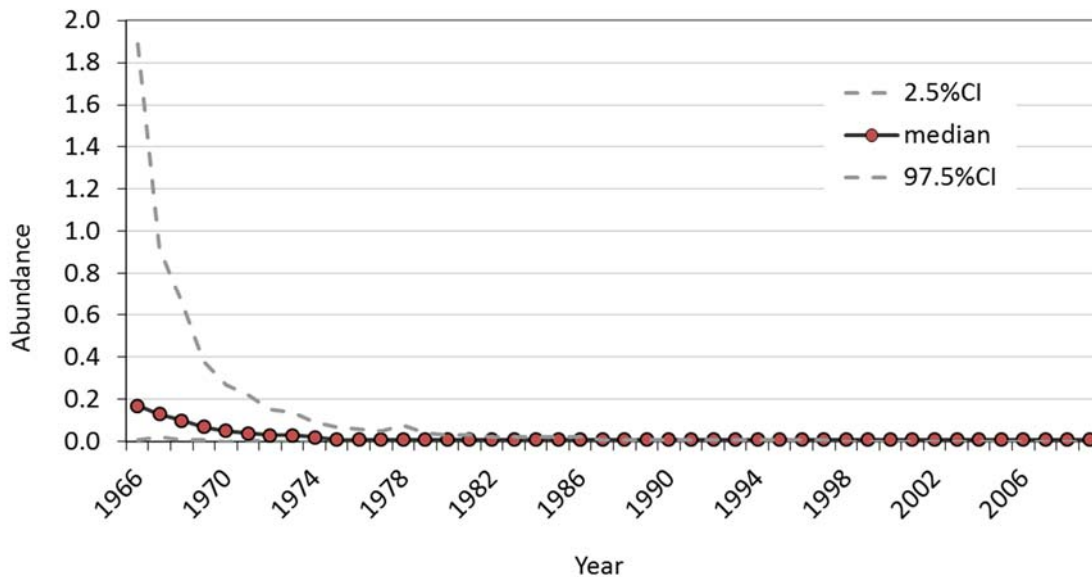


Figure 1–32. Changes in relative abundance of Golden-winged Warbler in Connecticut based on hierarchical Bayesian analyses of BBS data (1966–2009).

**BBA:** BBA surveys were conducted from 1982–1986. Golden-winged Warbler was detected in 37 blocks, with breeding confirmed in 10 blocks from northwestern Connecticut (Bevier 1994, USGS BBEA 2012). The atlas also documented hybrids scattered throughout the state (Bevier 1994).

**BBC:** Golden-winged Warbler was recorded on one Breeding Bird Census plot in "mixed habitat" in 1988–1989. There have been no subsequent detections of the species.

**Habitat Use:** Golden-winged Warbler occurs on abandoned farmland with scattered trees and shrubs bordered by second-growth forest (Bevier 1994). It also occurs on forest clearcuts and pine plantations (S. Kearney-McGee, Connecticut Department of Environmental Protection [CTDEP], pers. comm.).

**Current Research and Monitoring:** From 2000–2007, the CTDEP Wildlife Division monitored potential and historic nesting locations using playback recordings. These inventories identified Golden-winged Warbler consistently at only three locations. From 2005–2008, CTDEP Wildlife Division also monitored 35 sites for early successional bird species, including Golden-winged Warbler. Golden-winged Warbler was detected at only one site, and hybrids were detected at two sites.

**Threats:** Maturation of successional habitats, hybridization with Blue-winged Warbler, and human development are important threats to the persistence of Golden-winged Warbler in Connecticut.

## Rhode Island

**State Legal Status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** SX

**Summary:** Historically, Golden-winged Warbler occurred as a regular but very local summer resident in the northeastern portion of Rhode Island. Breeding was first confirmed at Wenscott Reservoir, North Providence, where territorial birds were present at least through the period 1931–1943. Three known or suspected breeding locations in Rhode Island were wholly within the towns of Cumberland, Lincoln, and neighboring North Providence, a region characterized by many rocky outcroppings and a generally richer flora than that of more granitic portions of the northwestern part of the state (Ferren 2001). Golden-winged Warbler now appears to be extirpated as a breeder and is only rarely seen as a migrant. Its extirpation occurred approximately 40 years after the arrival of Blue-winged Warbler.

**BBS:** Golden-winged Warbler has not been recorded on BBS routes in the state.

**BBA:** The Rhode Island Breeding Bird Atlas was conducted from 1982–1987 (Enser 1992). Golden-winged Warbler was not detected during the atlas period (USGS BBEA 2012).

**BBC:** Golden-winged Warblers has not been recorded recently on Rhode Island Breeding Bird Census plots, although few have been conducted in suitable habitat during the past 30 years.

**Habitat Use:** Golden-winged Warbler inhabited old fields with scattered shrubs and black locust (*Robinia pseudoacacia*).

**Current Research and Monitoring:** No research or monitoring specific to Golden-winged Warbler is known to be occurring in Rhode Island.

**Threats:** The decline of Golden-winged Warbler in Rhode Island is correlated with the range expansion of Blue-winged Warbler. As Blue-winged Warbler increased in abundance during the 1960s, the remaining Golden-winged Warblers disappeared. Surveys conducted in Cumberland and Lincoln (Providence County) in 1984 failed to detect Golden-winged Warbler but recorded 65 Blue-winged Warblers and one Brewster's Warbler.

## Pennsylvania

**State legal status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** S4

**Summary:** During the late 1860s, Golden-winged Warbler was reported as a rare to uncommon breeder throughout Pennsylvania, with most birds concentrated in the western counties (McWilliams and Brauning 2000). It undoubtedly increased with the subsequent expansion of abandoned farmland and old field habitat in Pennsylvania. By the mid-1950s, the species remained scarce on the high plateau of the Poconos but was a widespread breeding species

in the southern part of the Pocono region and throughout the Valley and Ridge Physiographic Province (Street 1956, cited in Brauning 1992). By the 1990s, Golden-winged Warbler had been replaced by Blue-winged Warbler throughout much of Pennsylvania with the exception of higher elevation sites (generally above 600 m) within the Valley and Ridge and Pocono regions (Brauning 1992) and in more forested landscapes of the mountainous Allegheny High Plateau

section of the Appalachian Plateau Province (northern Centre and Clinton counties) (J. Larkin, unpubl. data). As there are viable breeding populations of Golden-winged Warbler at lower elevations within all these regions, however, it is not entirely clear whether the current distribution of the species is driven by elevation or by more complex dynamics of extensively forested landscapes (Larkin, pers. comm.).

**BBS:** Golden-winged Warbler has been recorded on 19 BBS routes in the last 10 years (2001–

2010), down from 31 routes in the 1990s and 44 routes from the period 1966–1987. Analyses of long-term BBS data (1966–2010) suggest significant declines of -6.7% per year (95% CI: -8.6, -4.8;  $n = 56$  routes; Figure 1–33; Sauer et al. 2012).

By 2100, if trends and variability in trends persist as they have for the last 40 years, Golden-winged Warbler has a 100% (95% credible level: 99.5%, 100%) risk of a further 90% loss in the Pennsylvania population (Figure 1–34).

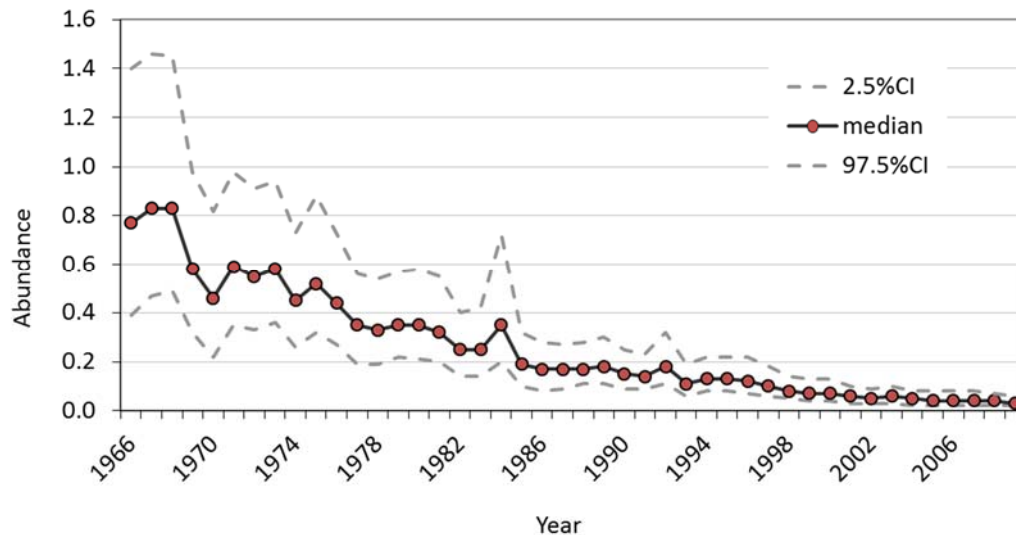


Figure 1–33. Changes in relative abundance of Golden-winged Warbler in Pennsylvania based on hierarchical Bayesian analyses of BBS data (1966–2009).

**BBA:** The first Pennsylvania Breeding Bird Atlas was conducted from 1983 to 1989. Golden-winged Warbler was reported in 615 atlas blocks and breeding was confirmed in 86 blocks (Brauning 1992). Data collection for the second atlas effort was begun in 2004 and completed in 2008. Golden-winged Warbler was recorded in 240 blocks and breeding was confirmed in only 36 blocks (Wilson et al. 2012). This change represents a 58% decline in the number of blocks with confirmed breeding.

**BBC:** Golden-winged Warbler was recorded in aspen clearcuts and abandoned fields during the 1980s and in hardwood forest with scattered pine (*Pinus* spp.) in

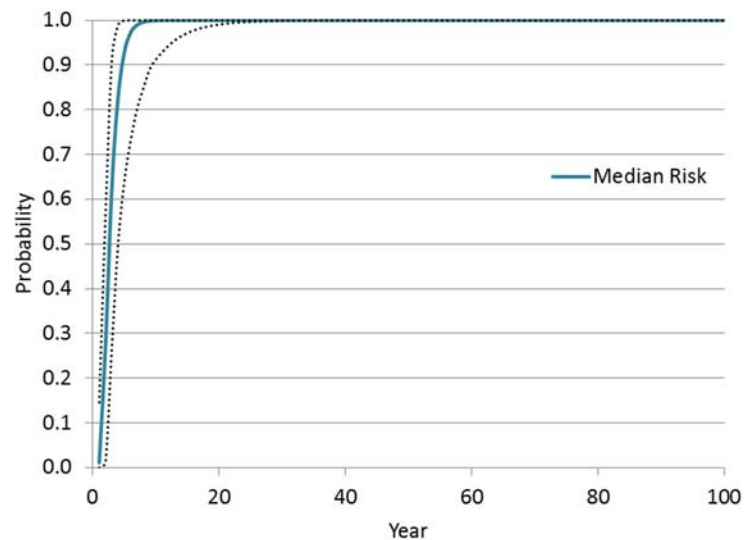


Figure 1–34. Risk of quasi-extinction for Golden-winged Warbler in Pennsylvania as determined by a 90% decline from the year 2000 population by year 2100. Dashed lines represent the 95% credible interval. See Appendix C for methods.

