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STATUS AND CONSERVATION PRIORITIES OF GOLDEN-WINGED WARBLER (*VERMIVORA CHRYSOPTERA*) IN NORTH AMERICA

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ON THE BASIS of North American Breeding Bird Survey (BBS) data for 1966–2005, Golden-winged Warbler (*Vermivora chrysoptera*) populations have been declining for ≥ 40 years (annual average decline: -2.5% year⁻¹, $P < 0.01$, $n = 274$ routes; Sauer et al. 2005). Because of these population declines, the species is listed as “threatened” by the Committee on the Status of Endangered Wildlife in Canada, is a “species of management concern” in the United States (U.S. Fish and Wildlife Service), and is on the Partners-in-Flight Continental Watch List (Rich et al. 2004). Golden-winged Warblers are state-listed as “endangered” in Indiana, Ohio, and Massachusetts, “threatened” in Kentucky and Georgia, and “of management concern” in Tennessee, New Jersey, New York, Connecticut, and Wisconsin. Golden-winged Warblers are also listed as “extremely high priority” on the Audubon Society’s Watch List (National Audubon Society 2002). A recent status review was conducted for the U.S. Fish and Wildlife Service for the species that included data on trends, distribution, and threats for the species’ range (D. Buehler et al. unpubl. data). The purpose of the present paper is to summarize the

key results of the status review and to report on the recommendations of the Golden-winged Warbler Working Group to heighten awareness of the conservation needs of this species.

DISTRIBUTION, HABITAT USE, AND BREEDING BIOLOGY

Golden-winged Warbler is a Nearctic–Neotropical migratory species that breeds from Georgia to Massachusetts in the eastern United States, extending westward through the Great Lakes states (Michigan, Wisconsin, and Minnesota) and northward into the Canadian provinces of Quebec, Ontario, Saskatchewan, and Manitoba (D. Buehler et al. unpubl. data). The species’ range has generally been shifting northward over the past 40 years, with recent westward advances into aspen (*Populus* spp.) parklands in Saskatchewan and Manitoba, though the population size in these areas is very small (several hundred birds). Range contraction has occurred along the southern edge of the range in the Midwest (Wisconsin, Illinois, Indiana, and Ohio), in New England, and in lower elevations in the southern Appalachians (D. Buehler et al. unpubl. data).

Golden-winged Warbler nesting habitat has a characteristic gestalt of open patches of shrubs

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of different heights interspersed with young trees or set on a forested edge—either a forest edge feathered by shrubs into a grassy field or a patchy mosaic of grasses, shrubs, and trees (Confer 1992). These habitat conditions can be found in upland or lowland settings, including overgrown fields or pastures; along ungrouted power-line rights-of-way; on recovering coal surface-mine lands; along the edges of or in openings in alder (*Alnus* spp.), tamarack (*Larix decidua*), or willow (*Salix* spp.) swamps; in small islands of deciduous trees; after forest blow-downs or burns; or in clearcuts densely stocked with young trees and shrubs and broken by herbaceous logging roads and landings. Nests are typically built on or near the ground, in a clump of forbs (often *Solidago* spp.), grasses, or sedges, and are constructed out of herbaceous materials (Confer 1992). Habitat availability is a key factor limiting Golden-winged Warbler populations, because many of the habitat attributes required by this species are ephemeral in nature. These disturbance-dependent habitats have, in general, been declining in extent across many parts of the species' range, as old fields succeed to forest, as young forests grow into later seral stages, and as wildfires are prevented and controlled (Askins 2001). Many other disturbance-dependent species are experiencing significant population declines (Hunter et al. 2001), presumably because of habitat limitations.

The species' breeding season is generally short, lasting only about six weeks. Golden-winged Warblers are single-brooded (Confer 1992). Nest initiation occurs within days of their arrival on the breeding grounds; starting dates range from early May in Georgia to early June in Ontario. Nests are usually built within two to three days, and egg laying ensues shortly thereafter, with an average clutch size of five eggs across the range (range: 3–6 eggs). Nest success is variable across the Golden-winged Warbler breeding range. Excellent success was reported in North Carolina (72.5% of nests successful; Mayfield [1975] method), where predation rates were low, Brown-headed Cowbird (*Molothrus ater*) nest parasitism was not reported, and hybridization with Blue-winged Warblers (*V. pinus*) was rare (Klaus and Buehler 2001). Poorer nest success has been reported from New York (e.g., 38%; Confer and Larkin 1998), where predation rates were greater, Brown-headed Cowbird parasitism affected 33% of

nests, and competition and hybridization with Blue-winged Warblers were more common. On the basis of demographic analyses of reproduction and survival (L. Bulluck and D. Buehler unpubl. data), the North Carolina population may be a source, limited by habitat availability, whereas some upland New York and Pennsylvania populations may be sinks, limited by nest predation, parasitism, competition, and hybridization.

