Conservation Assessment
for
Black-throated Blue Warbler (Dendroica caerulescens)

Male Black Throated Blue Warbler

Female Black Throated Blue Warbler

USDA Forest Service, Eastern Region

January 31, 2003

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This document is undergoing peer review, comments welcome

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EXECUTIVE SUMMARY

This is a draft conservation assessment designed to provide a synopsis of the life history, ecology, and management and conservation concerns of the Black-throated Blue Warbler (*Dendroica caerulescens*). The focus of this conservation assessment is on information specifically relevant to Region 9 of the United States Department of Agriculture Forest Service.

The Black-throated Blue Warbler is a Neotropical migratory songbird that breeds in the northern hardwood forests of North America. The male has a showy coloration that consists of a distinctive dark blue back with black on the sides of the head, throat, and sides of the breast. The underside of the male is a snowy white. The female Black-throated Blue Warbler has a drastically different appearance with an overall olive green color and white supercillium. The Black-throated Blue Warbler migrates annually from its tropical winter habitat in the Greater Antilles and Central America to its breeding grounds in the northern U.S. and southern Canada and returns to its winter habitat in the fall. In general, the species is most abundant in New England and its densities decrease toward the western periphery of its range.

D. caerulescens is a habitat specific bird with a distinct affinity for large contiguous northern hardwood forests of maple, beech, and birch with scattered softwoods. An additional habitat requirement is the presence of a dense understory, a need likely resulting from its habit of nesting in dense shrubs about 1 m from the forest floor. The species has likely evolved this habitat specificity in response to the natural disturbance regime of the northern hardwood forests. In northern hardwood forests catastrophic disturbances such as fire and large windstorms are rare and stands adopt an uneven aged structure due to small gap openings that result from the toppling of single or small groups of trees. These small gap openings often lead to a proliferation of the shrub layer. Prior to European colonization of North America up to 85% of northern hardwood forests were in a mature or old-growth stage. Despite its dependence on a dense shrub layer, Black-throated Blue Warblers are rarely found in early successional habitat, seemingly requiring the presence of overstory trees. Uneven aged timber harvest methods such as selection or group cuts can effectively mimic the natural disturbance regime and seem to be compatible with Black-throated Blue Warbler conservation. The conversion of northern hardwood forests to other cover types would likely be detrimental to *D. caerulescens*.

ACKNOWLEDGEMENTS

Thanks are extended to Ed Lindquist, Forest Wildlife Biologist, Superior National Forest, for the opportunity to prepare this document. We also thank Jeff Hines, Minnesota Department of Natural Resources for recent funding to conduct field work on the Black-throated Blue Warbler in northeastern Minnesota. This conservation assessment was also improved by the review and comments of JoAnn Hanowski and Jim Lind.

NOMENCLATURE AND TAXONOMY

Class: Aves

Order: Passeriformes

Family: Emberizidae

Genus: Dendroica

Binomial Name: *Dendroica caerulescens*

Subspecies: 2 recognized
D. c. caerulescens: breeds from Pennsylvania north to southern Canada (Nova Scotia west to Ontario)
D. c. cairnsi: breeds from West Virginia south to Georgia

Common Name: Black-throated Blue Warbler

Synonyms: None

American Ornithologist's Union Code: BTBW

DESCRIPTION OF SPECIES

Although both sexes weigh about 10 g and share a relatively stocky, short-necked appearance, the male and female of this species bear little resemblance to each other. In fact, in the early- and mid-19th century the male and female Black-throated Blue Warbler were believed to be separate species with the female mistakenly classified as the Pine Swamp Warbler (Audubon 1841). The species does not molt into a vastly different fall plumage so year-round identification is simplified. The male is a distinctive dark rich blue above with black on the throat, sides of the head, and sides of the breast. Some feathers on the dark blue back show central black spotting. The underside of the male is snowy white (including axillars and underwing coverts) with an occasional slight buff or yellow on the flanks. Remiges and rectices are black with subterminal white spots on the outer rectices. The primary and secondary coverts are black. There is a distinctive white spot at the base of the primaries that extends 9-14 mm beyond the greater primary coverts (Holmes 1994). Younger males can be distinguished from after second year males by the dull primary coverts, olive green margins on most feathers but particularly the alula coverts, ashy gray edgings to the various black regions, brown tint to primaries and secondaries, and bluish-gray or bluish-olive edging to remiges (particularly secondaries and tertials) in younger males (Holmes 1994, Graves 1997a).

The female Black-throated Blue Warbler lacks the distinctive blue, black, and white coloration of the male. The female is olive green above with a buffy to yellowish underside that becomes increasingly olive on the sides and flank. The tail is darker and

slightly grayer than the back. A distinctive whitish yellow supercillium occurs over the eye. This streak continues into slight dark shading on the auriculars. The lower half of the eye ring is white. Similar to the male, the female has a white spot at the base of the primaries however it extends only 4-8 mm beyond the greater primary coverts (Holmes 1994). Wing linings show a white tint. As females age the loss of feather edges makes the dorsal surface take on a more olive and less green hue, and the ventral surface becomes increasingly white and less yellow.

The southern subspecies *D. c. cairnsi* tends to be darker on the dorsal side of both males and females (Holmes 1994). The dorsal blue on the back and crown of the male are often marked with black patches. The female *D. c. cairnsi* is also a darker olive above and on the flanks and has less yellow underside. Juveniles of both sexes and subspecies are olive brown above with dark brown or black retrices and remiges. The retrices and remiges of juvenile females tend to be more brown with green edgings than the black with blue edgings these areas display on juvenile males. On all juveniles the ventral surface is a lighter olive than the dorsal region (Holmes 1994).

The vocalizations of this species are not as extensively studied as those of other warblers. Holmes (1994) provides an excellent summary of the vocalizations of *D. caerulescens*.