1993; there have been no subsequent detections on BBC plots. Reported densities were generally low, although one site in an aspen clearcut had four territories on a 4-ha cutting. Golden-winged Warbler territory densities ranged from 1.3 to 3.7 territories per 10 ha on sites located in north central Pennsylvania (J. Larkin, unpubl. data).

**Habitat Use:** Golden-winged Warbler in Pennsylvania inhabits abandoned fields, utility rights-of-way, forest regeneration areas, forested wetlands, beaver swamps, managed shrublands, and scrub-oak barrens (Brauning 1992). The species has also been observed in scrub-shrub habitats on and adjacent to reclaimed surface mines in Potter and Clinton counties (J. Larkin, pers. comm.). Extensive forest cover (i.e., >70% forest within 0.5 miles) and high elevation comprise critical habitat elements for Golden-winged Warbler for reducing interactions with Blue-winged Warbler (Bakermans et al. 2011, Larkin and Bakermans 2012, Bakermans and Larkin 2012).

Bellush (2012) found that male Golden-winged Warblers foraged selectively on black locust, pin cherry (*Prunus pensylvanica*), white oak (*Quercus alba*), and *Rubus* spp.; arthropod surveys confirmed that these tree and shrub species also had the highest values for prey availability. Tree and shrub species composition also differed between Golden-winged Warbler territories and adjacent unoccupied areas of similarly-aged habitat; this finding was consistent with patterns of forage site selection and prey abundances (Bellush 2012). Corroborating findings in Minnesota (Streby et al. 2012), Frantz (unpubl. data) also concluded that spot mapping alone does not accurately reflect Golden-winged Warbler space use and habitat needs during the breeding season. Telemetry-delineated use areas in Pennsylvania averaged 3.6 times larger than their respective spot-mapped territories and revealed more space use overlap between males.

**Current Research and Monitoring:** Sproul State Forest and Bald Eagle State Park in Clinton and Centre counties in central Pennsylvania comprised one of the eight study sites involved in the 2008–2010 collaborative research project of the Golden-winged Warbler Rangewide Conservation Initiative (Appendix D). Kubel and Yahner (2007) studied Golden-winged Warbler density and nesting success along rights-of-ways in Pennsylvania in comparison to 1-ha patch clearcuts. In 2010–2011, J. Larkin and M. Bakermans (Indiana University of Pennsylvania) modeled the density of Golden-winged Warbler in 222 timber harvests across northeastern (Monroe, Pike, Northampton, and Carbon counties), north-central (Clinton, Centre, and Lycoming counties), and southwestern (Bedford, Blair, Fayette, Somerset, and Westmoreland counties) Pennsylvania. The results were used to develop best habitat management practices for Maryland and Pennsylvania (Bakermans et al. 2011). Currently, one year (2012) of a multi-year, multi-state project examining Golden-winged Warbler response to several Natural Resources Conservation Service conservation practices has been completed. The study sites (timber harvests) that are used in the Pennsylvania portion of the study are located in Monroe and Pike counties. Pennsylvania is also participating in the spatially-balanced monitoring program being coordinated by the Cornell Lab of Ornithology and implemented throughout the Appalachian region.

**Threats:** Primary threats include the loss of early successional habitats due to ecological succession and loss of extensively forested landscapes due to development (including natural gas extraction and wind energy development) as well as interactions with Blue-winged Warbler that may lead to genetic introgression or local replacement.

## New Jersey

**State legal status:** Endangered

**Natural Heritage Rank (see Table 1–6 for definitions):** S2

**Summary:** Golden-winged Warbler is considered an uncommon migrant and rare breeding species in New Jersey (Leck 1984). Based on 2000–2002 surveys by New Jersey Division of Fish and Wildlife biologists (NJDFW), an estimated 80–90 pairs were present in the northwestern part of the state (Ridge and Valley and Southern New England physiographic provinces). However, according to data from 2008 surveys (S. Petzinger, NJDFW, pers. comm.), approximately only one quarter of this population remains in New Jersey. The New Jersey Highlands was once a place where Golden-winged and Blue-winged warbler co-existed for almost a century (Confer and Larkin 1998, Confer and Tupper 2000), but it now seems that the last stronghold for Golden-

winged Warbler in the state is in the Newark Watershed within the Highlands. Blue-winged Warbler has expanded through the Delaware River Valley during the last thirty years (Gill 1997) but now may be declining in northwestern New Jersey (S. Petzinger, pers. comm.)

**BBS:** Golden-winged Warbler has been recorded on only one BBS route in the past 10 years, in 2001 (Sauer et al. 2011). Figure 1–35 shows the population trend (-9.3%/year, 95% CI: -16.3, -2.4) derived from hierarchical analyses of long-term BBS data (1966–2010; Sauer et al. 2012). However, data are insufficient to permit confident conclusions regarding the New Jersey trend based on BBS data alone.

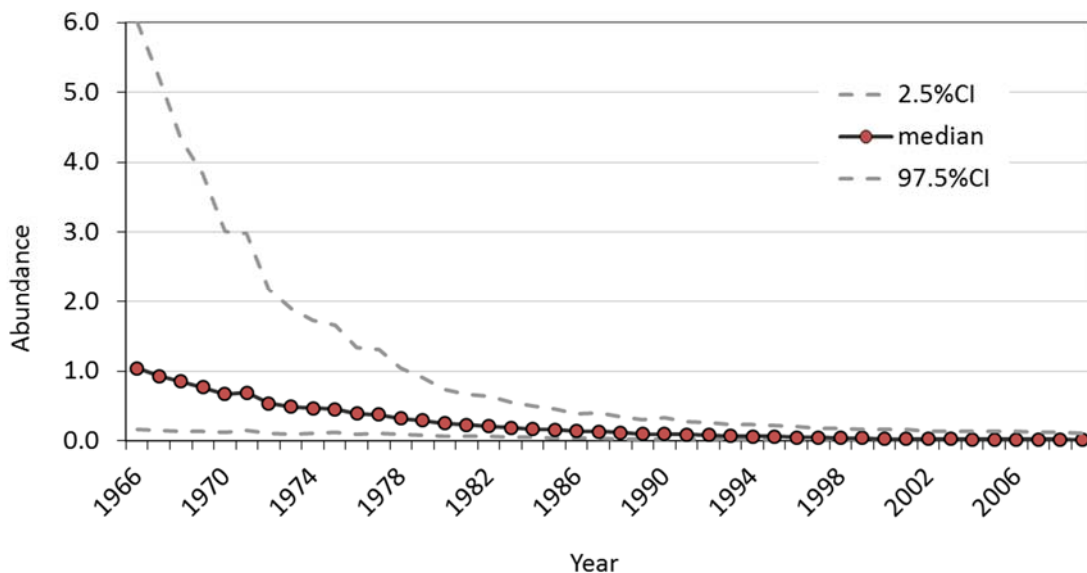


Figure 1–35. Changes in relative abundance of Golden-winged Warbler in New Jersey based on hierarchical Bayesian analyses of BBS data (1966–2009).

**BBA:** The New Jersey Breeding Bird Atlas project was conducted from 1994 to 1997. Golden-winged Warbler was reported from 66 blocks, and breeding was confirmed on 25 blocks. Blue-winged Warbler, in contrast, was reported from

458 blocks and confirmed breeding on 207 blocks (V. Elia, NJ Audubon, pers. comm.).

**BBC:** Golden-winged Warbler has not been recorded recently on New Jersey Breeding Bird

Census plots despite the fact that some were conducted in areas of suitable habitat.

**Habitat Use:** In New Jersey, Golden-winged Warbler primarily uses wetland components of utility rights-of-way, but the species also occurs in early- and mid-successional forested wetlands, upland components of utility rights-of-way, and occasionally in old fields. The majority of the Golden-winged Warblers observed during the 2008 survey were in areas with less than 50% tree cover and a mixture of shrubs and herbaceous cover (S. Petzinger, pers. comm.).

**Current Research and Monitoring:** New Jersey conducts state-wide point counts to monitor avian populations every 5-7 years. The third round of these counts was completed in 2008. A project monitoring Golden-winged Warbler return rates, habitat use, and productivity began in 2003 and was completed in 2007.

**Threats:** Habitat loss is a major threat in New Jersey, mainly through lack of appropriate active forest management. However, it appears that the New Jersey Golden-winged Warbler population is declining despite the availability of habitat, which suggests that threats outside of the state may be driving declines (S. Petzinger, pers. comm.).

## West Virginia

**State legal status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** S2

**Summary:** While the historical distribution of Golden-winged Warbler in West Virginia is not well documented, its current distribution follows patterns similar to those in other middle Appalachian states. The species breeds in the southern mountainous region of West Virginia (mostly Mercer, Summers, Monroe, Greenbrier, and Pocahontas counties) and in the Appalachian Mountain chain to the northeast (Randolph, Barbour, Tucker, and Preston counties) at elevations above 610 meters (2,000 feet) and primarily between 850 and 915 meters (2,800–3,000 feet). It still breeds at isolated sites in the coalfields (McDowell, Wyoming, and Raleigh counties), almost entirely on reclaimed narrow strip benches at or above 610 meters (R. Bailey, pers. comm.). Throughout the state, however, Golden-winged Warbler has gradually been replaced by Blue-winged Warbler (Canterbury et al. 1993, 1996; Canterbury and Stover 1999) and is now out-numbered by Blue-winged Warbler in

most areas of the state with the exception of higher elevations (Canterbury 1997, Gill et al. 2001, P. Wood pers. comm.). Although Golden-winged Warbler increases with elevation to a point of numerical dominance relative to Blue-winged Warbler, there may be no Golden-winged Warbler sites remaining where Blue-winged Warbler is not also present (R. Bailey, pers. comm.). Golden-winged Warbler is almost entirely absent above 1200 meters (4,000 feet) even where the forest type is deciduous (R. Bailey, pers. comm.).

**BBS:** Golden-winged Warbler has been recorded on 10 BBS routes in the last 10 years (2001–2010), down from 23 routes in the 1990s (1991–2000). Analyses of long-term BBS data (1966–2010) suggest steep declines of -9.2%/year (95% CI: -11.0, -7.3;  $n = 44$  routes; Figure 1–36, Sauer et al. 2012).