HYBRIDIZATION

Significant research has been conducted on the effects of hybridization on Golden-winged Warbler populations (Short 1963; Confer and Knapp 1977, 1981; Gill 1980, 1997; Shapiro et al. 2004; Dabrowski et al. 2005), though significant issues remain unresolved. Gill (1980) reported on the tendency for Blue-winged Warbler populations to replace Golden-winged Warbler populations within 50 years of first contact (Gill 1987, 1997). In West Virginia, replacement of Golden-winged Warblers by Blue-winged Warblers appears to be occurring more rapidly (R. Canterbury unpubl. data). Although this pattern was noted in several areas of sympatry, Confer et al. (1998) documented a population in New York (Sterling Forest) where co-existence has occurred for >100 years.

In the southern Blue Ridge mountains of North Carolina, Georgia, and Tennessee, and in the Cumberland Mountains of Tennessee, associations between Golden-winged and Blue-winged warblers follows a more complex pattern (Welton 2003, Klaus 2004). The two species are generally isolated by elevation, with Golden-winged Warblers generally occurring at >600 m elevation and Blue-winged Warblers occurring at <600 m (Welton 2003). Contact between phenotypically pure Golden-winged and Blue-winged warblers is minimal, though a few hybrids (~5% of the breeding Golden-winged Warbler population) occur in sympatry and mate with Golden-winged Warblers (L. Bulluck and D. Buehler unpubl. data). It is unknown whether these hybrids were produced locally or represent dispersing individuals from other regions.

Cross-matings of phenotypically pure Golden-winged and Blue-winged warblers reduces the productivity of both species, both of which would otherwise mate with conspecifics,

though such pairings are only infrequently observed. Genetic introgression of Blue-winged Warbler genes into Golden-winged Warbler genomes and vice versa is a more insidious process, because it can occur without detectable phenotypic effects. All introgression studies to date have been based on mitochondrial DNA (mtDNA); patterns of nuclear gene flow are unknown. Nuclear DNA is responsible for plumage characteristics. Furthermore, given the lack of Golden-winged Warbler \times Blue-winged Warbler pairs and the preponderance of backcrossing, it is not surprising that there are birds with phenotypes of one species with mtDNA haplotypes of the other. Recent work by Shapiro et al. (2004) and Dabrowski et al. (2005) suggest that, contrary to the findings of Gill (1997), introgression of mtDNA is occurring symmetrically between Golden-winged and Blue-winged warblers. Documenting the extent of introgression across the range and drawing the long-term implications of introgression on population viability of both species remain important research priorities.

POPULATION STATUS

Although populations are declining across most of the Golden-winged Warbler range, significant differences exist in terms of the rates of decline and the apparent underlying causes. In the southeastern region (Georgia, North Carolina, Tennessee, Virginia, and Kentucky), apparent steep population declines (-6.7% year $^{-1}$; $P = 0.13$, $n = 11$ routes; Sauer et al. 2005) are most likely linked to loss of early-successional habitat. Breeding Bird Survey data are insufficient for monitoring populations at the state level, because Golden-winged Warblers occur on too few routes for reliable analysis. Golden-winged Warblers in this region are generally restricted to elevations of >600 m. Availability of early-successional habitat on these sites has declined because of forest maturation in general, reduced timber harvest, and effective wildfire prevention (Klaus and Buehler 2001). Judging from the success of experimental forest management in Chattahoochee National Forest, Georgia, habitat restoration using prescribed fire may lead to reversal of population declines in this region (N. Klaus pers. comm.).

In the northeast (West Virginia, Pennsylvania, New York, New Jersey, and Massachusetts),

population declines have been very steep (-8.6% year $^{-1}$; $P < 0.001$, $n = 127$ routes; Sauer et al. 2005). The greatest declines have occurred in West Virginia (-10.2% year $^{-1}$; $P < 0.001$, $n = 31$; Sauer et al. 2005); recent declines (1996–2005) appear to be even greater (-27% year $^{-1}$; $P < 0.01$, $n = 14$; Sauer et al. 2005). Golden-winged Warblers have been extirpated from large areas of New England that were first occupied after 1900 (Gill 1980, Confer 1992, D. Buehler et al. unpubl. data). Habitat availability has undoubtedly declined for similar reasons, as has been found in the Southeast (Litvaitis 1993). However, in the Northeast, populations appear to be demographically limited as well, because of poor reproductive success, owing in part to Brown-headed Cowbird parasitism, high rates of nest predation, and greater rates of hybridization and competition associated with Blue-winged Warbler presence (Confer et al. 2003). Restoration of habitat without addressing the underlying demographic limitations may not prevent further decline of the species.