Despite scattered documentations of female singing, almost all singing is performed by males. Singing occurs almost exclusively during the breeding season from early May through early August. At least three distinct songs have been recognized in this warbler. The first is the most commonly heard song, typically referred to as a buzzy *zee-zee-zee-zreeeee*. The final note in this song is most often slurred upwards (Holmes 1994). Bent (1953) notes from 41 recorded samples that 54% end in an upward slur, 34% are unslurred, and 12% are slurred downward. This standard Black-throated Blue Warbler song is typically sung 5-6 times per minute. In Massachusetts, the average interval between renditions of the most common song was 17.4 seconds (Nice 1930). The second song is also fairly common and contains two notes, often referred to as *zree-zhrurrrr*. The second note most often slurs upwards (Holmes 1994). Nice considers this two-note song to be the most rare Black-throated Blue Warbler song (Nice 1930). The third song is similar to the standard song but each of 3-5 notes is delivered more slowly and slur upwards. This song is typically rendered as *zhrurrrr... zhrurrrr... zhrurrrr*. Holmes (1994) states that songs 2 and 3 are commonly given between two counter-singing males and may have some unknown role in communication between rival males. Males also utter a fast staccato of trilled notes during aggressive encounters between other males (Holmes 1994).

The only call documented in the Black-throated Blue Warbler is a flat sounding note rendered as *ctuk*. Although emitted by both sexes, it is most commonly given by the female, particularly during the breeding season. Females are also known to emit a fast, high-pitched twitter when attempting to distract a potential predator near the nest (Holmes 1994).

LIFE HISTORY

Migration

A Neotropical migratory bird, the Black-throated Blue Warbler migrates annually from its tropical winter habitat in the Greater Antilles and Central America to its breeding grounds in the northern U.S. and southern Canada. On average, this bird leaves its winter grounds in April and arrives on the breeding grounds in late-April to early-May, departing again in late-August to early-September and arriving back in winter areas in mid-October (Holmes 1994). Near the western boundaries of its range, *D. caerulescens* typically passes through the southern lower peninsula of Michigan in mid-May but occasionally in late-April as it returns to breeding areas. It again passes through southern Michigan in mid-September to early-October migrating south to wintering locations (Walkinshaw and Dyer 1953).

Sexual Behavior and Courtship

The mating system is generally monogamous but polygamy has been documented (Petit et al. 1988, Holmes et al. 1992). In addition, as in other parulids, fertilizations outside of the pair bond are a common facet of the Black-throated Blue Warbler mating system (Chuang et al. 1999). However, male Black-throated Blue Warblers that pursue extra pair copulations must do so at the expense of guarding their mate. Chuang-Dobbs et al. (2001a) found a negative relationship between the intensity of mate guarding by male Black-throated Blue Warblers and the probability of a brood containing young sired by other males. Interestingly, older males tended to feed nestlings at higher rates if the brood did not contain extra pair young (Chuang-Dobbs et al. 2001b). Because this relationship did not exist in yearling (second year) males, older male Black-throated Blue Warblers may be better able to assess paternity (Chuang-Dobbs et al. 2001b). The development of extra pair fertilizations in this species seems to arise primarily from local synchrony in the breeding status of surrounding females rather than population-level synchrony or high densities of breeding birds (Chuang et al. 1999).

Nest Characteristics

The Black-throated Blue Warbler is a shrub nesting bird. The female is almost exclusively responsible for nest site selection (Holmes 1994). The species primarily nests in northern hardwood forests with a dense understory although nests are also placed in other deciduous and mixed deciduous-coniferous forests with a dense understory. Evergreen shrubs with broad leaves such as mountain laurel (*Kalmia latifolia* L.) and rhododendron (*Rhododendron* spp.) are common nest substrates as are deciduous saplings and shrubs, conifer saplings, and the terminal branches of fallen trees (Nice 1930, Harding 1931, Walkinshaw and Dyer 1953, Holmes 1994). Nests have also been noted in raspberry thickets (Bent 1953) and in such large ground cover vegetation as ferns (Lind 1999). The Black-throated Blue Warbler most often places the nest in the fork of a sapling or shrub at a height of approximately 1-1.5 m (Holmes 1994). However,

nests are also frequently found at heights less than 1 m. In northern Michigan, 3 nests were found between 13-35 cm above the ground (Walkinshaw and Dyer 1953) and the average height of 4 nests in northern Minnesota was 27 cm (Lind 1999). Nests are about 49 mm in diameter with a depth of 42 mm and a bottom thickness of 12 mm (Walkinshaw and Dyer 1953). Nests are built from a variety of locally available materials such as bark, wood, cobwebs, pine needles, moss, small rootlets, and mammal hair (Harding 1931, Bent 1953, Walkinshaw and Dyer 1953, Holmes 1994). Both parents participate in nest sanitation (Nice 1930, Harding 1931). There is no evidence that old nests are reused (Holmes 1994).

Concealment of the nest may play a major role in the choice of nest site. In the White Mountains of New Hampshire, an almost complete canopy of vegetation was typically present immediately above the nest (Holway 1991). Holway (1991) found that Black-throated Blue Warbler nests had: (1) significantly lower visibility, (2) significantly greater shrub density, (3) increased vegetation density below 1.5 m, and (4) more open vegetation immediately surrounding the nest than random locations. Although *D. caerulescens* may select these nest locations in an effort to conceal the nest from predators, other potential factors influencing choice of nest location include proximity to dense shrubs for foraging and the favorable microclimate provided by overhead vegetation (Holway 1991). However, Steele (1993) suggests that any need for a dense shrub layer based on foraging may be of importance only during periods when juveniles must be fed rather than during the breeding season as a whole. Thus, the selection by Black-throated Blue Warblers for a dense understory may be influenced more by nest-site requirements than a need for preferred foraging sites (Steele 1993). Interestingly, Black-throated Blue Warblers seem to respond to shrub density at the plot (15 ha) scale rather than at the scale of an individual territory. This situation may be due to all territories being located on plots with a shrub density above a threshold level that fulfils the life history requirements of Black-throated Blue Warblers (Steele 1992).

Eggs are ovate and have a cream or white color with sparse brown or gray spotting that may become more concentrated in the larger end of the egg (Harding 1931, Bent 1953, Walkinshaw and Dyer 1953). Clutches vary in the amount and coloration of spotting (Harding 1931). Bent (1953) states that the mean size of Black-throated Blue Warbler eggs is 16.9 x 12.8 mm. Most clutches contain four eggs (Harding 1931, Bent 1953). Incubation typically begins the day prior to the last egg laid and lasts for about 13 days (Holmes et al. 1992, Holmes 1994).