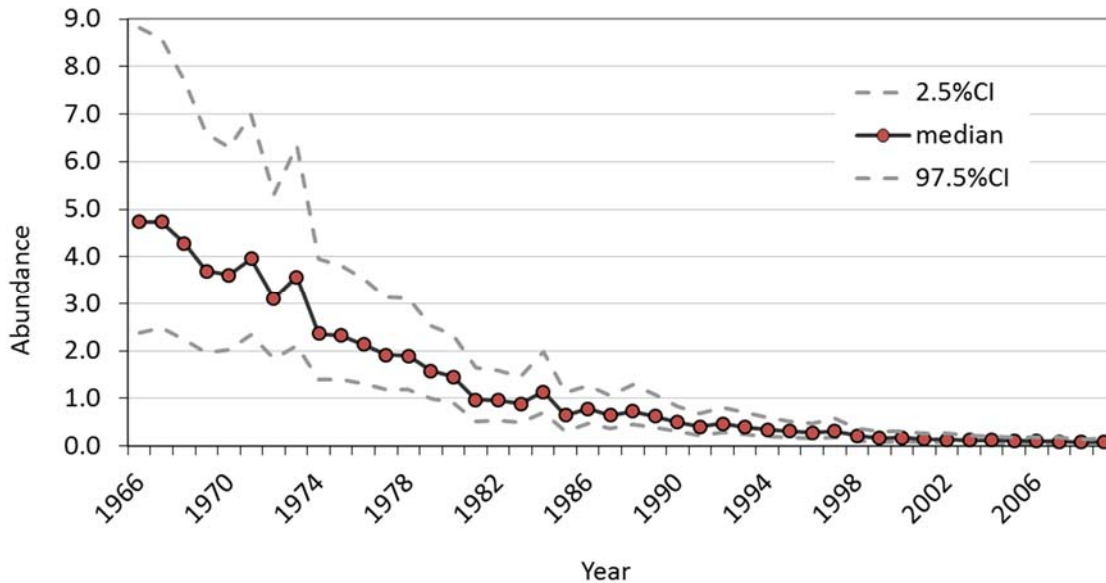


Figure 1–36. Changes in relative abundance of Golden-winged Warbler in West Virginia based on hierarchical Bayesian analyses of BBS data (1966–2009).

**BBA:** Field work for the first West Virginia Breeding Bird Atlas project was conducted from 1984 to 1989. At that time, Golden-winged Warbler was found to be fairly widely distributed throughout most of the state with the exception of the northern Ohio River Valley and eastern Panhandle (Buckelew and Hall 1994). The species was reported from 172 blocks and breeding was confirmed in 32 of those blocks (USGS BBEA 2012). By contrast, Blue-winged Warbler was reported from 213 blocks with confirmed breeding in 72 of those blocks. West Virginia's second atlas project began in 2009 and is due to be completed in 2014. Effort to date has surpassed that of the first atlas project, and spatial coverage is at least similar (K. Aldinger, R. Bailey, pers. comm.). Preliminary results indicate Golden-winged Warbler detections in 73 blocks, with breeding confirmed in 15 blocks (CLO BBA 2012); in contrast, Blue-winged Warbler has been detected in 249 blocks and confirmed as a breeder in 22 blocks (CLO BBA 2012).

**BBC:** Golden-winged Warbler has not been recorded recently on West Virginia Breeding Bird Census plots, although few plots were in suitable habitat during the past 30 years.

**Habitat Use:** Golden-winged Warbler nests in low second-growth and open woodlands, including powerline rights-of-ways (Buckelew and Hall 1994) and abandoned contour strip mines (Canterbury et al. 1996, Canterbury and Stover 1999). The species occurs most frequently in persistent shrubby habitat associated with old fields, abandoned farmland, areas managed for grazing (e.g., Aldinger 2010), reclaimed surface mines (strip benches), and shrubby wetlands, and only rarely in even-age forest harvests (P. Wood, pers. comm.).

**Current Research and Monitoring:** Parts of Monongahela National Forest in Randolph and Pocohantus counties comprised one of the eight study sites involved in the 2008–2010 collaborative research project of the Golden-winged Warbler Rangewide Conservation Initiative (Appendix D). P. Wood and colleagues (USGS West Virginia Cooperative Fish and Wildlife Research Unit, West Virginia University) are currently evaluating Golden-winged Warbler habitat, demography, and movements on areas managed for grazing on the Monongahela National Forest and adjacent privately-owned pasturelands. Golden-winged Warbler is

monitored through BBS and the spatially-balanced monitoring program being coordinated by the Cornell Lab of Ornithology and implemented throughout the Appalachian region.

**Threats:** Replacement by Blue-winged Warbler and habitat loss from ecological succession, surface mining, and development for natural gas extraction are seen as significant threats in the state (R. Tallman, WV DNR, pers. comm.). Wind energy development in high elevation areas can result in habitat loss through disturbance of existing shrublands or maintenance of turbine sites as homogeneous grassy habitats. Similarly, mountaintop mining, particularly at higher elevations, removes old mined strip benches

where shrubland habitats have supported Golden-winged Warbler; current reclamation practices are not producing new habitat suitable for the species (P. Wood, pers. comm.). Management actions that typically create hard edges (sharp forest/grass transitions) and homogeneity also comprise a threat (or at least an opportunity loss)—for example, state-maintained wildlife openings that are neatly mowed grassy clearings in the middle of a forest or national forest allotments where the shrub component consists mostly of large hawthorns (K. Aldinger, pers. comm.). Informed management actions could increase suitable habitat for the species, but the potential is not always realized.

## Maryland

**State Legal Status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** S3

**Summary:** Golden-winged Warbler was first documented as a breeding species in western Maryland in 1895. Prior to European settlement in this region, however, it was likely locally common in scattered forest openings such as those associated with large wetland systems, shale barrens, and early successional habitats created through the use of fire by Native Americans (D. Boone, pers. comm.). By the early 1900s, the species was reported as an increasingly common breeder in western Maryland (Eifrig 1904, Robbins and Blom 1996) as shrubby old fields and lightly grazed pasture became more prevalent on the landscape and as forests in some areas recovered from intensive logging and fires (Lorimer 2001). The distribution of Golden-winged Warbler appears to have been

contracting westward in recent years, and the species is no longer common in western Maryland (Robbins and Blom 1996).

**BBS:** Golden-winged Warbler has been detected on nine BBS routes in the state since 1966, but on only four in the last 10 years (2001–2010; Sauer et al. 2011). Blue-winged Warbler is now detected on routes where Golden-winged Warbler formerly had been present. Analyses of long-term BBS data (1996–2010) suggest a steep decline in Maryland (-5.8% per year, 95% CI: -8.3, -3.3;  $n = 9$ ; Figure 1–37; Sauer et al. 2012). However, the low number of route detections makes it difficult to draw confident conclusions regarding trends in western Maryland based on BBS data alone.

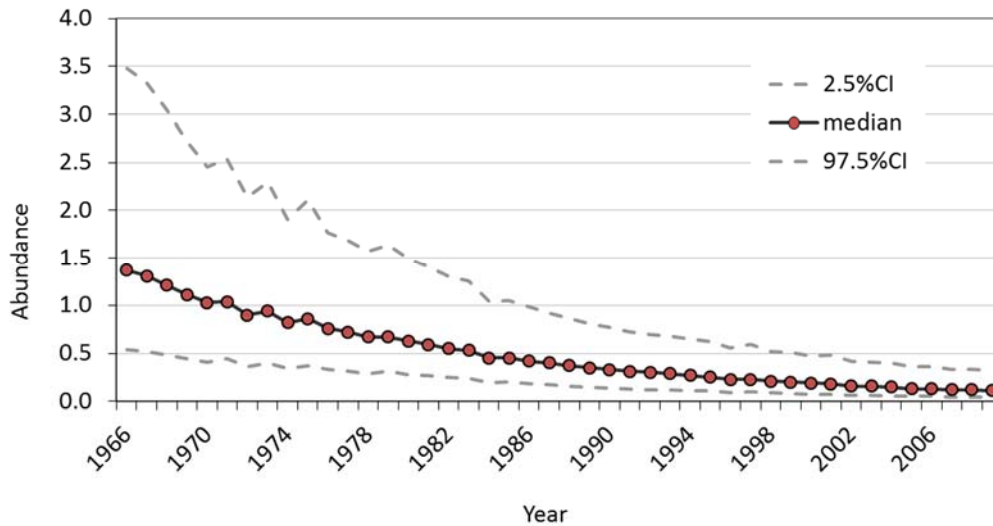


Figure 1–37. Changes in relative abundance of Golden-winged Warbler in Maryland based on hierarchical Bayesian analyses of BBS data (1966–2009).

**BBA:** Maryland's first Breeding Bird Atlas project was conducted from 1983 to 1987. Golden-winged Warbler was reported from 110 blocks with breeding confirmed on 18 blocks (Robbins and Blom 1996). Breeding was confined to the western portion of the state, in the Allegheny Plateau and western half of the Ridge and Valley physiographic province. A second atlas project was begun in 2002 and completed in 2006 (Ellison 2010). Golden-winged Warbler was detected on only 38 blocks, a 65% reduction from the first effort, with breeding confirmed in just six blocks (Ellison 2010, USGS BBEA 2012). The species range also contracted approximately 40–50 km to the west, with breeding records now confined to just scattered blocks in the Allegheny Plateau and far western section of the Ridge and Valley (Ellison 2010). The decline was particularly severe in the Ridge and Valley where it occurred in 82% fewer blocks (46 vs. 8). There were 54% fewer blocks with Golden-winged Warbler detections (65 vs. 30) in the Allegheny Plateau between the first and second atlas time periods (Ellison 2010, G. Brewer, pers. comm.).

**BBC:** Golden-winged Warbler has not been recorded on Maryland Breeding Bird Census plots, although few have been conducted in suitable habitat during the past 30 years.

**Habitat Use:** Golden-winged Warbler occupies brushy oak-hickory (*Carya* spp.) and mixed mesophytic habitats with small openings as well as shrub-meadow ecotones in high-elevation wetlands (Stewart and Robbins 1958). Beavers play a role in maintaining a shifting mosaic of suitable breeding habitat in wetland systems by creating or maintaining shrub-dominated patches (G. Brewer, MD DNR, pers. comm.). Golden-winged Warbler also occurs on old fields in later stages of succession, especially fields with periodic grazing (D. Boone, pers. comm.), and on reclaimed surface mines in the western mountains where a similar vegetation structure of scattered shrubs and small trees persists due to poor growing conditions.

**Current Research and Monitoring:** Although a number of breeding bird inventory and research projects have occurred in western Maryland since the 1980s, only one has specifically targeted Golden-winged Warbler. In 2011, data were collected as part of a regional study to inform best management practices related to silvicultural treatments. Out of 30 points with potentially suitable habitat in the Allegheny Plateau and western Ridge and Valley, Golden-winged Warbler was detected at only one point. In 2009, Golden-winged Warbler was one of the

target species in western Maryland for Audubon Maryland-DC Important Bird Area (IBA) data collection and may be a target for other potential IBAs in the future. Golden-winged Warbler is not actively tracked by the Natural Heritage database, but its status is under review.

**Threats:** The displacement of Golden-winged Warbler by Blue-winged Warbler is a concern, especially in the Ridge and Valley physiographic province where the two species show the greatest overlap in their breeding distributions. During the late 1800s, Blue-winged Warbler was an uncommon and local breeder, with no nesting records in western Maryland (Kirkwood 1895). In the 1950s, Blue-winged Warbler was still fairly uncommon, and there was no overlap with the Golden-winged Warbler breeding range (Stewart and Robbins 1958). During the 1980s, the first Breeding Bird Atlas revealed a significant westward Blue-winged Warbler range expansion

into the Ridge and Valley, with a few isolated blocks in the Allegheny Plateau physiographic province (Robbins and Blom 1996). However, the 2002–2006 atlas data indicate that Blue-winged Warbler has since declined, with 29% fewer block detections statewide as well as 9% fewer block detections in western Maryland where Golden-winged Warbler occurs (Ellison 2010). BBS data also suggest a Blue-winged Warbler decline of 1.8% per year since 1980, although too few birds were detected on BBS routes to produce a significant trend (Ellison 2010).