In the north-central region, populations have declined slightly over the past 40 years (-1.4% year $^{-1}$; $P = 0.03$, $n = 104$ routes; Sauer et al. 2005). Over the past 15 years, populations have even begun to decline in Minnesota (-4.5% year $^{-1}$; $P < 0.01$, $n = 23$; Sauer et al. 2005), where Golden-winged Warblers have been relatively common in appropriate habitat. Demographic data on Golden-winged Warbler populations is lacking in the north-central region, so it is difficult to assess the underlying cause of the decline. Loss of early-successional habitat to forest maturation, human development, and wetland loss may be contributing factors.

Populations in Ontario have increased with the northward expansion of the Golden-winged Warblers' breeding range. This northward expansion appears to be limited by the distribution of suitable forest types; Golden-winged Warblers appear to be limited to deciduous forests and tamarack swamps and are not expanding into the spruce (*Picea* spp.) and fir (*Abies* spp.) forests associated with the Canadian Shield. Despite the northward expansion into Ontario, populations in this region appear to be declining sharply over the past 15 years (-6.6% year $^{-1}$; $P = 0.08$, $n = 27$; Sauer et al. 2005), which is similar to the trend reported for Minnesota. The Ontario population north of Lake Erie has been extirpated. Farther west, populations in Saskatchewan and

Manitoba may be increasing into the aspen parklands; however, current BBS data are too limited to define population trends because known populations are composed of only several hundred individuals (D. Buehler et al. unpubl. data).

THREATS

Habitat loss has been identified as a significant threat range-wide for this species (D. Buehler et al. unpubl. data). On the breeding grounds, habitat loss is occurring because of old-field and forest succession and because of human development, including loss of wetlands. On the wintering grounds, habitat loss is linked to deforestation in montane oak forests of northern South America and in Central America. In addition, hybridization has been identified as a significant threat to population viability in northeastern populations and potentially in other regions, as the Blue-winged Warbler continues to expand its range and as hybrid individuals become more common in the Appalachians and Canada. Clutch size has also been shown to decline with proximity to Blue-winged Warblers, possibly reflecting a competitive interaction (J. Confer unpubl. data). Brown-headed Cowbird parasitism is also contributing to population declines in northeastern populations inhabiting agriculture-dominated landscapes.

Northward range expansion may be linked to global warming, but the relationship with population declines is unclear. Southern Appalachian populations appear to be retreating to higher elevations but have yet to reach elevational or physiological limits. Range expansion northward in Ontario has reached the Canadian Shield, an area dominated by coniferous forests as opposed to the northern hardwood forests occupied in southern Ontario. Further expansion northward is unlikely, even with additional warming, because Golden-winged Warblers generally do not use these coniferous forests.

GOLDEN-WINGED WARBLER WORKING GROUP

The Golden-winged Warbler Working Group was formed out of a meeting held in conjunction with the annual American Ornithologists' Union (AOU) conference in Champagne-Urbana, Illinois, in 2003. On the basis of this initial meeting, a symposium on Golden-winged Warblers was held at

the 2004 AOU annual meeting in Quebec City, Quebec, and a conservation workshop was held in 2005 in Siren, Wisconsin. Workshop objectives were to (1) increase awareness of the Golden-winged Warbler's conservation status throughout its range; (2) identify gaps in knowledge and develop priorities for coordinated Golden-winged Warbler research and management; (3) develop and implement a conservation plan for Golden-winged Warblers that includes research, education, management, regional coordination, and monitoring; and (4) develop a mechanism for information sharing and conservation-action follow-through. The workshop attendees split up into committees assigned to identify specific priorities for action within three main topics: (1) breeding-grounds research and monitoring, (2) breeding-grounds management, and (3) wintering-grounds research, monitoring, and management. Professional facilitators assisted these committee meetings and promoted effective and timely consensus. A steering committee was formed, and technical committee chairs were appointed in each of the three committees. More information on working-group objectives and activities can be found on the working-group's website (see Acknowledgments).

BREEDING GROUNDS RESEARCH AND MONITORING COMMITTEE

The committee's goal is to facilitate the direction of breeding-grounds research and monitoring on Golden-winged Warblers to ensure that critical conservation questions are answered in a timely manner for conservation purposes. The committee is working to establish research and monitoring priorities to focus funding either on areas most needed for conservation purposes or on areas where current data are lacking, or both. A secondary role of this committee is the dissemination of relevant information from research and monitoring projects. On the basis of workshop deliberations, priority research and monitoring projects were identified as follows (in no particular order):

1. Define and manage habitat quality for Golden-winged Warblers: Identify the characteristics of Golden-winged Warbler habitat that lead to sustainable populations and develop strategies for managing that habitat, including developing management strategies that favor Golden-winged

Warblers over Blue-winged Warblers where they are sympatric.