Population Biology and Viability

Multiple brooding is relatively common in the Black-throated Blue Warbler with 35% of females having a second brood in New Hampshire (Holmes et al. 1992). Due to the prevalence of multiple brooding, an average *D. caerulescens* pair produces 6.6 eggs per season, with 5.2 of those eggs hatching and 4.3 of the hatchlings becoming fledglings (Holmes et al. 1992). Since each female typically lays four eggs per nest, these figures are tempered by such population limiting factors as predation. The nesting success rate of Black-throated Warblers in New Hampshire is 63% (Holmes et al. 1992), a relatively

high figure compared to other studies of nest success in Neotropical migrants (Hanski et al. 1996).

The Black-throated Blue Warbler reaches higher population densities in areas with a more dense shrub layer (Holmes et al. 1996). Habitats having a dense shrub layer have been shown to lead to increased reproductive outputs in Black-throated Blue Warblers mainly via the double brooding of older ($\geq$ 2 years) parents, which are more common in these high quality habitats (Holmes et al 1996). The incidence of multiple brooding is also positively related to the age of the parents, particularly the male, and is responsible for much of the annual variation in the number of young fledged per female (Holmes et al. 1992). Graves (1997b) found that despotism by older males leads to a prevalence of younger birds at the periphery of its geographic range. The prevalence of yearling birds may decrease the overall fecundity of Black-throated Blue Warblers in the southeastern U.S. and Great Lakes region. The importance of multiple brooding for overall reproductive performance shows that events on the breeding grounds may exert greater control over Black-throated Blue Warbler populations than events during migration or on the wintering grounds (Holmes et al. 1992).

Black-throated Blue Warbler populations may be limited by several non-exclusive factors. The predation of eggs and nestlings is potentially the major factor limiting *D. caerulescens*. Elevated nest predation rates associated with the increasing fragmentation of once contiguous forests may be worsening this problem (Wilcove 1985, Robinson et al. 1995). It is unknown if the fragmentation of forests has the same detrimental impact on Neotropical migratory passerines as fragmentation by such relatively permanent land-use changes as agriculture or urbanization (Bayne and Hobson 1997, Tewksbury et al. 1998). Evidence is mounting that the landscape context of fragmentation may have a profound effect on whether fragmentation increases predation rates (Donovan et al. 1997). Forest fragmentation may be more detrimental to Neotropical migratory passerines when the matrix habitat is agriculture than when the landscape maintains a predominantly forested nature (Bayne and Hobson 1997, Donovan et al. 1997, Tewksbury et al. 1998). Because Black-throated Blue Warblers inhabit extensively forested landscapes more likely subjected to timber harvest than permanent human disturbances, additional landscape-scale research regarding the effects of landscape context and fragmentation is warranted. Other factors potentially limiting populations of *D. caerulescens* include weather patterns (Rodenhouse and Holmes 1992, Sillett et al. 2000), climate change (Sillett et al. 2000) and reduced food supply (Rodenhouse and Holmes 1992). Rodenhouse and Holmes (1992) found that food limitation was capable of reducing Black-throated Blue Warbler breeding productivity to below replacement level by reducing the number of renesting and multiple brood attempts.

Diet

During the breeding season the adult Black-throated Blue Warbler diet consists of arthropods such as larval and adult Lepidoptera, Coleoptera, and Diptera. Based on field observations, the primary prey species are larval (81%) and adult Lepidoptera (14%) (Robinson and Holmes 1982). Nestlings are fed a diet largely (58-87%) comprised of

larval Lepidoptera (Rodenhouse and Holmes 1992, Goodbread and Holmes 1996). However, direct inspection of stomach contents indicated a much greater use of Coleoptera (50%) (Robinson and Holmes 1982). Because field observations and identification of stomach contents are both techniques subject to biases, the relative frequency of individual prey species in the adult Black-throated Blue Warbler diet deserves further study.

D. caerulescens forages mainly from leaves (79%) and bark (8%) in the forest understory (Robinson and Holmes 1982). Males typically forage higher than females (5.9 vs. 3.3 m) (Holmes 1986). Despite the main foraging substrate being leaves in both sexes, males forage to a slightly greater extent on twigs and branches (Holmes 1986). Unlike most *Dendroica* warblers, its preferred foraging method is the hover (prey picked from substrate while in flight) rather than the glean (prey picked from substrate while standing or hopping) (Robinson and Holmes 1982). However, the Black-throated Blue Warbler is similar to other parulids in that it searches rapidly for its prey, moving > 24 times per minute (Robinson and Holmes 1982). It prefers to advance horizontally to new foraging perches with a typical movement distance of about 0.7 m (Robinson and Holmes 1982). In general, foraging rate, movement patterns, search radius, and prey acquisition maneuvers do not differ among different vegetation layers and species (Robinson and Holmes 1984).

HABITAT

Several Region 9 National Forests contain breeding habitat for the Black-throated Blue Warbler. These National Forests include the Green Mountain in Vermont, the White Mountain in New Hampshire, the Finger Lakes in New York, the Allegheny in Pennsylvania, the Monongahela in West Virginia, the Huron-Manistee, Hiawatha, and Ottawa in Michigan, the Chequamegon-Nicolet in Wisconsin, and the Superior and Chippewa in Minnesota.

Breeding Range

Throughout its breeding range the Black-throated Blue Warbler is most commonly found in contiguous tracts of relatively undisturbed northern hardwoods and mixed deciduous-coniferous forests (Holmes 1994). Common overstory species include northern hardwoods such as maples (*Acer*), birches (*Betula*), and beech (*Fagus grandifolia*) with eastern hemlock (*Tsuga canadensis*), spruce (*Picea*), and balsam fir (*Abies balsamea*) present in mixed stands (Holmes 1994). Although most common in northern hardwoods at the western margin of its range in Minnesota, it is also found in mixed deciduous conifer forests and mixed deciduous stands dominated by paper birch (*B. papyrifera*) and quaking aspen (*Populus tremuloides*) (Steffes 1999).