Other threats include loss of habitat to development, changes in land-use practices, and the loss of former natural disturbance regimes (e.g., fire and beaver activity). The latter would have provided a shifting mosaic of small openings in a predominantly forested landscape (G. Brewer, MD DNR, pers. comm.).

## Virginia

**State Legal Status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** S3

**Summary.** Golden-winged Warbler breeds in western Virginia but is absent as a breeding species in the Virginia Piedmont and Coastal Plain (Rottenborn and Brinkley 2007). In 2001, GOWAP atlas (Barker Swarthout et al. 2009) in southwestern Virginia detected about 40 territorial males in four counties (Giles, Grayson, Montgomery, and Wythe). Surveys led by USFS and Virginia Important Bird Area Program (VA IBAP) detected 25 individuals in Highland County in 2005 and 8 individuals in Bath County in 2006. A 2006 systematic breeding survey across the majority of the historical range of the species in Virginia found that Golden-winged Warbler continues to decline in the state and is being replaced in order of abundance by Blue-winged Warbler (Wilson et al. 2007). Fifty territorial Golden-winged Warbler males and six females were detected in 11 of 40 counties surveyed

(including Bath, Highland, Alleghany, Rockbridge, Pulaski, Carroll, Tazewell, Smyth, Grayson, Washington, and Lee counties); the majority of observations were in Bath and Highland counties (Wilson et al. 2007). Golden-winged Warbler has been nearly extirpated from the Blacksburg area (Montgomery County) coincident with increases of Blue-winged Warbler and extensive development (R. Canterbury, unpubl. data).

**BBS.** Golden-winged Warbler has been recorded on two BBS routes in the last 10 years (2001–2010; Sauer et al. 2011). Figure 1–38 shows the population trend (-7.7%/year; 95% CI: -11.2, -4.0;  $n = 9$  routes) derived from hierarchical analyses of long-term BBS data (1966–2010; Sauer et al. 2012). Low abundance along BBS routes preclude confident conclusions regarding the Virginia trend based on BBS data alone.

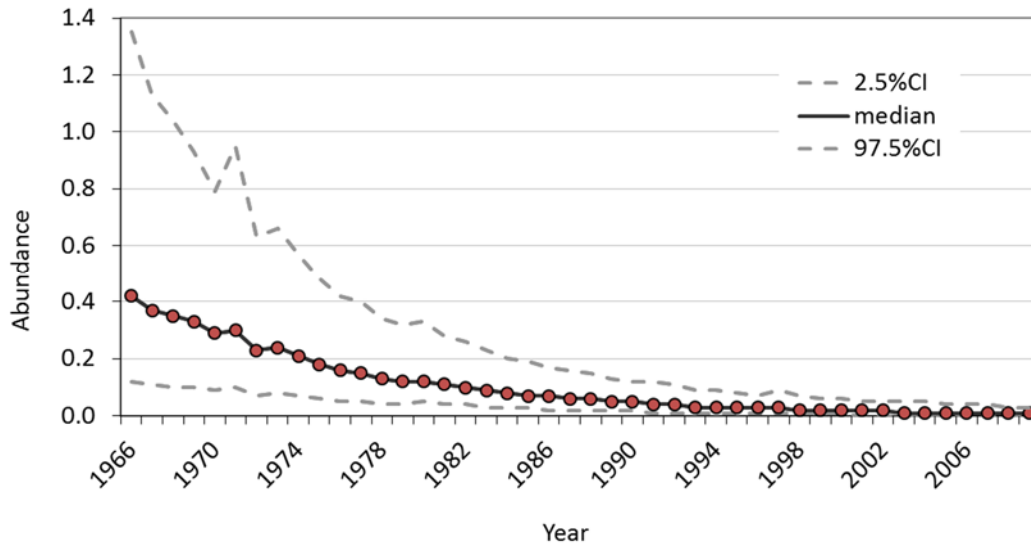


Figure 1–38. Changes in relative abundance of Golden-winged Warbler in Virginia based on hierarchical Bayesian analyses of BBS data (1966–2009).

**BBA.** The Virginia Breeding Bird Atlas project was conducted from 1985 to 1989 (Trollinger and Reay 2001). Golden-winged Warbler was reported from 53 (34 priority) blocks, and breeding was confirmed in nine (six priority) blocks (USGS BBEA 2012). Blue-winged Warbler was reported from 41 (28 priority) blocks with confirmed breeding in seven (four priority) blocks (USGS BBEA 2012).

**BBC.** Golden-winged Warbler has not been recorded recently on Virginia Breeding Bird Census plots, although few have been conducted in suitable habitat during the past 30 years.

**Habitat Use.** Golden-winged Warbler has been documented in old fields and clearcuts at elevations ranging from 580 to 760 m on the George Washington-Jefferson National Forest (J. Overcash, pers. comm., Conner and Adkisson 1975). In a recent systematic roadside breeding survey, Golden-winged Warbler was detected in idle farm/pastureland and forest clearcuts more frequently than expected (based on the number of such habitats surveyed) and in open-canopy mid-successional forest, powerline rights-of-way, and other shrub patches less frequently than expected (Wilson et al. 2007). There were no

detections in shrubby wetlands or strip mines, although the species has previously been reported from mineland sites in southwestern Virginia (C. Croy, pers. comm.). Golden-winged Warbler was only detected at elevations >460 m with the majority of observations occurring at >700 m (Wilson et al. 2007). A 2010 Virginia Department of Game and Inland Fisheries (VDGIF) status assessment of Golden-winged Warbler in wildlife openings, regenerating clearcuts, successional forests, utility rights-of-way, and beaver wetlands on four Wildlife Management Areas (WMAs) documented the species within only two habitat patches on two WMAs (VDGIF, unpubl. data).

In an intensive 2010 breeding season survey in the Golden-winged Warbler population stronghold in Bath and Highland counties, Bulluck and Harding (2010) did find Golden-winged Warbler in shrubby wetlands, but the species was not more likely to occupy such sites than sites lacking water features. Idle farm/pastureland comprised the predominant early successional habitat type within the two counties. In general, Golden-winged Warbler was associated with sites with moderately to highly clumped vegetation where ≥50% of saplings and shrubs were

arranged in a contiguous patch; in addition, the species preferred sites with more mid-stature (1–2 m) shrubs (~29% in occupied vs. 18% in unoccupied sites). Landscape-level occupancy modeling suggested that suitable habitat on the landscape was unoccupied and that occupied sites were somewhat spatially clustered on the landscape (Bulluck and Harding 2010).

**Current Research and Monitoring.** As noted above, Bullock and Harding (2010) completed an intensive survey and analysis of Golden-winged Warbler habitat characteristics, detection probability, and occupancy at both local and landscape scales in Bath and Highland counties. The species has been monitored through county-level breeding bird forays conducted by the Virginia Society of Ornithology since 1966. Monitoring begun in 2004 by USFS biologists on George Washington and Jefferson National Forests, particularly in burned areas, is continuing (C. Croy, pers. comm.). The 2005–2006 surveys by USFS and VA IBAP were repeated in 2009 by the IBA program. Virginia, like other states in the region, is also participating in the spatially balanced monitoring program being coordinated by the Cornell Lab of Ornithology and implemented throughout the Appalachians.

**Threats.** Potential displacement by Blue-winged Warbler is evidenced by its eastward expansion to geographic areas and elevations formerly occupied only by Golden-winged Warbler and by a reversal in Golden-winged Warbler's historical status as numerically dominant over Blue-winged Warbler (Wilson et al. 2007). Blue-winged Warbler has been documented in all counties in which Wilson et al. (2007) found Golden-winged Warbler (Wilson et al. 2007; M. Elfner, unpubl.

data; A. Weldon, unpubl. data). On the other hand, the low number of hybrids detected by Wilson et al. (2007) suggests that the impact of hybridization and genetic introgression may be minimal to moderate. The greatest concentrations of Blue-winged Warbler occurred in southwestern Virginia in Buchanan, Dickinson, Wise, Russell, and Tazewell counties; only Tazewell had Golden-winged Warbler detections (Wilson et al. 2007). Co-occurrence of the two species in the same habitat patches was documented in only two locations. Blue-winged Warbler was found in utility rights-of-way and shrubby wetlands more often than expected, while Golden-winged Warbler showed the opposite pattern for these two habitat types (Wilson et al. 2007).

The same factors affecting loss of early successional habitat rangewide (see pages 1–36–40) are also at work in Virginia, including reforestation, fire suppression, reduced timber harvest, urban development, and reduced acreage of abandoned farmland (S. Harding, pers. comm.). However, the landscape in Bath and Highland counties, which harbor most of the state's Golden-winged Warblers, is 80–95% forested with suitable moderate- to high-elevation early successional habitat being maintained as pasture and idle farms. Both counties have low human populations and current habitat conditions are not expected to change drastically in the coming decades (S. Harding, pers. comm.). Furthermore, both Wilson et al. (2007) and Bulluck and Harding (2010) documented the presence of suitable habitat unoccupied by Golden-winged Warbler, suggesting that habitat may not be a limiting factor in Virginia.

## USFWS Southeast Region 4 Summary

### Kentucky, Tennessee, North Carolina, Georgia, South Carolina

Region 4 supports an estimated 1.2% of the total global population of breeding Golden-winged Warbler, with five states harboring historical or present breeding populations. Current breeding records for the species are almost completely restricted to the Southern Blue Ridge and Cumberland Mountains of the Southern Appalachians. Golden-winged Warbler has been extirpated as a breeding species from South Carolina, and it breeds only in small numbers in northern Georgia and southeastern Kentucky. According to a population viability analysis (cf. Figure 1–7), the species is also at risk of extinction in North Carolina and Tennessee over the next century. Although the breeding elevation range for Golden-winged Warbler is from 300 to 1500 m, recent observations suggest that the species is increasingly restricted to elevations above 600 m (Klaus and Buehler 2001, Welton 2003). As measured by the BBS from 1966 to 2010, Golden-winged Warbler in Region 4 has experienced the steepest decline of any

USFWS Region, a decline of -8.74% per year (95% CI: -12.35, -5.62;  $n = 15$  routes) (Sauer et al. 2012). With the possible exception of Kentucky, there is virtually no evidence that interactions with Blue-winged Warbler have been responsible for this regional decline. Although Blue-winged Warbler has expanded into some areas formerly occupied by Golden-winged Warbler, this closely-related species remains uncommon at best in the Southern Appalachians.