2. Develop a genetic atlas and isotope atlas for Golden-winged Warblers: Document where genetically pure populations of Golden-winged Warbler exist and document levels of introgression elsewhere.
3. Develop a standardized habitat classification for Golden-winged Warblers; develop a classification protocol for consistent description of Golden-winged Warbler habitat.
4. Expand the Golden-winged Warbler Atlas for monitoring populations and habitats: Redirect the Golden-winged Warbler Atlas project to meet population-monitoring objectives and track habitat change on the basis of the habitat classification above.
5. Continue monitoring in regions where demographic data have consistently been collected (e.g., Ontario, New York, West Virginia, and Tennessee) while initiating new projects where these data are lacking and where the habitat use is quite different (e.g., Minnesota and Wisconsin).

BREEDING GROUNDS MANAGEMENT COMMITTEE

The committee's goal is to help direct conservation actions intended to sustain Golden-winged Warbler populations across the breeding range, in concert with other bird-conservation priorities and initiatives. Because of the unique management needs in each of the regions occupied by Golden-winged Warblers, management priorities are listed first for the continent as a whole and then for each region. Some of the priorities are not mutually exclusive. The following actions, listed in order of priority, were identified by the committee.

Continental

1. Protect and maintain shrub wetlands (e.g., beaver wetlands, riparian zones).
2. Promote general public, resource manager, not-for-profits, and landowner education on Golden-winged Warbler needs. Develop and distribute a guide to Best Management Practices for Golden-winged Warblers.
3. Promote rotational management of adjacent sites—stands (prescribed burns, timber harvest, etc.) to maintain early-successional

component in an area or landscape (target areas of relatively high densities).

4. Incorporate Golden-winged Warbler conservation needs into Natural Resources Conservation Service (NRCS) Farm Bill and other landowner incentive programs.
5. Promote habitat management in areas of core populations (redistribute spatial focus; emphasize bird species associated with mature forests in low population areas).

North-central Region

1. Emphasize lowland shrub protection and management.
2. Develop and promote timber harvest and burning prescriptions that promote high-quality breeding habitat.
3. Continue to use conservation easements and NRCS for protection and restoration of scrub-shrub habitat overall.
4. Develop better rights-of-way management.

Northeastern United States

Developing a conservation strategy in the Northeast is problematic without additional information on what habitat conditions promote successful co-existence of Golden-winged and Blue-winged warblers or promote successful competition and dominance by Golden-winged over Blue-winged warblers. The following actions are generic in nature until a better fundamental understanding of habitat characteristics for sustainable populations are known.

1. Develop conservation easements, or promote land acquisition where populations exist to protect habitat from human development (NRCS, forest stewardship).
2. Develop better rights-of-way management strategies that promote sustainable Golden-winged Warbler populations.
3. Focus on habitat management in areas not adjacent to agriculture to avoid Brown-headed Cowbird parasitism.

Southern Appalachians

1. Promote effective and appropriate forest and shrubland management (e.g., clearcutting, burning, shelterwood).
2. Develop conservation easements, or promote land acquisition where populations

exist to protect habitat from human development (NRCS, forest stewardship).

3. Improve management of grassy, shrubby habitat (including balds) >600 m.
4. Restore and manage open oak woodland-savannah habitats through the use of prescribed fire.
5. Develop and incorporate better mine reclamation and re-mining guidelines through work with industry.

WINTERING GROUNDS COMMITTEE

The committee's goal is to direct and facilitate research, monitoring, and management activities for Golden-winged Warblers on the wintering grounds. Priority actions identified by this committee include:

1. Develop a plan for the conservation of Golden-winged Warblers during the non-breeding season.
2. Determine the locations of important Golden-winged Warbler areas in each country in Central America and South America, including mapping important bird areas and improving analysis of the distribution of the species on the wintering grounds.
3. Integrate Golden-winged Warbler conservation with the conservation of resident tropical birds and other species currently being monitored.
4. Immediately raise funds to engage an international coordinator to continue the momentum of the workshop and its international component.

CONCLUSIONS

Golden-winged Warbler populations appear to be declining significantly across most of its range. Golden-winged Warblers have already been extirpated from areas of New England and the Ohio River Valley. Given the rates of decline, isolation of eastern populations from north-central populations is expected in the next few decades, with additional extirpation expected in the East. The formation of the Golden-winged Warbler Working Group is intended to focus conservation attention, promote sustainable populations, and ensure the conservation of the species, in spite of significant threats of habitat loss on the breeding grounds and wintering grounds, and hybridization. The 2005 meeting in

Wisconsin provided the perfect opportunity for communicating about regional needs and differences, prioritizing future actions, and establishing partnerships for future collaboration that will make these actions coordinated and more likely to become reality.

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