Across its breeding range, the Black-throated Blue Warbler has a well-known affinity for forests with a dense shrub layer (Holmes et al. 1996). Presumably, this preference for a dense understory results from the shrub-nesting and foraging behavior of this species. In a Quebec study of *D. caerulescens* habitat, only four out of 17 habitat variables were

statistically significant and all four were related to the extent of development in the shrub layer (Darveau et al. 1992). The significant variables included sugar maple (stems/plot), first branch height (m), shrubs 0-5 cm dbh, and low deciduous shrubs. The shrub species most commonly used by Black-throated Blue Warblers vary by geographic location. In New England, hobblebush (*Viburnum alnifolium*), sugar maple (*A. saccharum*) saplings, beech, striped maple (*A. pennsylvanicum*), and such conifers as red spruce (*P. rubens*) and balsam fir are common understory species (Steele 1992, Steele 1993, Holmes 1994). Further south in the Appalachian Mountains, mountain laurel, rhododendron, Canada yew (*Taxus canadensis*), small conifer saplings, and other deciduous bushes and saplings are used by the Black-throated Blue Warbler. In the western portions of its range sugar maple saplings, mountain maple (*A. spicatum*), beaked hazel (*Corylus cornuta*), balsam fir and other deciduous saplings are the species most often utilized by *D. caerulescens* (Lind 1999, G. Niemi, unpubl. data).

Because of its affinity for forests with a dense understory, in addition to species composition, the age or seral stage of a stand also affects the distribution of Black-throated Blue Warblers. Small-scale disturbances such as natural canopy gap formation or selective harvest in mature northern hardwood stands may be important to *D. caerulescens*. In New Hampshire and Maine, the Black-throated Blue Warbler was most common in northern hardwood stands with a diameter at breast height (dbh) of $\geq$ 30 cm (DeGraaf and Chadwick 1987). Also in New Hampshire, numbers of *D. caerulescens* based on point counts conducted in the White Mountain National Forest did not differ between managed stands consisting of 65% sawtimber (dbh > 25.4 cm) and reserve stands consisting of 96% sawtimber (Welsh and Healy 1993). Principal components analysis of avian habitat associations in Vermont placed the Black-throated Blue Warbler in the intermediate-canopy dense understory category (Thompson and Capen 1988). These stands were associated with pole-sized hardwoods with canopy closures of about 55-80% and a mean diameter breast height of 8-15 cm. These types of stands were found in both 20 year old clearcuts and areas of recent selective logging (Thompson and Capen 1988). Black-throated Blue Warblers were also more common in selection cuts than uncut stands in New Brunswick (Bourque and Villard 2001). Seemingly, this type of overstory structure facilitates the development of the dense understory vegetation preferred by Black-throated Blue Warblers.

However, it is important to consider the reproductive demographics of a species before concluding that population density accurately reflects habitat quality (Van Horne 1983). For example, it was noted in New Brunswick that Black-throated Blue Warblers reached higher densities in selection cuts but that reproductive parameters did not differ between selectively cut and uncut stands (Bourque and Villard 2001). At a larger scale, the extent of timber harvest in the landscape as a whole (intensive vs. moderate) did not significantly affect reproduction (Bourque and Villard 2001). Assuming adult and juvenile mortality of 40 and 70% respectively, none of the forest types examined in this study produced sustainable numbers of Black-throated Blue Warblers (Bourque and Villard 2001). This research highlights the need to obtain estimates on both adult and juvenile mortality before predicting demographic trends. In general, longer term studies

are needed to better understand the relationships between population densities and reproductive performance.

An extensive literature exists on the effect of forest/habitat fragmentation of Neotropical migrant songbirds such as the Black-throated Blue Warbler (Wilcove 1985, Andrén 1994, Robinson et al. 1995, Hanski et al. 1996, Donovan et al. 1997, Hartley and Hunter 1998, Askins 2000). In the past two decades, several long-term studies from eastern North America have detected declining populations in many songbird species (Robbins et al. 1989b, Askins et al. 1990, Askins 2000). Most songbirds experiencing population declines are both Neotropical migrants and forest specialists requiring relatively large patches of mature forest for breeding (Askins 2000). Increased fragmentation of the temperate forests in which these birds breed is frequently implicated as a causative mechanism for the declines (Robinson et al. 1995). In addition to the direct effect of reducing the amount of available breeding habitat, forest fragmentation may also indirectly affect avian reproduction through the increased populations of nest predators often found in fragmented areas. High rates of nest predation in fragmented breeding zone forests may be a primary factor limiting songbird populations (Wilcove 1985, Robinson et al 1995, Donovan et al. 1997).

Landscape context has recently emerged as an important factor determining the effect of habitat fragmentation on nest predation rates (Robinson et al. 1995, Donovan et al. 1997). Much of the evidence supporting the association between habitat fragmentation and increased nest predation emanates from regions where the landscape is dominated by agriculture or urbanization and forests persist as remnant fragments embedded in an agricultural or urban matrix (Robinson et al. 1995, Donovan et al. 1997). Landscapes dominated by contiguous forest have not consistently shown similar trends of increased predation associated with the relatively temporary disturbances, such as timber harvest, that typically fragment forested landscapes (Robinson et al. 1995, Bayne and Hobson 1997, Donovan et al. 1997). In a forest-dominated landscape, the contrast between patches of mature forest and managed timberland is typically much less than in a landscape dominated by agriculture where cultivated fields are adjacent to forest fragments. This reduced contrast between habitats may increase the functional size of a forest fragment in a dynamic forest landscape and consequently mitigate negative effects of fragmentation (Harris 1984). The effect of fragmentation on avian reproductive rates may be negligible or even positive in extensively forested landscapes since some nest predators inhabiting contiguous forest are habitat specialists and are not attracted to open areas within a forested matrix (Tewksbury et al. 1998). Ultimately, the characteristics of the local nest predator community have a profound influence on whether fragmentation in either an agricultural or a forested landscape is detrimental to songbird fecundity. To design effective continent-scale conservation plans for Neotropical migrants and other passerine species, it is critical to better comprehend the complex relationships that exist between nest predation, habitat fragmentation, and landscape context.

Although the distribution of the species is limited to extensively forested areas, the effects of fragmentation specifically on the Black-throated Blue Warbler are unclear. Providing the landscape matrix remains forested, small-scale fragmentation by forestry

may not be incompatible with Black-throated Blue Warbler conservation. There was no difference in Black-throated Blue Warbler reproductive performance between moderately and intensively harvested landscapes in southeastern Canada (Bourque and Villard 2001). In Vermont, both the number of Black-throated Blue Warbler adults detected on point counts and the brood density of the species were higher in 500 ha closed-canopy control sites than similarly sized study sites with a canopy disturbance of $\leq$ 10% (Buford and Capen 1999). These differences were not statistically significant however. The authors suggest that the relatively minor disturbance level may not be extreme enough to adversely affect breeding bird density in their study or the statistical power of their experiment may be too low to detect any differences that may exist (Buford and Capen 1999). Nonetheless, when viewed collectively, the brood density of area-sensitive, forest-interior birds such as the Black-throated Blue Warbler was significantly less in the disturbed forest plots. This result may reflect the initiation of deleterious demographic effects (Buford and Capen 1999).