Of 219 sites with Golden-winged Warbler detections surveyed by GOWAP (Barker Swarthout et al. 2009) in the Cumberland Mountains Region (eastern Tennessee and Kentucky, southern West Virginia), 59% were in reclaimed strip mines and 18% were in upland shrub habitats (Figure 1–39). A majority of the birds on reclaimed strip mines were found on older, contour-type mines which are currently passing into more advanced seral stages and becoming less favorable for Golden-winged

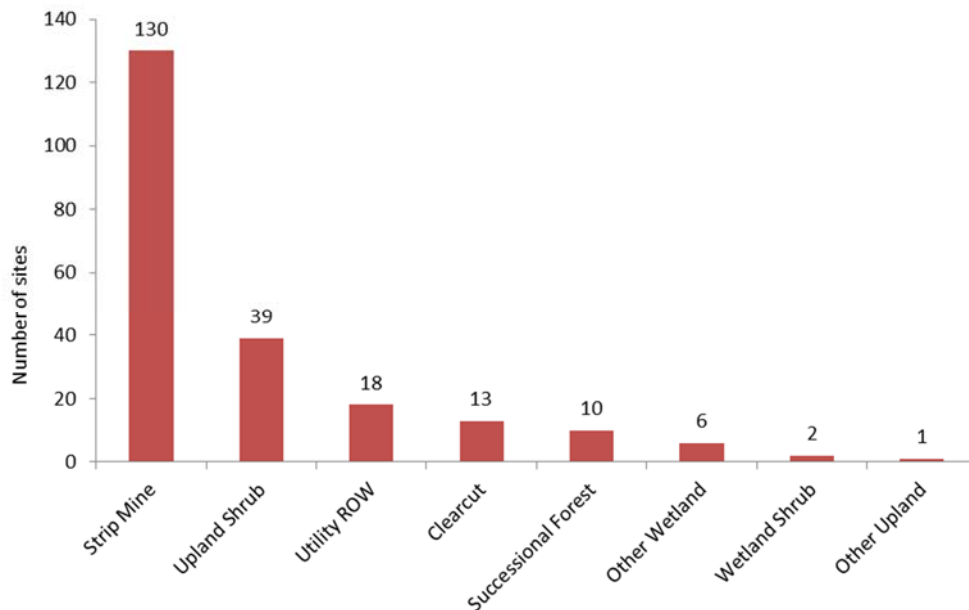


Figure 1–39. Distribution of habitat types at sites in the Cumberland region where Golden-winged Warbler was detected. Since sampling was non-random, these data represent only habitats where the species was detected and therefore do not characterize use versus availability of habitat. See Appendix F for habitat definitions. In this figure, Upland Shrub = upland shrubby field + upland abandoned farm and Wetland Shrub = alder swamp + beaver wetland + shrub wetland.

Warbler. The larger mountain top removal mines and new reclamation techniques do not favor the species (R. Canterbury, pers. comm.). Golden-winged Warbler has responded positively to prescribed burning at sites in Tennessee (D. Buehler, pers. comm.).

Of 197 GOWAP sites in the Southern Blue Ridge region (southern Virginia to Georgia), the

majority of birds were in upland shrub (67%) and other upland habitats (10%) such as abandoned farm fields at high elevations (Figure 1–40). Birds were also found infrequently in utility rights-of-way (9%) and successional forest (8%) habitats. Only a small number were found in clearcuts, but these may have been under-represented in the sample.

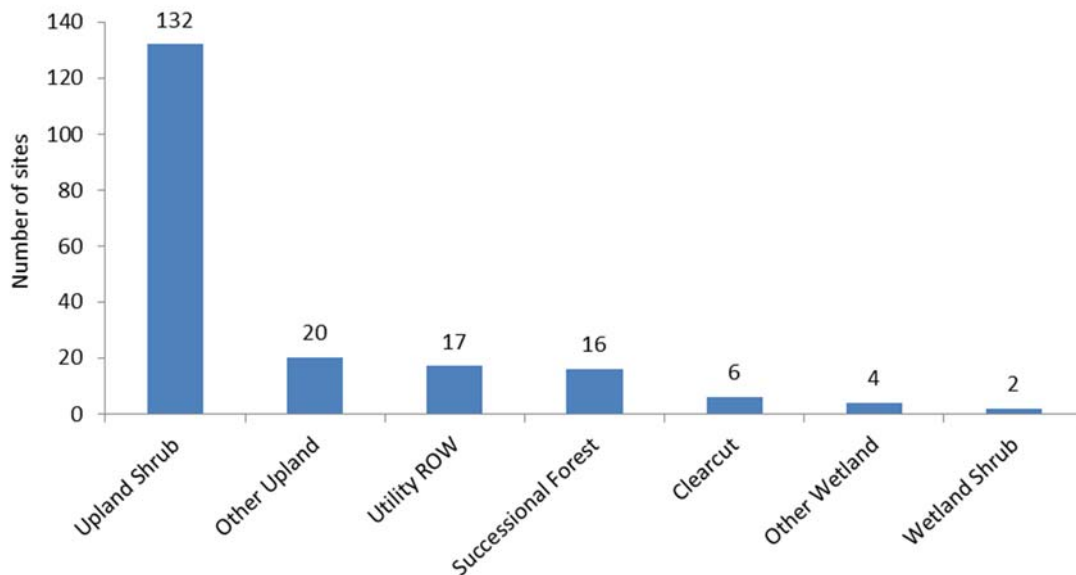


Figure 1–40. Distribution of habitat types at sites in the Southern Blue Ridge region where Golden-winged Warbler was detected. Since sampling was non-random, these data represent only habitats where the species was detected and therefore do not characterize use versus availability of habitat. See Appendix F for habitat definitions. In this figure, Upland Shrub = upland shrubby field + upland abandoned farm and Wetland Shrub = alder swamp + beaver wetland + shrub wetland.

## Kentucky

**State Legal Status:** Threatened

**Natural Heritage Rank (see Table 1–6 for definitions):** S2

**Summary:** Mengel (1965) listed Golden-winged Warbler as a very rare summer resident in Kentucky, confined to parts of the Cumberland Mountains and possibly the Cumberland Plateau. Prior to European settlement, breeding populations in Kentucky were likely limited to scattered summits higher than 850 m. Though still confined to the southeastern portion of the state, Golden-winged Warbler breeding populations likely expanded as forested ridgetops

were converted to early successional habitat as a result of strip mine reclamation and logging operations. Following a similar pattern, Blue-winged Warbler has recently expanded into southeastern Kentucky, including some high elevation areas where pure Golden-winged Warbler populations have most consistently been found. Hybrids and phenotypes evidencing genetic introgression are now commonly observed in these mixed populations.

**BBS:** Golden-winged Warbler has been recorded on three BBS routes in southeastern Kentucky, with six individuals recorded from 1973–1979. There have been no detections on BBS routes since 1979 (Sauer et al. 2012). Blue-winged Warbler is now recorded on all three of the routes that formerly listed Golden-winged Warbler. BBS data are insufficient to estimate population trends.

**BBA:** A Breeding Bird Atlas was conducted in Kentucky from 1985 to 1991. Only four breeding pairs of Golden-winged Warbler were documented from southeastern Kentucky (Palmer-Ball 1996). Two of these were July records of adult females accompanied by freshly molted immatures and thus may have represented migrant rather than breeding birds.

**BBC:** Golden-winged Warbler has not been recorded on Kentucky Breeding Bird Census plots, although few have been conducted in suitable habitat during the past 30 years.

**Habitat Use:** Golden-winged Warbler inhabits overgrown old fields and areas that have been recently cleared, including clearcuts, reclaimed coal surface mines, and utility corridors (Palmer-Ball 1996). Sixteen 2003 GOWAP records in nine quadrants ranged in elevation from 390 to 780 m, with most observations above 600 m (Barker Swarthout et al. 2009; S. Vorisek, Kentucky Department of Fish and Wildlife Resources [KDFWR], pers. comm.). Patton (2007) found that 2004–2005 Golden-winged Warbler territories at sites with only Golden-winged Warbler ( $n = 25$ ) tended to be found at higher elevations (775–925 m), on flatter slopes, and with more grass cover

than Blue-winged Warbler territories at locations where both species were present ( $n = 22$ ). Typically Golden-winged Warbler is found on drier slopes that support a well-developed forb cover of goldenrod and sericea lespedeza (*Lespedeza cuneata*) with patchy clusters of black locust and blackberry (Patton et al. 2010).

**Current Research and Monitoring:** Research in 2006–2008 examined productivity, habitat choice, and reproductive behavior in mixed populations of Golden-winged and Blue-winged warblers in Bell and Whitley counties (P. Hartman and D. Westneat, University of Kentucky). KDFWR will continue monitoring Golden-winged Warbler populations on various state point count surveys and, like other states in the region, will participate in the spatially balanced monitoring program being coordinated by the Cornell Lab of Ornithology and implemented throughout the Appalachians.

**Threats:** Ecological interactions and hybridization with Blue-winged Warbler likely comprise a significant threat to the persistence of Golden-winged Warbler in Kentucky. Monitoring efforts (2003–2008) indicate that declines of Golden-winged Warbler in southeastern Kentucky coincide with the arrival of Blue-winged Warbler. Populations of both species in eastern Kentucky occur on abandoned and reclaimed coal surface mines that may be vulnerable to re-mining activities. Modern reclamation practices generally do not produce suitable habitat for Golden-winged Warbler. Future viability of the species is also threatened by loss of open oak woodlands and savannas resulting from limitation of forest management on public lands.

## Tennessee

**State Legal Status:** In need of management

**Natural Heritage Rank (see Table 1–6 for definitions):** S3

**Summary:** Golden-winged Warbler was considered a rare species by early ornithologists in Tennessee; it was reported from the Southern Blue Ridge Mountains and eastern Cumberland escarpment in the late 1800s (Nicholson 1997). With intensive forest clearing in the early 1900s, Golden-winged Warbler abundance likely increased. Stupka (1963) reported Golden-winged Warbler as fairly common at low and middle elevations in Great Smoky Mountains National Park into the 1950s, although those populations have since disappeared as forests have matured (Nicholson 1997). A small population was reported from clearcut areas within the Cherokee National Forest during the 1990s; that population has also disappeared in recent years as forests matured (Klaus 1999). Golden-winged Warbler occurred in abandoned farmlands and young pine plantations along the eastern Cumberland escarpment until the late 1990s. Most of these habitats have since succeeded and no longer support the species. Today, sizeable populations (>100 breeding pairs) persist only on public lands, including Royal Blue

and Sundquist wildlife management areas in the Cumberland Mountains of Tennessee. Most birds occur on old, narrow surface-mine benches and more modern reclaimed sites (Yahner and Howell 1975, Nicholson 1997, M. Welton, pers. comm.). Blue-winged Warbler is still relatively rare in most areas occupied by Golden-winged Warbler. There is no indication that declines of Golden-winged Warbler are related to competition or genetic swamping from Blue-winged Warbler.

**BBS:** Golden-winged Warbler has been recorded on seven BBS routes in Tennessee, primarily within the Cumberland Plateau and Cumberland Mountains. In the past 10 years (2001–2010), the species has been detected on only three routes. Analyses of long-term BBS data (1966–2010) suggest that Golden-winged Warbler in Tennessee has experienced steep declines of -7.7% per year (95% CI: -11.5, -4.4;  $n = 7$  routes; Figure 1–41; Sauer et al. 2012). However, low abundance along BBS routes confounds confident conclusions regarding trends in Tennessee based on BBS data alone.

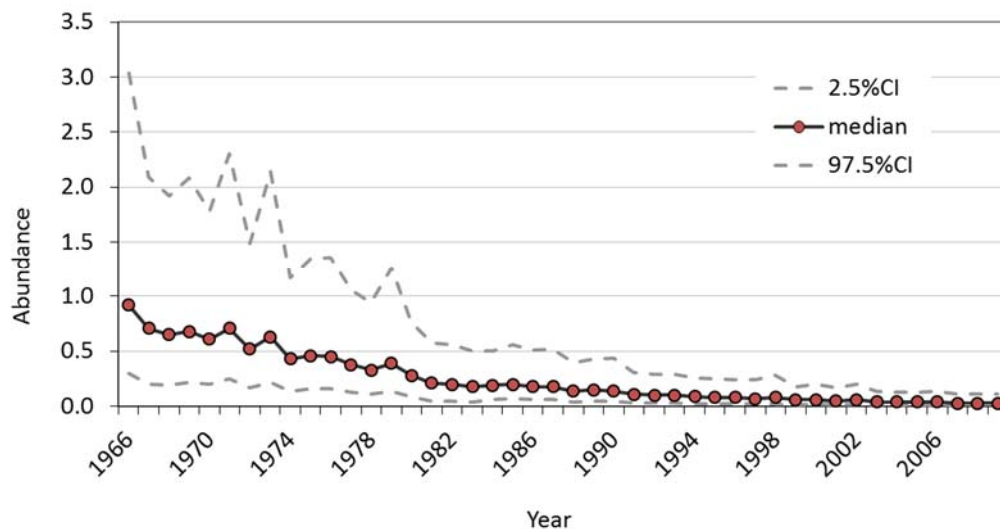


Figure 1–41. Changes in relative abundance of Golden-winged Warbler in Tennessee based on hierarchical Bayesian analyses of BBS data (1966–2009).

By 2100, if trends and variability in trends persist as they have for the last 40 years, Golden-winged Warbler has a 100% (95% credible level: 100%, 100%) risk of a further 90% population loss in Tennessee (Figure 1–42).

**BBA:** A Breeding Bird Atlas project was conducted from 1986 to 1991. Golden-winged Warbler was recorded in 20 priority and 19 supplemental blocks, primarily on the Cumberland Plateau and in the Cumberland Mountains (Nicholson 1997). GOWAP monitoring in 2001–2002 (Barker Swarthout et al. 2009) documented Golden-winged Warbler on 59 sites across two disjunct physiographic areas—the northern Cumberland Plateau and Mountains, especially on coal surface mines, and in the southern Blue Ridge Mountains in northeastern Tennessee (Welton 2003).

**BBC:** Golden-winged Warbler has been recorded on several Breeding Bird Census plots: Great Smoky Mountains National Park, 30 pairs per 100 ha (1947–1948; Kendeigh and Fawver 1981); surface mines in the Cumberland Mountains, 3.9–7.7 pairs per 100 ha (1972–1973; Yahner 1972, 1973); and surface mines in the Cumberland Mountains, 4.3–8.5 pairs per 100 ha (1979–1980; Nicholson 1979, 1980). No census plots in similar surface mine habitat in the Cumberland Mountains have been monitored since 1980.

**Habitat Use:** Habitats used in the Cumberland Mountains include abandoned farms, surface mines with fescue (*Festuca* spp.) and scattered black locust, and rarely young pine plantations in the grass stage (Nicholson 1997). Elsewhere, regenerating clearcut areas have been used when suitable herbaceous cover is present (Klaus 1999).

**Current Research and Monitoring:** North Cumberland Wildlife Management Area in northeastern Tennessee (Scott, Campbell, and Anderson counties) was one of the eight study sites involved in the 2008–2010 collaborative research project of the Golden-winged Warbler Rangewide Conservation Initiative (Appendix D). Research at this site began in 2003 and is ongoing (D. Buehler, University of Tennessee). Bulluck (2007) and Bulluck

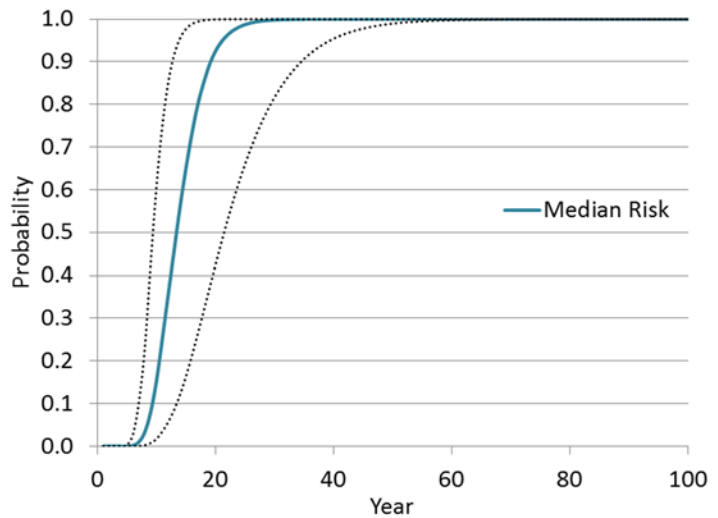


Figure 1–42. Risk of quasi-extinction for Golden-winged Warbler in Tennessee as determined by a 90% decline from the year 2000 population by year 2100. Dashed lines represent the 95% credible interval. See Appendix C for methods.

and Buehler (2008) reported the results of recent research on Golden-winged Warbler in the Cumberland Mountains, including nesting habitat and ecology, territory size, demography, and effects of land use on long-term population trends. Golden-winged Warbler is tracked in the state's Natural Heritage database. In addition, Tennessee is participating in the spatially-balanced monitoring program being coordinated by the Cornell Lab of Ornithology and implemented throughout the Appalachian region.

**Threats:** Limited forest management on public lands since 1990 has reduced the availability of early successional habitat to the extent that the future viability of Golden-winged Warbler is threatened—at least in the Southern Blue Ridge portions of Tennessee. Populations have been virtually extirpated from the southern districts of the Cherokee National Forest (Klaus et al. 2005). Modern surface mining reclamation practices generally do not produce suitable habitat for Golden-winged Warbler, and existing populations on abandoned and reclaimed coal surface mines may be vulnerable to re-mining activities. Interactions with Blue-winged Warbler are not perceived to comprise a threat to Golden-winged Warbler in Tennessee.

## North Carolina

**State Legal Status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** S3

**Summary:** Brewster (1885, 1886) reported Golden-winged Warbler to be abundant in the second-growth forests and open oak woodlands of western North Carolina (elevations between 600 and 1200 m). Pearson et al. (1942) described a 1906 nest with four young located in a pasture near Waynesville (approx. 900 m elevation). Today, Golden-winged Warbler remains a locally common summer resident at middle and high elevations (600–1600 m) across western North Carolina. GOWAP surveys in 2001 located approximately 100 Golden-winged Warbler pairs across western North Carolina (Barker Swarthout et al. 2009). Recent surveys by Audubon North Carolina (Smalling pers. comm.) have detected Golden-winged Warbler in 15 of the 20 western counties in the state concentrated in five key population centers: near the Amphibolite peaks in the northwest; the New River Corridor (especially the north fork); Roan Mountain; the Max Patch mountain area; and the Nantahala National Forest (from Franklin to Robbinsville and the Fontana area). Historical records exist for four

additional counties (mostly at lower elevations). Blue-winged Warbler is still rare in the state, occurring in only four counties in extreme southwestern and northwestern North Carolina (Smalling pers. comm.). Although a few hybrids have been detected within areas occupied predominately by Golden-winged Warbler in western North Carolina, there is no evidence of extensive hybridization. Hybrid territories typically comprise only about 7–12% of occupied territories, depending on the area of the state (Smalling pers. comm.).

**BBS:** Golden-winged Warbler has been recorded on four BBS routes in the last 10 years (2001–2010). Analyses of long-term BBS data (1968–2010) suggest that Golden-winged Warbler has experienced relatively steep declines of -10.1% per year in North Carolina (95% CI: -15.7, -4.3;  $n = 8$  routes; Figure 1–43; Sauer et al. 2012). However, there are insufficient data to confidently draw conclusions regarding trends in North Carolina based on BBS data alone.

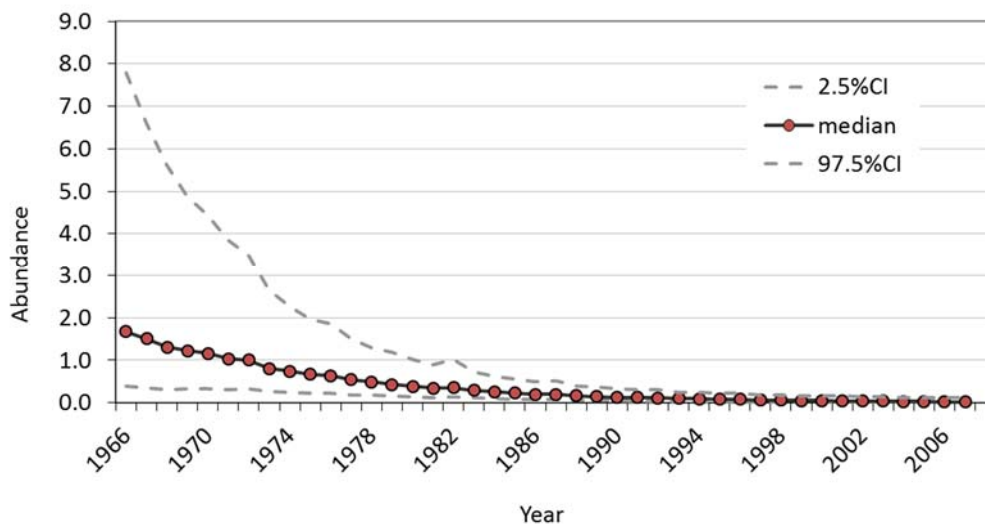


Figure 1–43. Changes in relative abundance of Golden-winged Warbler in North Carolina based on hierarchical Bayesian analyses of BBS data (1966–2009).

**BBA:** A Breeding Bird Atlas was conducted from 1988 to 1993. Golden-winged Warbler was detected in 20 survey blocks across western North Carolina (North Carolina Museum of Natural Science, unpubl. data).

**BBC:** Golden-winged Warbler has not been recorded on North Carolina Breeding Bird Census plots, although few have been conducted in suitable habitat during the past 30 years.

**Habitat Use:** During the breeding season Golden-winged Warbler uses old fields, lightly to moderately grazed agricultural lands, woodland edges, and early successional mixed mesophytic forests (NC Natural Heritage database, C. Smalling, pers. comm.). It has been reported from recently harvested (<15 years old) northern hardwood and oak-hickory forests with logging roads and log landings with grass/forb cover in Nantahala National Forest (Klaus 1999, Klaus and Buehler 2001), from floodplain wetlands and associated early successional uplands in southwestern North Carolina (Rossell 2001, Rossell et al. 2003), and from Christmas tree plantations, either newly planted fields or fields abandoned after harvest. A predictive model for western North Carolina (Brown 2007) reinforced the importance of a contiguous forest landscape despite the species affinity for early successional habitat.

**Current Research and Monitoring:** Watauga County in northwestern North Carolina comprised one of the eight study sites involved in the 2008–2010 collaborative research project of the Golden-winged Warbler Rangeland Conservation Initiative (Appendix D). Research on these Watauga County successional forests at mid- to high elevations (>1000m) is continuing (C. Smalling, Audubon North Carolina). Over 100 locations in the Amphibolite peaks, New River corridor, and Roan Mountain areas of northwestern North Carolina are surveyed annually as part of a long-term monitoring effort. North Carolina is also continuing to refine a habitat suitability model (Brown 2007) to aid in evaluating the efficacy of warbler management techniques and has been a leader in fostering cooperative efforts to sustain Golden-winged Warbler non-breeding populations in Nicaragua. The state is also participating in the spatially-balanced monitoring program being coordinated by the Cornell Lab of Ornithology and implemented throughout the Appalachian region.