Lastly, elevation has also been implicated as affecting the distribution of Black-throated Blue Warblers. However it may be that a relationship with elevation is simply an artifact of northern hardwood stands being most common at higher elevations throughout the northeastern U.S. This association with elevation also occurs in the westernmost portion of the Black-throated Blue Warbler geographic range. In Minnesota, the species is a common breeding bird along the North Shore of Lake Superior. Here the moderating climatic influence of Lake Superior allows northern hardwood stands, rather than the mixed conifer boreal forests more typical of the region, to persist in the highlands immediately above the lake (Flaccus and Ohmann 1964). Also steep terrain is often less likely to be disturbed by humans and thus provides the type of contiguous forest that the species may prefer (Holmes 1994). At this point it is unclear whether this association between Black-throated Blue Warblers and elevation is indirect, occurring as a result of elevation influencing the distribution of its preferred northern hardwoods habitat, or if elevation does directly influence resource selection in the species.

Winter Range

The species also inhabits areas with a dense understory in its tropical wintering grounds. Typical habitat includes dense tropical forests, second-growth forests with a well-developed understory, agricultural plantations (coffee and citrus), and shrubby areas near fence rows and other developed areas (Holmes 1994).

DISTRIBUTION AND ABUNDANCE

The breeding range of the Black-throated Blue Warbler extends as far north as Prince Edward Island and Nova Scotia in the east to far southwestern Ontario at the western boundary of its range. In the northeastern U.S., *D. caerulescens* range continues south through much of New England except for coastal areas, includes most of the steep forested regions of New York and Pennsylvania and follows the spine of the Appalachians as far south as northern Georgia. Westward, the species is found in much of southern Quebec and Ontario with the exception of the portion of southeastern Ontario

immediately north of Lake Erie. The western U.S. range consists of the northern lower peninsula of Michigan, most of the upper peninsula of Michigan, northern Wisconsin, and extreme northeastern Minnesota. The distribution of the Black-throated Blue Warbler based on Breeding Bird Survey (BBS) data is shown in Appendix 1.

The species leaves its breeding grounds during a block of time extending from mid-late August through early-mid October (Holmes 1994). During migration it will rest and feed in shrubby and forested habitat (Holmes 1994). The winter range of *D. caerulescens* consists primarily of the Greater Antilles, from Puerto Rico, Hispaniola, and Cuba to Jamaica although it is an occasional visitor to portions of the Lesser Antilles and coastal areas of east Central American countries on the Yucatan peninsula and immediately south (Holmes 1994).

The species is common throughout the northern hardwood forests of New England. In general, Black-throated Blue Warbler populations are smaller toward the periphery of its range (Holmes 1994, Graves 1997b). Although populations decrease substantially westward through the Great Lakes range of *D. caerulescens*, it can be locally abundant at the western periphery of its range in Minnesota (Lind 1999, Steffes 1999). The population trend based on BBS data across the geographic range is presented in Appendix 2.

Conservation Status

Globally, The Nature Conservancy (TNC) Heritage Status conservation ranking system gives the Black-throated Blue Warbler a "G5" ranking, meaning the species is globally demonstrably widespread, abundant and secure (NatureServe 2002). Nationally, TNC ranks the Black-throated Blue Warbler as "N5B" in both the U.S. and Canada, meaning the species is demonstrably widespread, abundant and secure at the national level in its breeding range (NatureServe 2002). Among Region 9 states containing National Forest lands in the geographic range of the Black-throated Blue Warbler the species is ranked as “S5” (secure) in New York, New Hampshire, and Vermont; “S4” (apparently secure) in Michigan, Pennsylvania, and West Virginia; “S3” (vulnerable) in Wisconsin; and “SU” (unrankable) in Minnesota (NatureServe 2002).

Risk evaluations conducted by the U.S. Forest Service consider the species to be a regional forest sensitive species (RFSS) on the Superior and Chippewa National Forests in Minnesota. It is considered to be present and not at risk at all remaining Region 9 National Forests in the New England/Eastern and Lake States areas.

Both the U.S. Forest Service RFSS and TNC rankings reflect the increasing scarcity of the species in the western portion of its geographic range. Since 1991, the Natural Resources Research Institute of the University of Minnesota has been conducting point counts for breeding birds throughout the Superior and Chippewa National Forests in Minnesota, the Chequamegon National Forest in Wisconsin, and scattered locations in southern Minnesota (Forest Birds of Minnesota 2002). The number of individual Black-throated Blue Warbler detections over 1991-2002 reflects their overall scarcity in this

region with only 111 and 64 detections in the Superior and Chequamegon National Forests respectively. For comparative purposes, a common Neotropical migrant of the region, the Ovenbird, has been detected 6970 times in the Superior and 6020 times in the Chequamegon during this time period. The rarity of the Black-throated Blue Warbler precludes statistically relevant trend evaluation but preliminary habitat analyses indicate it is most common in sugar maple stands (G. Niemi, unpubl. data). A habitat affinity of this bird with sugar maple stands containing a dense understory is known in northern Minnesota (Lind 1999, Steffes 1999). Despite its rarity, the Black-throated Blue Warbler is frequently one of the most common breeding birds in northern hardwood stands along the North Shore of Lake Superior in northern Minnesota (Lind 1999, Steffes 1999). However, in other areas of northern Minnesota the bird is often absent from seemingly suitable habitat (Hanowski 1999).