**Threats:** Principal threats to Golden-winged Warbler in North Carolina include continued residential development at elevations suitable for the species (600–1200 m), greatly reduced forest management on the Pisgah and Nantahala National Forests, and unmanaged forest regeneration following agricultural abandonment (resulting in a very transient early successional phase).

## Georgia

**State Legal Status:** Endangered

**Natural Heritage Rank (see Table 1–6 for definitions):** S1

**Summary:** Golden-winged Warbler is now a rare summer resident in the mountains of northern Georgia. After five years (1999–2003) of surveying potential habitat on public and private lands within the historic Georgia range, Klaus (2004) found fewer than 20 occupied territories. The species was formerly reported as a fairly common summer resident in northern Georgia (Burleigh 1958). Breeding was first recorded in

Whitfield County in 1859 (Baird et al. 1874). Other historical breeding records include Dade County in 1885 and Towns, Union, Dawson, and Fannin counties during the first half of the 20<sup>th</sup> century (Burleigh 1958). Blue-winged Warbler was first reported nesting in Georgia in the early 1920s and was considered rare at best, occurring mostly in areas not known to historically support Golden-winged Warbler (Burleigh 1958). In

northern Georgia, most areas formerly occupied by Golden-winged Warbler have succeeded to middle-aged or mature hardwoods. With decreased commercial timber harvest and increased fire suppression, no replacement habitat has been created at suitable elevations. Blue-winged Warbler populations have also declined steeply, and the few individuals encountered in recent years have all occurred at lower elevations than Golden-winged Warbler (N. Klaus, Georgia DNR, pers. comm.).

**BBS:** Golden-winged Warbler was recorded on two BBS routes in northeastern Georgia from 1975–1988, but there have been no detections since 1988. BBS data are insufficient to estimate population trends.

**BBA:** A Breeding Bird Atlas project was conducted from 1994 to 2001 (Schneider et al. 2010). Golden-winged Warbler was recorded only at a few previously known sites in extreme northern Georgia. These included overgrown pastures in Union County north of Suches and several Hurricane Opal salvage logging cuts at Ledford Gap, Fannin County. In 2000, several pairs were seen engaged in courtship and territorial behavior in the population north of Suches. During the first week of June 2002, the year after BBA surveys were completed, a male Golden-winged Warbler was seen feeding recently fledged young at the Ledford Gap site. Several hybrids were also seen at this site the same year, including an adult female Lawrence’s Warbler carrying food (Klaus 2004). A third site in northwest Rabun County was occupied only in 2002 after an intense fire destroyed hundreds of hectares of forest.

**BBC:** Golden-winged Warbler has not been recorded on Georgia Breeding Bird Census plots, although few have been conducted in suitable habitat during the past 30 years.

**Habitat Use:** Golden-winged Warbler uses forest clearings and old fields overgrown with scrubby underbrush; it also occupies clearcuts less than 13 years old (Klaus and Buehler 2001).

**Current Research and Monitoring:** A multi-agency research project is monitoring potential breeding habitat in montane areas of northern Georgia. Although Golden-winged Warbler is tracked through the Natural Heritage database, there are currently no records of this species.

**Threats:** Interactions with Blue-winged Warbler do not appear to comprise a threat to Golden-winged Warbler in Georgia. However, limited forest management on public land has resulted in minimal availability of early successional habitat to the extent that the future viability of Golden-winged Warbler in Georgia is threatened. The only significant Golden-winged Warbler population in the state is on Brawley Mountain within the Chattahoochee National Forest (Fannin County). This population, which consisted of about three territorial pairs in 2003, has since grown to 12–15 pairs. Suitable habitat exists here as a result of Hurricane Opal in 1995 and subsequent salvage logging, prescribed burns, and one wildfire. Management authorities are proposing that an additional 160 hectares of early successional habitat be created on Brawley Mountain through timber harvest, prescribed burning, and the use of herbicides. These treatments will be monitored to determine their effectiveness.

## South Carolina

**State Legal Status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** SNA

**Summary:** In the late 1800s, Golden-winged Warbler was reported from Pickens, Greenville, and Oconee counties in the mountains of

northwestern South Carolina (Loomis 1890, 1891; Sprunt and Chamberlain 1949; Post and Gauthreaux 1989). Although large-scale timber

harvesting during this period created abundant habitat, Golden-winged Warbler still was presumed to be restricted to higher elevations (750–1050 m). Today these areas are heavily forested and contain very little suitable habitat with the exception of a few small scattered clearcuts and powerline rights-of-way. There are no nesting records for Golden-winged Warbler from the 20<sup>th</sup> century (J. Cely, pers. comm.). Blue-winged Warbler has not yet been documented as nesting in South Carolina (Dunn and Garrett 1997, J. Cely, pers. comm.) and thus has played no role in the extirpation of Golden-winged Warbler from the state.

**BBS:** No Golden-winged Warblers have been recorded on South Carolina BBS routes.

**BBA:** A Breeding Bird Atlas was conducted from 1988 to 1995, but no Golden-winged Warblers were recorded.

**BBC:** Golden-winged Warbler has not been recorded on South Carolina Breeding Bird Census plots, although none have been conducted in suitable habitat during the past 30 years.

**Habitat Use:** Golden-winged Warbler formerly frequented open, brushy hillsides and pastures where low bushes and vines grew profusely (Sprunt and Chamberlain 1949).

**Current Research and Monitoring:** No research or monitoring specific to Golden-winged Warbler is known to be occurring in South Carolina.

**Threats:** No specific data.

## Canada

### Saskatchewan, Manitoba, Ontario, Quebec

Canada supports an estimated 16.4% of the global population of breeding Golden-winged Warbler in three provinces, with possible expansion into a fourth (Table 1–7). Ontario contains the core breeding population, approximately 15.3% of the global population. The Canadian population of Golden-winged Warbler has appeared to be relatively stationary or increasing (+1.7% per year; 95% CI: -1.6, 5.0;  $n = 36$  routes; Sauer et al. 2012) over the long-term (1967–2010).

A range-wide analysis of genetic introgression between Golden-winged and Blue-winged warblers suggests that Manitoba may be home to the only remaining genetically pure populations of Golden-winged Warbler throughout the breeding range (Vallender et al. 2009). These pure populations appear to exist only in the area around Riding Mountain National Park and the Duck Mountains, with the first cryptic hybrids being discovered in southeastern Manitoba in 2009 (Vallender, unpubl. data).

## Saskatchewan

**Provincial legal status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** SNA

**Summary:** The Natural Heritage Inventory has not mapped Golden-winged Warbler records because currently the species is considered accidental in the province (J. Keith, SA

Conservation Data Center, pers. comm.). There is one confirmed breeding record, and there are reports of probable and possible breeding in the eastern mountains (Smith 1996).

**BBS:** No Golden-winged Warblers have been reported on BBS routes (1966–2010).

**BBA:** There are 11 atlas records for Saskatchewan; several, within a reasonable distance of a breeding population at Riding Mountain National Park, involve breeding behavior. Most of the records, however, are spring and fall migrant observations (Smith 1996).

**BBC:** No known records from censuses.

**Habitat Use:** No specific data.

**Current Research and Monitoring:** As part of a Northwest Golden-winged Warbler Working Group project, monitoring has been conducted in the southeastern portion of the province near the Duck Mountains and Porcupine Hills since 2008. To date, no Golden-winged Warbler genetic samples have been collected; however, the close proximity of Saskatchewan to the genetically pure populations in Riding Mountain National Park and the Duck Mountains in Manitoba suggest that Golden-winged Warblers in the province are likely unaffected by hybridization at this point in time.

**Threats:** No specific data.

## Manitoba

**Provincial legal status:** Unlisted

**Natural Heritage Rank (see Table 1–6 for definitions):** S3B

**Summary:** Golden-winged Warbler was first observed near Winnipeg in 1887. Five additional sightings were reported from 1905–1928, and a small breeding population was discovered east of Winnipeg in 1932. The species was rediscovered in the same general area in 1978 and still occurs there regularly today (Koes 2003). In 2008, over 200 individuals were recorded in this region (Artuso 2008). A second population, centered near Riding Mountain National Park in western Manitoba, was first detected in 1967. Monitoring efforts and Golden-winged Warbler sightings have increased in recent years across the province, with over 395 territorial birds recorded in 2008 and 2009 combined (C. Artuso, Bird Studies Canada, pers. comm.)

**BBS:** Golden-winged Warbler has been recorded on six BBS routes in southeastern Manitoba during the past 10 years (2001–2010; Sauer et al. 2011). This species was not detected on BBS routes prior to 1995. Thus long-term analysis of BBS data (1968–2010) suggests that Golden-winged Warbler has experienced an astronomical increase of +32.6% per year (95% CI: +9.1, +80.6;  $n = 7$  routes; Sauer et al. 2012).

**BBA:** No Breeding Bird Atlas has been completed in Manitoba (BBEA 2008), although one is currently in progress (2010–2014), with preliminary results available on the web (<http://www.birdatlas.mb.ca>).

**BBC:** No data.

**Habitat Use:** The recently discovered and possibly expanding population of Golden-winged Warbler in Manitoba occurs in trembling aspen (*Populus tremuloides*) or mixed deciduous forest stands, especially those with open areas with soft edges created by tree-fall gaps or occasionally with harder edges such as those produced by agriculture. Specific habitat types include upland bur oak (*Quercus macrocarpa*) scrub mixed with trembling aspen; stands dominated by over-mature trembling aspen with standing snags and canopy gaps promoting a dense shrub layer; regenerating deciduous stands or mixed deciduous and conifer stands after fire or logging; alder swales in boreal (mixed) forest or bogs; marshland /trembling aspen ecotones, including beaver-modified ponds and stream edges, marsh edges, and grassland edges; and along rights-of-

way in various habitat including tamarack bogs and the habitats mentioned above (Artuso 2008; S. VanWilgenburg, Environment Canada, pers. comm.; W. Vanderschuit, Parks Canada, Riding Mountain National Park, pers. comm.).

**Current Research and Monitoring:** In 2008, an *ad hoc* multi-agency committee was established to coordinate Golden-winged Warbler monitoring and research in Manitoba and neighboring areas of Saskatchewan and northwestern Ontario. The Canadian *Species at Risk Act* requires the preparation of a Golden-winged Warbler recovery strategy for which the multi-agency committee plans to contribute enhanced distribution and habitat data. By 2010, researchers collected both genetic and stable isotope samples from 355 birds; collection of this information will continue through the next several years (W. Vanderschuit, pers. comm.; Vallender et al. 2009). From 2008–2010, Bird Studies Canada mapped the distribution and broad habitat associations of Golden-winged

Warbler in Manitoba and adjacent Saskatchewan using playback surveys; this survey work is complete and is now transitioning into more intensive nest monitoring. Distribution mapping will continue under the auspices of the atlas project. LP Canada Ltd. also began conducting playback surveys for Golden-winged Warbler in 2008 (C. Artuso, pers. comm.).

**Threats:** Although Manitoba is believed to host the only pure genetic populations of Golden-winged Warbler throughout the breeding range (Vallender et al. 2009), several phenotypic Brewster’s Warblers have been detected in Manitoba in recent years, including one male captured near Riding Mountain National Park (C. Artuso and S. Van Wilgenburg, pers. comm.). In addition, a Blue-winged Warbler was captured at Delta Marsh Bird Observatory in the spring of 2010. These discoveries suggest that introgression of Blue-winged Warbler DNA into the pure Golden-winged Warbler population may be imminent.

## Ontario

**Provincial legal status:** Special Concern

**Natural Heritage Rank (see Table 1–6 for definitions):** S4

**Summary:** Golden-winged Warbler arrived in Ontario in the early 1900s but was only observed in the extreme southwestern portions of the province (McCracken 1994). They expanded to the western counties near Lake Erie by 1909 (Speirs 1985, McCracken 1994) and then northeastward throughout the southwestern peninsula toward Toronto in the 1930s (Peck and James 1983). Golden-winged Warbler was considered fairly common throughout the Bruce Peninsula and northward to Sudbury by the 1970s (Speirs 1985, McCracken 1994). Currently the species occurs in greatest abundance along the southern edge of the Canadian Shield. In some areas of southern Ontario, a substantial decline in Golden-winged Warbler populations correlates with the arrival and expansion of Blue-

winged Warbler in the region (Mills 1987). Except for areas in Norfolk County (e.g., Long Point), Golden-winged Warbler has now all but vanished from extreme southwestern Ontario as a breeding species.

**BBS:** Golden-winged Warbler has been recorded on 30 BBS routes in Ontario in the last 10 years (2001–2010), primarily in the southeast. Analyses of long-term BBS data (1967–2010) suggest a relatively stationary population throughout Ontario (+0.9% per year; 95% CI: -2.5, +4.1;  $n = 49$  routes; Figure 1–44); the present-day median population estimate is, however, roughly twice that of the 1966 population estimate (Sauer et al. 2012).

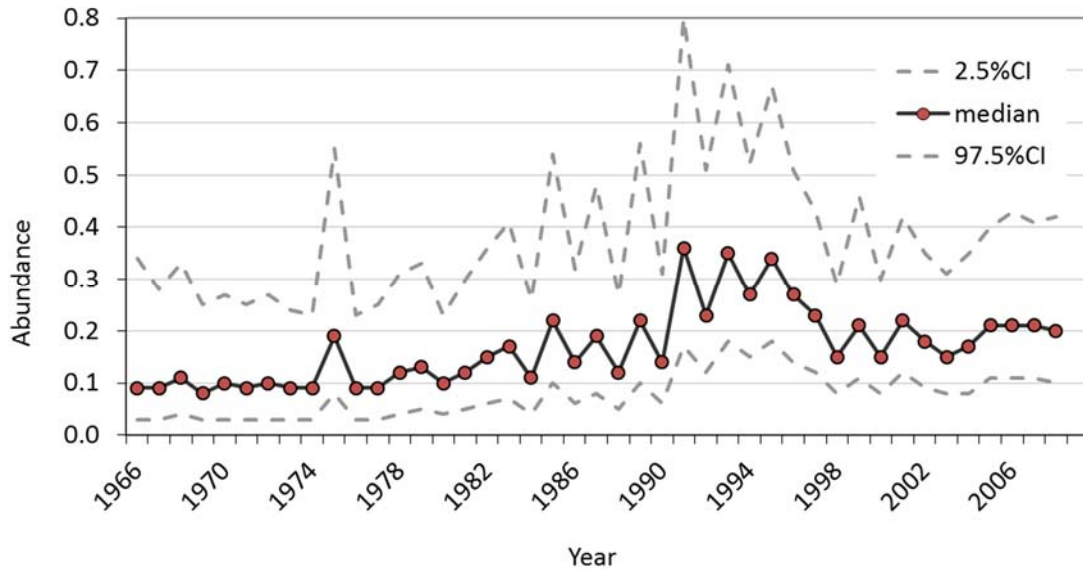


Figure 1–44. Changes in relative abundance of Golden-winged Warbler in Ontario based on hierarchical Bayesian analyses of BBS data (1966–2009).

**BBA:** The first Ontario Breeding Bird Atlas project was conducted from 1981–1985 (Cadman et al. 1987). Golden-winged Warbler was reported from 469 priority squares, and breeding was confirmed in 23% of those squares (BBEA 2008). The second atlas project was conducted from 2001–2005 (Cadman et al. 2007). Golden-winged Warbler showed significant declines of up to 65% in its previous strongholds in the province. For example, the probability of occurrence dropped from 26% to 19% in the Southern Shield. Breeding was confirmed in only 15% of squares that reported the species, and nests were only located in two squares (highlighting the difficulty in finding Golden-winged Warbler nests).

**BBC:** Golden-winged Warbler was reported from old field habitat in 1994 (one pair per 5.8 ha) and 1995 (two pairs per 5.8 ha).

**Habitat Use:** Studies from Queen’s University suggest that Golden-winged Warbler in Ontario prefers scrubby upland vegetation over wetland habitats.

**Current Research and Monitoring:** Research on Golden-winged Warbler has been conducted under the direction of R. J. Robertson at Queen’s

University Kingston since 1997. Individual projects include studies on song variation (Harper et al. 2010), nest-site selection and predation (Demmons 2000), genetic architecture in a newly formed hybrid zone (Vallender et al. 2007a,b; 2009), nestling sex ratios (Neville et al. 2008), parental feeding habitats (Reed et al. 2007), and population monitoring protocols (King et al. 2009). Many of the later projects (Reed et al. 2007; Vallender et al. 2007a,b; Neville et al. 2008; Vallender 2009; Harper 2010) have addressed effects of hybridization as the numbers of Blue-winged Warbler and hybrids increase in the region. Genetic analyses conducted in the mid-2000s indicated that up to 30% of phenotypic Golden-winged Warblers sampled as breeders in southern Ontario were actually cryptic hybrids (Vallender et al. 2007b). Subsequent analysis suggested that an additional population near Barrie, Ontario (N 44° 22' 770", W 79° 42' 130") also had been affected by hybridization, although to a minimal degree, with 7% of phenotypic Golden-winged Warblers showing Blue-winged Warbler-specific DNA (Vallender, unpubl. data). A Canada-wide study which included Ontario birds (Vallender et al. 2012) found no difference in blood parasite infection probability between pure and hybrid Golden-winged Warblers, adding to

the evidence that hybrids in the *Vermivora* system do not face postzygotic selection (cf. pages 1–25-27).

Long Point Bird Observatory’s long-term banding studies showed an increase in the number of Golden-winged Warblers captured over the period 1960–2000 (Bird Studies Canada 2001). However, Blue-winged Warbler captures also

increased during this time period such that the capture ratio of Golden-winged Warbler to Blue-winged Warbler decreased from 2.6:1 (1960–1969) to 0.25:1 (1990–1999).

**Threats:** The primary threat in Ontario is the potential genetic replacement of Golden-winged Warbler by expanding populations of Blue-winged Warbler.

## Quebec

**Provincial legal status:** Likely to be designated Threatened or Vulnerable  
**Natural Heritage Rank (see Table 1–6 for definitions):** S3

**Summary:** Golden-winged Warbler was first detected in Quebec in 1957, and its abundance and range increased until the mid-1980s. The breeding range appears to have contracted since then and is now limited to the southwestern corner of the province. Golden-winged Warbler is considered a rare breeding bird in Quebec (Gauthier and Aubry 1996).

**BBS:** Golden-winged Warbler has been recorded on only a single BBS route in southern Quebec in

the last 10 years (2001–2010 Sauer et al. 2011). Figure 1–45 shows the population trend (-2.1%/year, 95% CI: -11.1, +7.6) derived from hierarchical Bayesian analyses of long-term BBS data (1967–2010; Sauer et al. 2012). Insufficient data due to low abundance along BBS routes, however, preclude confidently drawing conclusions regarding the Quebec trend based on BBS data alone.

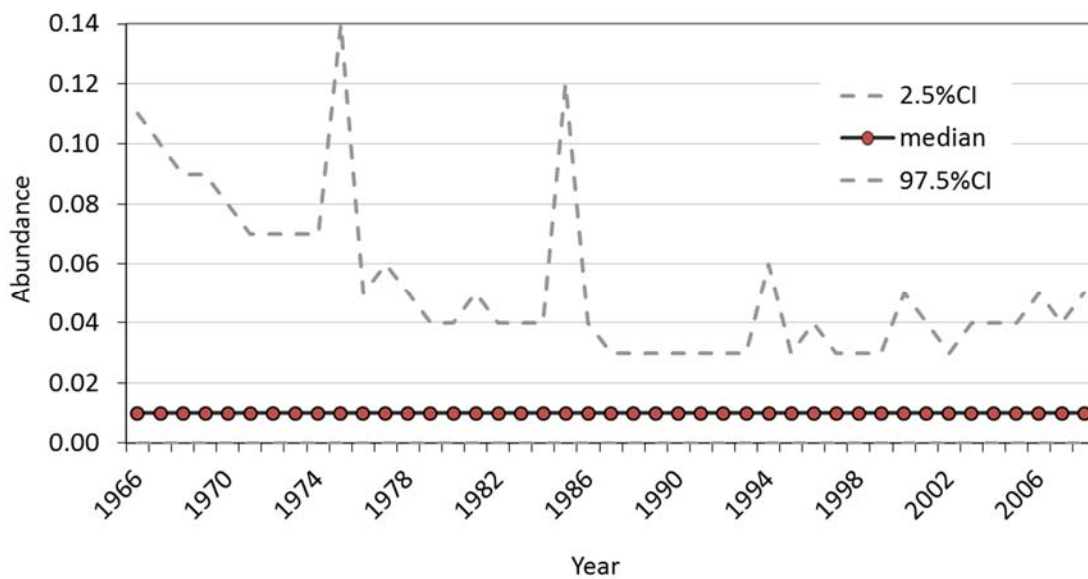


Figure 1–45. Changes in relative abundance of Golden-winged Warbler in Quebec based on hierarchical Bayesian analyses of BBS data (1966–2009).

**BBA:** The Quebec Breeding Bird Atlas project was conducted from 1984 to 1989 (Gauthier and Aubry 1996). Golden-winged Warbler was reported from 31 (1.3%) of 2,464 atlas blocks.

**BBC:** No Quebec census plots have been conducted in suitable habitat.

**Habitat Use:** Golden-winged Warbler inhabits old fields and abandoned pastures, often near a forest edge. Many of these fields occur on poor soils, and thus regrowth is quite slow. Vegetation often consists of deciduous shrubs that are several meters in height along with scattered deciduous trees.

**Current Research and Monitoring:** Since 1994, Canadian Wildlife Service (CWS) Québec region and Regroupement Québec Oiseaux (RQO) have conducted a species-at-risk monitoring program. This effort has recorded 124 potential breeding sites for Golden-winged Warbler, and breeding was confirmed at 12 of those sites. Genetic monitoring of the small Quebec population has been taking place since 2007. The first cryptic hybrid Golden-winged Warblers were detected in 2008 (Vallender et al. 2009) but remain at low levels as of 2010 (Vallender, unpubl. data).

**Threats:** Primary threats include the destruction and ecological succession of suitable habitat.



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