POTENTIALTHREATS AND MONITORING

Present or Threatened Risks to Habitat or Range

The primary risk to the Black-throated Blue Warbler throughout Region 9 is the loss and fragmentation of forests. The breeding distribution of this species seems to be partially dependent on the presence of extensive forest cover. In Pennsylvania, counties with greater than 75% forest cover had far more Black-throated Blue Warbler breeding records than less forested counties (Reid 1992). Almost no Black-throated Blue Warblers were found to breed in counties with less than 25% forest cover (Reid 1992). Throughout its range in eastern North America the Black-throated Blue Warbler is considered an area-sensitive bird of the forest interior that primarily inhabits forested patches greater than 100 ha in size (Robbins et al. 1989a, Holmes 1994). Even in areas with extensive forest cover, the additional presence of a dense understory is also a key factor affecting the distribution of *D. caerulescens* (Reid 1992). This dependence on dense understory vegetation may preclude straightforward classification of the Black-throated Blue Warbler as an interior specialist. For example, in New Hampshire Black-throated Blue Warbler territories were skewed toward clearcut borders and the species was significantly more abundant in edge habitat than in forest interiors (King et al. 1997). In Vermont Black-throated Blue Warblers were most abundant at a distance of 50 m from 0.4 ha patch cuts (Germaine et al. 1997). Although forest fragmentation involving relatively permanent anthropogenic disturbances such as agriculture or urban development is clearly detrimental to the species, more research is needed to determine how this bird is affected by the relatively temporary fragmentation and disturbances that accompany timber harvest. Despite some questions involving smaller-scale habitat relationships, the distribution is limited to predominantly forested landscapes and regions.

There are several examples where selection cuts have a positive affect on *D. caerulescens* density (Walkinshaw and Dyer 1953, Webb et al. 1977, Germaine et al. 1997, Bourque and Villard 2001). Selection cuts in northern hardwood stands in New Brunswick contained higher densities of Black-throated Blue Warblers than reference stands but there was no statistically significant difference in reproductive success between the two study areas (Bourque and Villard 2001). Similarly at the western fringe of its range,

although Black-throated Blue Warblers were not detected during the study, there were few differences in the bird communities inhabiting managed, unmanaged, and reference northern hardwood stands in Minnesota (Hanowski 1999). Because they can be designed to mimic the small-scale gaps that form naturally, selection cuts may be the ideal management strategy in northern hardwood forests where the conservation of Black-throated Blue Warblers is a concern. Harvest methods that minimize soil compaction and destruction of understory vegetation are preferable in northern hardwood stands managed for passerine birds (Hanowski 1999).

In general, uneven age management techniques are preferable to even age forest management in northern hardwoods because they more effectively mimic natural disturbance processes. Several authors have proposed adopting forest management practices that mirror the prevailing natural disturbance regime of the region (Hunter 1990, Hunter 1993, Bergeron and Harvey 1997, Bergeron et al. 1999). Management based on natural disturbance regimes is a fundamental fit with modern ecosystem-based management.

Northern hardwood forests throughout Black-throated Blue Warbler range have natural disturbance regimes whose rotation period exceeds 1000 years (Bormann and Likens 1979, Lorimer 1989, Whitney 1990, Frelich and Lorimer 1991). This long rotation period contrasts dramatically to the short rotation disturbance regimes of 50-200 years common in the coniferous boreal forests found immediately to the north of northern hardwoods (Heinselman 1973, Pastor and Mladenoff 1992). The difference in natural rotation periods between these two adjacent forest types is due to the relative frequency and impact of catastrophic stand replacing disturbances. The major natural catastrophic disturbances affecting these forests are fire and wind, both of which occur less often in northern hardwoods. Despite increases associated with European settlement of North America, large fires are essentially rare and have little impact on the structure of northern hardwood forests (Bormann and Likens 1979, Frelich and Lorimer 1991). Large-scale windstorms such as tornadoes, hurricanes, and extratropical cyclones that affect large tracts of land are also relatively uncommon and do not have a dominant impact on the structure of northern hardwood forests (Bormann and Likens 1979, Frelich and Lorimer 1991). It is the more numerous and frequent small-scale windstorms that topple either individual trees or small forest patches that are responsible the uneven aged structure typical of northern hardwood forests (Bormann and Likens 1979, Frelich and Lorimer 1991). The Black-throated Blue Warbler is seemingly evolutionarily adapted to the natural processes of small gap formation in northern hardwood forests.

Given the prevalence of small gap stand dynamics over larger-scale disturbances in the structure of northern hardwoods, it is easy to see how uneven aged management techniques such as selection cuts are preferred over even aged methods such as clearcutting in this forest type. Because sugar maple grows vigorously around forest openings created by selection cutting (Tyson et al. 1992), selection cuts may be a feasible management technique to balance the economic needs of the forest products industry with the conservation needs of the Black-throated Blue Warbler. However, despite the apparent compatibility of the Black-throated Blue Warbler with moderate levels of

selection cutting, other Neotropical migrant birds may be negatively affected by even this relatively low impact silvicultural method. Bourque and Villard (2001) found that another Neotropical migrant passerine, the Ovenbird (*Seiurus aurocapillus*), had both lower densities and reduced reproductive performance in selection cuts than in reference stands.

Commercial, Recreational, Scientific, or Educational Overutilization

Scientific researchers have to be aware than nest monitoring efforts may facilitate nest detection by predators. The different search strategies employed by avian and mammalian predators require researchers to be particularly vigilant in minimizing their presence and sign around active nests. Avian predators such as corvids are known to be adept at locating food sources associated with conspicuous flagging or other monitoring materials in studies of nest success in central Pennsylvania (Yahner and Wright 1985). Mammals are considered the main predators on Black-throated Blue Warblers (Rodenhouse and Holmes 1992) and, as animals that hunt primarily by olfaction, may be able to follow human scent trails to passerine nests. Whelan et al. (1994) discusses the potential effect of olfactory cues on nest predation rates. However it is unlikely that researchers are having a large impact on Black-throated Blue Warbler populations.

Disease and Predation

Little information is available on the role of disease and parasites in regulating *D. caerulescens* populations. Holmes (1994) discusses two incidences of parasitism in nestlings by botfly and hematophagous fly larvae. No information on parasitism of adults found. Although no specific information was found regarding disease in Black-throated Blue Warblers, additional research regarding the effects of the emergent West Nile virus on all avian species in North America is greatly needed.

Predation on eggs and nestlings has been shown to be a major influence on population regulation in many species of Neotropical migratory passerines (Wilcove 1985, Robinson et al. 1995). However, in New England nest success in Black-throated Blue Warblers has been shown to be relatively high at 63% (Holmes et al. 1992). The most common nest predators in forested areas within the geographic range of the Black-throated Blue Warbler are typically mammals (Reitsma et al. 1990, DeGraaf 1995, Fenske-Crawford and Niemi 1997, Sloan et al 1998). Common mammalian nest predators include red and gray squirrel, Eastern chipmunk, fisher, raccoons, and various rodent species (Fenske-Crawford and Niemi 1997, Sloan et al 1998). Habitat fragmentation may be increasing predation rates by facilitating increases in predator populations (Robinson et al. 1995) but this phenomenon may be at least partially dependent on landscape context (Donovan et al. 1997). Additional research into landscape-scale issues affecting the predation or parasitism of passerine nests is needed.

Inadequacy of Existing Regulatory Mechanisms

Large tracts of contiguous forest would benefit many Neotropical migrant birds of conservation concern. Within extensive northern hardwood forest continued management of northern hardwood forests with such uneven age techniques as selection cuts and group cuts. These smaller-scale forestry operations will more effectively mimic the natural dynamics of this forest type (Lorimer 1989). Because up to 85% of presettlement northern hardwoods forest was in a mature or old-growth stage (Frelich and Lorimer 1991), both preserving existing old-growth stands and planning for expanded old-growth stands in the future would also more effectively replicate natural forest conditions. The conversion of northern hardwoods to other cover types may have a negative effect on Black-throated Blue Warbler.

The development of remote sensing technology and Geographic Information Systems (GIS) has revolutionized forest management in recent years. One potential shortcoming of this technology is the general inability of remote sensing and GIS to account for understory structure. This can limit the utility of GIS technology for species such as the Black-throated Blue Warbler whose habitat requirements are intrinsically linked to the structure of the forest understory. The traditional way around this limitation is by field study and time-consuming stand-level vegetation measurements. Recent advances in remote sensing technology like Light Detection and Ranging (LIDAR) methods may be able to provide managers important information about sub-canopy structure without the high logistical and financial costs associated with traditional site specific stand-level vegetation measurements.

Other Natural or Human Factors Affecting Continued Existence of Species

Global climate change may have a negative effect on Black-throated Blue Warbler populations. In Ontario, the distributions of several warbler species, including the Black-throated Blue Warbler, were found to be strongly associated with many climactic variables (Vernier et al. 1999). It is uncertain whether these associations are primarily due to direct effects, such as a physiological response, or indirect effects, such as climate affecting the distribution of preferred vegetation (Vernier et al. 1999). Regardless of the particular climactic pathway that affects the distribution of these migratory birds, the ultimate response by the species is real. Global climate change may have considerable effect on many avian species including Black-throated Blue Warblers. Adult survival and fecundity of Black-throated Blue Warblers were lower in years when the El Nino Southern Oscillation (ENSO) was impacting climate patterns (Sillett et al. 2000). If, as predicted, the severity of ENSO events increases with global warming there may be profound future impacts on Black-throated Blue Warbler populations (Sillett et al. 2000).

The development of forested areas for the construction of vacation and second homes may have a negative impact on Black-throated Blue Warblers. Impacts associated with land use changes of this type could occur via increased forest fragmentation, removal of land from active management, and reducing the ability to coordinate the actions of management entities at a landscape scale.

Deaths resulting from collisions with communication towers and other large structures during migration are a concern for most species of migratory birds. No species-specific information is available on the impact of tower kills on Black-throated Blue Warblers. In general, the construction of large towers or other structures may have a negative effect on the migratory pathways of passerine birds.

SUMMARY OF LAND OWNERSHIP & EXISTING HABITAT PROTECTION

The Black-throated Blue Warbler's affinity with high elevation hardwood forests means that its U.S. distribution coincides with a considerable amount of public land. Because northern hardwood forests are common at higher elevations, a fair amount of this habitat is intact due, in part, to the difficulty in logging steep terrain. The highgrading of more commercially viable softwoods has also historically spared some hardwoods (Bormann and Likens 1979). Because of these access difficulties or the liquidation of cut-over lands much of the northern hardwood forest is in public ownership. Much of the remaining northern hardwood habitat is in various Region 9 National Forests. Potential areas that may help maintain or increase late-successional northern hardwood stands include Research Natural Areas (RNA), State Natural Areas (SNA), Shipstead-Newton-Nolan lands, riparian setbacks, scenic rivers, and wilderness areas. Multiple agency and public-private coordination may be necessary to maintain such large tracts of contiguous forest at a landscape-scale.

SUMMARY OF EXISTING MANAGEMENT ACTIVITIES

Although the Black-throated Blue Warbler is certainly less common in the western half of Region 9, additional species-specific research would help clarify questions involving its distribution, abundance, and fecundity. At the western margin of its range it may more commonly be found in habitats other than northern hardwoods. More targeted monitoring and science-based research are needed for both *D. caerulescens* and all forest birds in the Great Lakes portion of Region 9. A more thorough understanding of the distribution and abundance of the Black-throated Blue Warbler would permit managers to better design management programs to meet the needs of this species.

PAST AND CURRENT CONSERVATION ACTIVITIES

The adoption of an ecosystem-centered forest management perspective within Region 9 would likely help conserve rare birds such as the Black-throated Blue Warbler. Through ecosystem management, forests can be managed not as isolated stands but as large-scale management units that can be used to facilitate the continued persistence of endemic species by preserving a wide range of habitats. This large-scale approach to forest management can help managers use human disturbances such as timber harvest to mimic natural disturbances, an approach that has been suggested as particularly important for passerine birds (Hobson and Schieck 1999). Ideally, by ensuring that silvicultural practices occur at sustainable levels within an ecosystem management perspective,

populations of endemic species will be conserved at biologically viable densities while simultaneously minimizing economic impacts to the forest products industry. Undoubtedly fully embracing ecosystem-based management will require the types of collaborations between management agencies and the public that do not currently exist and will be challenging to enact. Care should be taken, however, to consider the entire community of plants and animals that are found in northern hardwood forests and strive to maintain the biodiversity of many native organisms. For example, while selection cutting may enhance Black-throated Blue Warbler habitat it may concurrently reduce the habitat quality for other Neotropical migrant songbirds of management concern (Bourque and Villard 2001).

RESEARCH AND MONITORING

Existing Surveys, Monitoring, and Research

Considerable monitoring of passerines occurs in the Region 9. For example, 12 years of point count data has recently been collected in National Forests of the northern Great Lakes states (Forest Birds of Minnesota 2002). Other monitoring efforts are in place in other Region 9 National Forests. The Breeding Bird Survey (BBS) has been ongoing for almost 4 decades with considerable coverage in many Region 9 National Forests. An interactive web page exists for the BBS data and is a starting point for information about many passerine birds of conservation concern (Sauer et al. 2001). However, caution must be exercised since neither BBS or regional point count data are sufficient to permit the detection of trends for a rare bird such as the Black-throated Blue Warbler at the level of a National Forest. Detecting population trends of Black-throated Blue Warblers at the level of a National Forest would likely require long-term focused inventories of specific habitats.

Richard T. Holmes, Professor at Dartmouth College in Hanover, NH has been researching this species in northern New England with his colleagues and students for many years. In fact, the majority of the North American work published on this species stems from work involving Dr. Holmes. His Birds of North America account on the Black-throated Blue Warbler (Holmes 1994) has been cited extensively throughout this conservation assessment and is an excellent source for additional information on the biology of this species.

Survey Protocol

A point count methodology is the standard means to monitor most species of breeding birds including Black-throated Blue Warbler (Ralph et al. 1995, Howe et al. 1997). While they undoubtedly provide broad geographic coverage regarding the presence and density of numerous species, point counts do not address the critical issue of reproductive performance and population demographics. It is well known that the site specific density of a focal population may not be an adequate indicator of habitat quality in the absence of data on reproductive performance (Van Horne 1983). If the desire is to specifically monitor for the Black-throated Blue Warbler, more detailed studies of nest success

should be implemented. Ralph et al. (1993) provide detailed discussion of many common techniques used to monitor passerine birds, including the development of nest searching skills. In areas of its range where it is rare, particularly in the Great Lakes region, more intensive species-specific research is needed. Rare birds like the Black-throated Blue Warbler are often underrepresented in BBS routes or point counts and are better studied with a more stratified or focused research effort.

Research Priorities

Future research priorities for the Black-throated Blue Warbler in Region 9 include:

- Increased research into the ecology, distribution, reproduction, and demography of populations in the Great Lakes states
- Further investigation of the effects of landscape-scale habitat fragmentation and landscape context on the distribution and reproduction of the species
- Further investigation of the effect of uneven aged forest management practices on the species
- Development of habitat management plans for northern hardwood forests that conserve native biodiversity as a whole

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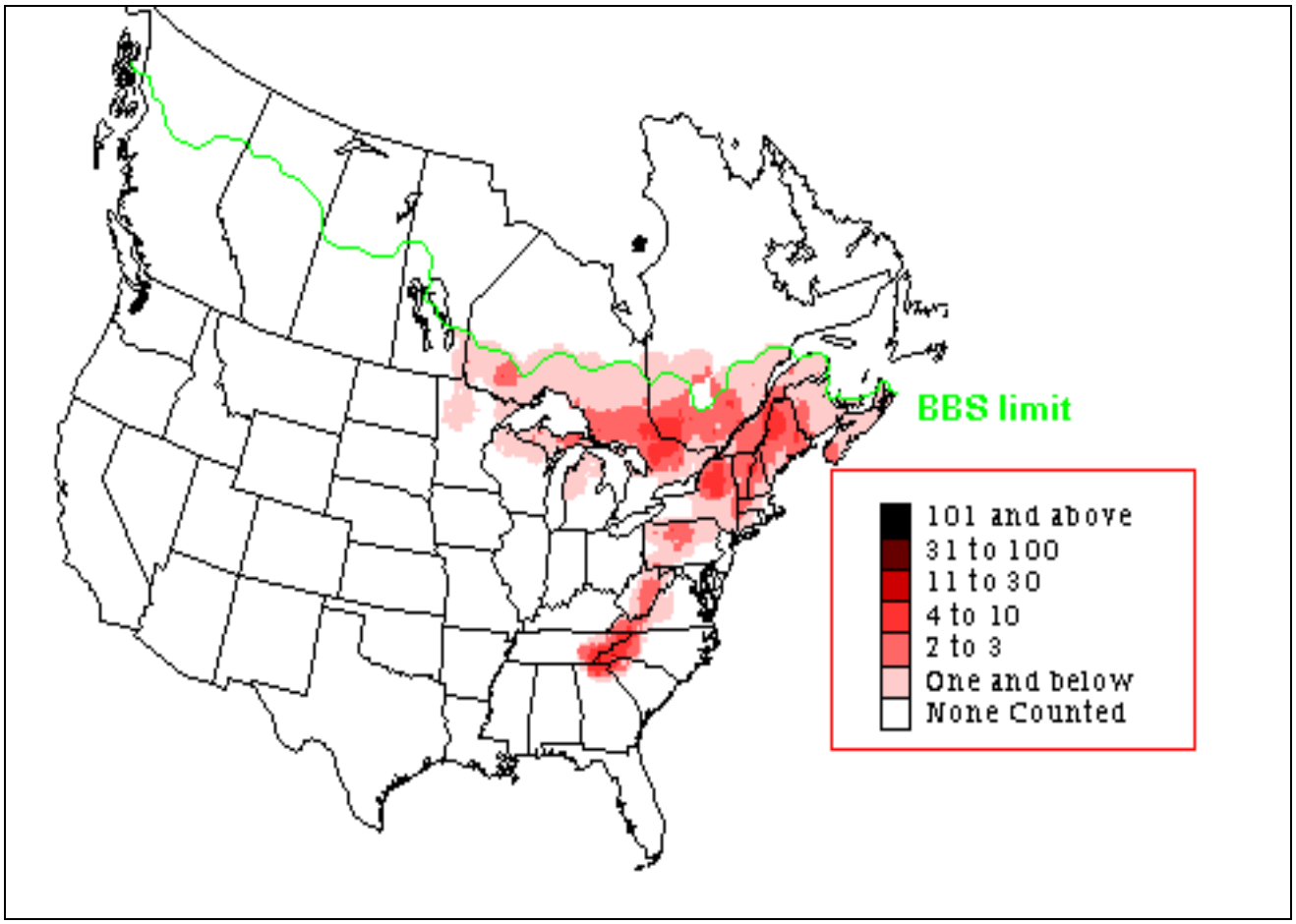
APPENDICES

Appendix 1: Breeding distribution of the Black-throated Blue Warbler as illustrated by BBS data.



Appendix 2: Population trends of the Black-throated Blue Warbler from BBS data.